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VEHICLE TECHNOLOGIES PROGRAM

2008 ANNUAL MERIT REVIEW

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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Introduction

The 2008 DOE Vehicle Technologies Program Annual Merit Review was held February 25-28, 2008 in Bethesda, Maryland. The review encompassed all of the work done by the Vehicle Technologies Program: a total of 280 individual activities were reviewed, by a total of just over 100 reviewers. A total of 1,908 individual review responses were received for the technical reviews, and an additional 29 individual review responses were received for the plenary session review.

The objective of the meeting was to review the FY 2007 accomplishments and FY 2008 plans for the Vehicle Technologies Program, and provide an opportunity for industry, government, and academic to give inputs to DOE on the Program with a structured and formal methodology. The meeting also provided attendees with a forum for interaction and technology information transfer.

The reviewers for the technical sessions were drawn from a wide variety of backgrounds, including current and former vehicle industry members, academia, government, and other expertise areas. In the technical sessions, these reviewers were asked to respond to a series of specific questions regarding the breadth, depth, and appropriateness of the DOE Vehicle Technologies Program. The technical questions are listed below.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

The plenary session reviewers were asked to respond to a different set of queries, designed to elicit their input on the overall direction of the Vehicle Technologies Program. The questions asked of the plenary session reviewers are listed below.

1. *In your judgment, what aspects of the OVT program will have the biggest impact and timely contribution to the DOE strategic goals?*

2. *Please comment on the trends over the past several years in DOE OVT funding and technical research focus. Provide your specific thoughts on the technology focus shifts (such as from combustion/emission control to plug-in hybrids, from heavy-duty to light-duty, and so on), explaining why you think these shifts in funding priorities enhance or detract from OVT support of DOE/EERE strategic goals in a timely manner.*

3. *Please comment on the current mix of activities in the OVT portfolio.*

    a. *What overall balance of research, demonstration, and deployment in the OVT portfolio should be pursued, and why?*

    b. *Should OVT place more emphasis on deployment and technology integration activities or lessen their emphasis and allow industrial partners to pursue this work? Why?*

    c. *How much high risk/high reward research (of the sort that industry would likely not perform on its own) should OVT be pursuing?*

    d. *How well does the OVT research portfolio reflect the balance of research needs for and the relative importance of the light-duty and the heavy-duty vehicle sectors?*

    e. *Are there areas of research outside the current OVT portfolio (such as pure electric vehicles, new fuels, and so forth) that DOE should consider for investments in research funds?*

    f. *Comment on the level of DOE's investment in enabling technologies (i.e., those that do not directly achieve petroleum reductions but rather enable the use of other technologies that do achieve petroleum reductions, such as materials, heat and mass transfer technologies, etc.) and the types of projects that should/should not be funded.*

    g. *Is the OVT investment in environmental and health impacts assessments of its future technologies appropriate and useful? Why?*

4. *Please provide any other comments you may have on the overall OVT program.*

Responses to the questions (both plenary and technical) were submitted electronically through a web-based software application, PeerNet, operated by the Oak Ridge Institute for Science and Education (ORISE). Database outputs from this software application were then analyzed and summarized to collate the multiple-choice, text comment, and numeric scoring responses to produce the summary report.

The report is organized into sixteen individual sections, one for each technical area (plus one section for the plenary session comments). Responses to the questions are summarized in the pages that follow, with summaries of numeric scores for each technical session, as well as text and graphical summaries of the responses for each individual technical activity. A list of the activities (and page numbers) for each section appears at the start of each section.

1. Plenary Session

Introduction

The plenary session at the Annual Merit Review included a series of presentations from DOE VT management that outlined the Program's goals, objectives, budgets, and activities. The purpose of the plenary session was twofold: 1) to provide attendees at the Merit Review with an overall context for VT mission and goals, to enhance their understanding of the more specific technical areas to be reviewed, and 2) to solicit feedback from a separate set of reviewers (separate from those on the technical review panels) on the overall direction of the VT program. For the review of the plenary session, the review panel was given a set of four specific questions for which they were to provide responses: these questions solicited written comments, not numeric assessments, so no scoring of the plenary session presentations was performed (unlike for the technical sessions, where a numeric score was included as part of the review).

Summary of Important Findings

A summary of major highlights of the responses is presented below, and a complete exposition of the breadth of comments is presented in the pages that follow.

Aspects of VT program that will impact DOE strategic goals

- Hybridization and vehicle lightweighting will make the greatest impacts on fuel use and thus on DOE strategic goals.
- Alternative fuels and advanced vehicle technologies also contribute to DOE strategic goals.
- The shift away from heavy-duty research was seen as detrimental to meeting DOE goals.
- For hybridization, vehicle electrification and battery research were seen as very important to success in meeting DOE petroleum reduction goals.
- Biofuels were also noted as contributing to petroleum reduction goals, but with cautions that environmental and food production concerns must be considered and addressed.
- Accurate economic assessments relative to vehicle technologies were also valuable to meeting petroleum goals.

Trends in VT funding and research focus

- Funding continuity for the program is critical.
- The shifts in portfolio focus demonstrate the program's flexibility to changing market conditions.
- The shift away from heavy-duty research was appropriate to some reviewers and inappropriate to others.
- Hybridization of vehicles is very important, and a research focus on energy storage and power electronics is critical.
- Hydrogen fuel cell vehicles were not seen as a priority by this review panel.

Overall balance of research, demonstration, and deployment

- The level of focus on research, demonstration, and deployment should be balanced, without focus on any one of them.
- Battery research and alternative fuel infrastructure development were noted by reviewers as specific areas for focus.
- Major external drivers on VT show a clear interest in near-term outcomes.

Relative emphasis on deployment (versus industrial involvement in these activities)

- VT should pursue more generic technology development and less company-specific activities. The industrial partnership experience is valuable, though, and the experiences should be shared across DOE offices.
- DOE and VT should take a proactive role in deployment for areas where it can have a beneficial leveraging role to play in closing the gap between laboratory settings and the commercial market.

Amount of high-risk/high-reward research

- DOE should pursue this high-risk research, as it will yield national rewards and is not likely to be undertaken by industry alone.
- High-risk research should be conducted separate from the FreedomCAR and Fuel Partnership.

Balance of light-duty versus heavy-duty research activities

- For some reviewers, there have been too many cuts in the heavy-duty research budget, perhaps pushing resources below a critical mass necessary for success.
- To others, the balance of light-duty and heavy-duty research is appropriate, but neither is funded to a sufficient level.

Additional areas of research focus

- Additional areas suggested included truck auxiliary power units/truck stop electrification, non-ethanol alternative fuels, advanced engines and combustion systems (including diesel-like combustion, batteries for pure electric vehicles, and carbon management modeling.

Investment in enabling technologies

- Enabling technology investment levels are appropriate. Additional areas for consideration in enabling technology include fuel blend impacts, traffic gridlock solutions, truck auxiliary power units, and biodiesel from non-food crops.
- Enabling technology research is a high priority, but should not be solely the funding responsibility of VT. Other DOE offices should participate in funding this research.

Appropriateness of health impacts research

- The health impacts work is useful, appropriate, and (to some reviewers) absolutely necessary.
- Health impacts assessments should be an integral part of VT thinking and planning.

Other comments

- The VT program is well managed and effective, but funding resources are limited.
- The broad scope of the program brings with it management challenges both in having sufficient resources overall to meet the needs of the scope and in prioritizing work to make best use of resources to meet the needs of the scope.
- Energy legislation in recent months is sending signals for the government to take a more active role in energy R&D.

Detailed Summation of Plenary Session Review Comments

The paragraphs below present the complete responses of the Plenary Session reviewers from the 2008 DOE Vehicle Technologies Annual Merit Review, arranged by question in logical subject-related paragraphs. Although the paragraphs below are not arranged in quotation form, they are the words of the plenary reviewers as received through the PeerNet system, with some grammatical adjustments and some efforts made to remove clues to the identity of the various reviewers. Important conclusions or observations of a reviewer or reviewers are emphasized throughout the text with sidebar text boxes.

Question 1: In your judgment, what aspects of the VT program will have the biggest impact and timely contribution to the DOE strategic goals?

Multiple reviewers indicated that the hybridization of both light and heavy duty vehicles combined with light-weight, less-expensive structures (such as carbon fiber composites) will make the greatest impact on reducing fuel usage in the shortest time. A reviewer indicated that a priority should be to make LDVs not only efficient but also safe. Of the presentations at the Plenary Session 1, he stated that there was not a single mention of safety, and yet that seems to be one of the principal impediments in the minds of many consumers against buying small, efficient vehicles. The public impression is that occupants of a small vehicle will be killed in a collision with an SUV or heavy truck. Technology has brought safety of LDV's a long way since Ralph Nader's "Unsafe at Any Speed," and surely more can be done. He cites a paper by Tom Wenzel and Marc Ross, "Safer Vehicles for People and the Planet" in American Scientist, vol. 96, p122, March-April 2008 edition.

Similarly, one reviewer wrote that VT needs to continue to emphasize making vehicles lighter while maintaining or improving their safety. He states this should not be done in a piecemeal fashion, but in a systematic approach for the entire vehicle. The materials chosen can be any combinations that meet the goal. A lighter vehicle can have smaller displacement engines and the fuel economy of the vehicle goes up correspondingly. A key enabler will be the introduction of fabrication, assembly and joining technology in support of lighter vehicles. The manufacturing technology must be less expensive than the current high legacy cost manufacturing systems being used. The manufacturing systems must be flexible so that they can rapidly accommodate shifting consumer preferences at minimal cost. He goes on to state that sales forecasts are made years before the first vehicles hit the road, and "they are always wrong." If the forecast calls for high sales volumes then tremendous capital outlays are made and must be amortized over the predicted forecast. If actual sales are much lower, the manufacturer loses significant profit. Conversely, if sales forecasts are low for niche markets and demand exceeds supply, the manufacturer must be able to respond very rapidly to the higher customer demand.

Hybridization and vehicle lightweighting will make the greatest impact on fuel use.

Again, another reviewer indicated that lightweight vehicles and hybridization will have the greatest and most immediate impact on oil reduction. He added that the public also needs to become comfortable driving lighter vehicles despite perceived safety concerns (the belief that heavier is safer). Comparison crash tests of light, strong vehicles versus heavy vehicles need to be demonstrated, perhaps in a way similar to the sensational 180 mph crashes at NASCAR and Formula 1 where the driver "walks away."

One person commented that strategic goals (including energy diversity and environmental impacts) have tremendous impacts on the program's worth. He went on to say that the advanced vehicle technology programs should have increased emphasis particularly because of CAFE standards and energy demand.

Electrical vehicle technologies, fuel efficiency, and alternative fuels were all indicated as important aspects of the VT program. One person simply listed the following aspects as the entire response to the question: PHEVs, Batteries, and Advanced Combustion Research. Another wrote that the use of alternative fuels and advanced vehicle technologies are very critical to the achievement of DOE's strategic goals. One reviewer noted that, over the long run, more efficient engines and fuels that are alternatives to petroleum will have a large impact.

Expanding on these topics, one reviewer wrote that alternative fuels and advanced vehicle technologies elements significantly contribute to DOE goals and the great decrease in funding for heavy-duty truck research is a significant concern to him. The shifting of DOE funding to more near-term implementation and deployment is considered unhealthy for the DOE government funded formula. This work is important, but it manipulates the "competitive commercial world" without always allowing support for "government" pre-competitive high-risk, high-payoff work that no one will properly pursue for the good of society in general without government funding.

Alternative fuels and advanced vehicle technologies contribute to DOE goals.

Vehicle electrification and battery research are important: batteries are critical to PHEVs.

One reviewer did not feel that there was quite enough information to comment on this topic appropriately. He wrote that the Fuels Technology, Technology Integration and Advanced Combustion Engine program presentation did not disclose the full range of potential program options nor did it provide a comprehensive list of current projects or project areas/objectives. Consequently, he wrote, it is difficult to view and evaluate the present program in these three areas in a holistic way.

This reviewer added that, regarding "timely contribution," materials technology work and battery research have a longer-term impact horizon in general than does the work on hybrid electric vehicle systems (similar to earlier comments). However, the impact time horizon of the program portfolio depends on the mix of specific projects being funded.

Shift to near-term implementation is "unhealthy". Shift away from heavy-duty work is a concern.

Similarly, another reviewer found it difficult to tell (upon reviewing the presentations) which aspects of VT had the largest impact on DOE strategic goals. The reason was that he did not have a copy of the Phil Patterson presentations, which should be the basis for drawing such conclusions. In retrospect, he thought, the Patterson presentation perhaps should have come earlier in the sequence of presentations. Also, in considering the impact on DOE Strategic Goals, this reviewer tends to look at it from the perspective of impact on energy markets, since the DOE Strategic Goals can change over time and are likely to change in response to changes in energy markets, as well as changes in legislation and government policy. Nonetheless, this reviewer thinks that electrification of the vehicle fleet would seem to have the largest impact on energy markets, so it would seem appropriate that this area have a heavy emphasis in the VT portfolio.

Two reviewers commented on the importance of advanced batteries, with one stating that they would improve the HEV's performance, and of course are critical to PHEVs. Another person stated that both advanced batteries and super ultracapacitors should be in the program. To make a PHEV work takes a storage device with about 600 W/kg power density and an energy density of 80-100 Wh/kg. He notes that it must also be economical to the application – a worthy challenge, and he hopes DOE gets there first.

A reviewer commented that the success in developing plug-in hybrids and creating liquid fuels from non-food (biomass rather than corn) sources both appear to have the biggest potential impact and timely contribution to the DOE strategic goals. However, he adds, there are additional considerations, outside of the scope of the EERE programs, which need to be recognized to achieve overall success for DOE, specifically related to how cleanly the electricity is generated. He referenced an article from the March/April 2008 Technology Review, entitled, "Tailpipes vs. Smokestacks," which presents estimates for emissions from conventional vehicles, from hybrid-electric vehicles, and from plug-in hybrid electric vehicles with electricity generated from eight different possible technologies. With conventional coal combustion generating the electricity, total emissions are estimated to be less with the hybrid electric vehicle than with the plug-in hybrid. As such, he concludes, technologies related to electric power generation, which are outside the scope and control of VT, must succeed in order for plug-in hybrids to contribute to a net reduction in automotive emissions.

Another reviewer stated that the biggest impact potential of current programs is likely in the bio-fuels area. He indicated that success here would impact cost, availability, green economy, and political/strategic security directly. All other areas of research have major industrial competitive challenges and EPA vs. green conflicts that will likely be settled by complex global industrial competition. He adds that picking the "right" technologies to back will always be problematic.

Biofuel environmental and food production impacts must be considered.

One person noted that, over the last two years, much new information has emerged that indicates that, in general, renewable fuels production is leading to "environmental disaster" in terms of impact on both total world system CO_2 burden and impact on water, specifically on oceanic life systems and interaction with CO_2. This is in addition to the more widely discussed impact on food production and world food prices and availability. (The reviewer has been tracking findings from Europe in some detail.) He believes that new fuel sources will be developed from feeds other than biofuels, and biofuels will become much less attractive as the full impact of their production becomes more widely understood. At the same time, it is becoming clear that technology is emerging from several sources that cleanly and cost effectively produce refinery feeds from tar sands, oil shale, coal, and very likely lignite. North America is far richer in these materials than any other region of the world, and program activities that link with this development will likely have by far the biggest impact on achieving DOE strategic goals.

PHEVs and biofuels (especially from non-food sources) are critical to DOE goals.

Regarding Ed Wall's presentation, one reviewer comments that the VT program on the whole is well balanced, with the R&D in Hybrid & Electric Systems, Materials Technologies, Fuels Technologies, and Engine & Emission Control Technologies all having the potential of making a significant impact. The Analytical Studies part plays an important role in providing scenarios of future impacts. What VT does not appear to provide are opportunities for small projects that explore innovative concepts that not covered by the current program. Mr. Wall mentioned STTR and SBIR, but these programs do not give a direct opportunity to universities and National Labs.

One person stressed the specific importance of applied research aimed at developing measurement and characterization capabilities such as combustion chambers and engines, coupled with advances in

diagnostic tools, predictive modeling and synergistic coupling of these efforts. He believes that the current VT program in these areas is highly laudable and should be expanded relative to specific, single-company-centric projects that are often better classified as product development.

The final reviewer began by stating that this briefing was critical to providing a wonderful mechanism for decision-making regarding factors including individual scenario selection and its "payoff" in various categories: cost, availabilities and long term supply/demand, societal benefit in general, etc. It is unfortunate, he comments, that the reviewers did not receive a handout of Phil Patterson's presentation.

He writes that (while he is not a modeler) he is well aware from others (not associated with VT) that NEMS is hard to use, not easy to modify, and can have buried assumptions. He is also aware that almost all predictions concerning energy "have been wrong." Still, having said the above, he is also of the opinion that developing scenarios remains very important in helping to understand what the consequences might be of not only new technologies but also energy policies. He encourages VT to continue such analyses.

Continuing, he writes that the plenary presentation on analytical studies consisted of an interesting discussion of various analysis methods and functions with EERE related to VT programs. The presentation did not, however, provide any overall understanding (for this reviewer) of how (or whether) systems analysis is used in VT to make management decisions on the portfolio. In addition, the presentation did not provide any numerical results showing the projected impacts of various lines of research or key technologies and how they contribute to the VT goals. Therefore, this question about impact and the following ones on priorities could not be addressed by this reviewer except in a rather "visceral" manner.

VT can provide value through accurate economic assessments.

This reviewer believes that accurate economic assessments will be among the highest value outputs that VT can provide to the nation. The combination of technical information available from the DOE and its partners puts VT in a unique position to develop unbiased assessments of likely consequences of technical deployment and policy encouragement scenarios. He appreciates that policy makers will not always listen to good advice, but the first step must be to develop such device so that the public can hold them accountable when they fail to listen. He applauds the return to VT of Mr. Patterson and encourages the expansion of his rather modest programs.

He also believes that some elements of economic analysis should be applied to DOE/VT funding decisions. He was not satisfied that Mr. Wall's criterion for funding choices (the bottom line is reduction in fuel usage) would be sufficient to make any but the most global choices. Program managers at all levels could benefit from assessments of likely technology adoption based on informed industrial economic judgment. Retrospective studies, even though they are anecdotal, would help to inform the PMs as well as the public of the value of DOE investments and the pitfalls associated with transition to actual deployment.

Question 2: Please comment on the trends over the past several years in DOE VT funding and technical research focus. Provide your specific thoughts on the technology focus shifts (such as from combustion/emission control to plug-in hybrids, from heavy-duty to light-duty, and so on), explaining why you think these shifts in funding priorities enhance or detract from VT support of DOE/EERE strategic goals in a timely manner.

Multiple reviewers commented on the importance of funding continuity. One person wrote that it is always very important to any successful program; however, because of the government realities of funding, an attempt to maintain alternate strategic (with decreased or increased funding realities) paths in place is important. Another reviewer added that funding continuity is key to any program success over time, but in general a decrease (with little time notice) is hugely negative to any "strategic" plan to be executed. One reviewer noted that the increase in Congressional plus-ups for DOE presents a great danger to any funding continuity or serious strategic goal pursuit. One other person noted that Ed Wall's discussion about a "relatively" stable DOE budget except this year (30 million dollar loss in hydrogen programs and increased emphasis in plug-in hybrid and alternate fuels / biofuels) was quite helpful. In fact, the reviewer added, his input provides data to support the strategic funding continuity of the program in most of the program elements over the past few "decades."

Funding continuity is critical.

One reviewer commented that the Budget Summary for Fuels Technology shows that the Budget Request for FY09 is down somewhat from FY08 and FY08. He noted a similar trend for Advanced Combustion Engine R&D. While he realizes that these budgets are not under VT's control, he indicated that these trends are still disturbing as petroleum usage and engine emissions are long term issues.

Three reviewers had general comments regarding overall funding trends. One person indicated that funding trends in this area clearly reflect the shift from more basic R&D to applications, integration and commercialization. However, he added, the large (%) increases in Technology Integration may or may not be warranted. The program should review this strategy based on the track record and future potential effectiveness of Technology Integration activities. Unfortunately, he adds, the Plenary presentation did not provide any insight on these activities. Given the Renewable Fuels Standard, there is a danger that DOE efforts in the Fuels Technology area will be overtaken by events. This could be extremely problematic given the potential that market forces, in the absence of a fuels technology breakthrough, could produce very disruptive changes to food supply and land use. The Fuels Technology Element should look well beyond the short-term ethanol, gasoline-substitution solution and focus on accelerating fuels options with long-term potential.

A second reviewer commented that Mr. Sullivan made clear in his remarks that the "pendulum" had swung very strongly in the direction of near-term goals. While the reviewer indicated he was not sufficiently familiar with the details of the portfolio to judge, based on some brief attendance at sessions later in the week he would agree that the work is strongly near-term. However, the time-line for new materials (such as carbon fiber composites) introduction is generally even longer than most other new technologies, so making this work more near-term is highly desirable.

The portfolio shifts demonstrate responsiveness to changing conditions.

A third reviewer added that it was clear from the presentations that there have been significant shifts in recent years in the VT portfolio. He thinks that this is

generally a good thing, as it indicates that the program is being responsive to changing external dynamics. If electrification indeed has the potential to have a significant impact on energy markets, then the shift from combustion/emission control to plug-in hybrids is the right move. Also, while the program has done a lot of good work in the heavy-duty vehicle area, it also is clear that there is a greater need to focus on light-duty vehicle technology. That is not to say that there do not remain significant R&D opportunities in heavy-duty vehicles; rather, it is just that, given budget limitations, the priority needs to shift to light-duty vehicles. Ultimately, these shifts appear to be in the right direction regarding meeting national energy policy goals and impacting energy markets.

Regarding the value of heavy-duty vehicle research, some reviewers disagreed with the above assessment. One asked, "Why the large reduction on heavy-duty vehicles?" Another commented that too little effort is being given to heavy-duty vehicles, where fuel economy pays for itself very quickly. The electrification of heavy-duty trucks can make them more fuel efficient and reduce the need to run engines at truck stops for hotel and refrigeration loads. Partial hybridization for creeping in congested areas and for regenerative braking will make a difference.

Many reviewers felt more heavy-duty research was needed. A few felt even more of a shift to light-duty was appropriate.

One person added that, in terms of the shift from heavy-duty to light-duty, he thinks the heavy-duty program has made a huge technology impact as relates to diesel, such as fuel consumption and emissions reduction. The findings from this program have led the world to make huge strides in light-duty fuel economy improvement, while in the U.S. this progress has not been effectively implemented in light-duty. A much more effective strategy for DOE would be to continue to push learning in a robust heavy-duty program, but to also drive hard to move the resulting learning to the U.S. light-duty community.

Another reviewer believes that combustion engine system improvement, including the required fuels and emissions controls, is still the most effective way to deliver DOE goals. Hybrids are a viable and important part of that logic thread. The potential impact of pure hybrids is small by comparison, for a variety of very good reasons, but this potential impact is real and should be pursued in proportion to the relative potential impact. One other person comments that the funding shifts are understandable, given pressures from high levels within EERE and from Congress. However, R&D on combustion and emissions can have a nearer-term significant impact than PHEVs. Of course, PHEVs will have internal combustion engines that could also benefit from the combustion and emissions R&D. In this respect, it is disappointing for this reviewer to see the DOE Request for Engine & Emission Control Technologies to be lower than the actual funding for FY07 and FY08.

In contrast, another person notes that the decrease (FY 2007 Appropriation to FY 2009 Request) in the Engine and Emissions Control Technologies budget should have the least overall impact on the program, because the industrial participants in the program should be able to make up for any shortfall in this area. He adds that the other three program areas (Fuels Technologies, Materials, and Hybrid and Electric Systems) show slight increases, and that this is appropriate given the expectations for success.

Multiple reviewers commented on the important of hybrid and plug-in hybrid vehicles. One person states that the hybridization of vehicles is critical, and that both Honda and Toyota have already

demonstrated the direct impact on the marketplace and the halo effect on their brands. The domestic automakers started their hybrid vehicle propulsion programs in partnership with the DOE in 1993. But now, the reviewer asks, where is the deployment? The lead time for maximum market penetration of new technologies is about 15 years, and yet we are just now seeing initial deployment of these vehicles. What have the OEMs been doing? Hybridization of lighter weight vehicles as mentioned in question #1 will provide additional fuel economy gains. Lighter vehicles will also make all-electric or plug-in hybrids more attractive to the consumer as range increases in all electric mode. To this reviewer, hydrogen powered fuel cell vehicles will just be a curiosity until reformers of other liquid fuels are cost competitive and durable. Another reviewer adds to this by stating that the increasing focus on plug-in hybrids is generally appropriate because this technology can have (depending on how it is deployed) a more immediate impact on petroleum consumption (efficiency) and a less disruptive external impact (fuel feedstock) than some other technologies and projects. Another reviewer states that there needs to be more focus on all-electric vehicles with a range of greater than 60 miles. This requires better batteries and power electronics that are capable of supporting a vehicle's hotel load requirements.

Hybridization of vehicles is extremely important. Energy storage and power electronics are key technologies.

One reviewer agreed that the keys to hybrid vehicle propulsion systems are power storage and power electronics. The research seems well-balanced with work on new materials for battery development and power electronics. One concern this person has is the traditional operating mode of the domestic auto industry of trying to leapfrog the competition by introducing an all-new model that incorporates many new technologies at one time. By the time the leapfrog program is ready, the competitors will have already surpassed the point where the new technology is intended to go by incremental improvements and multiple iterations. Then when the leapfrog technology does hit the market, there will be the inevitable glitches multiplied by the number of new technologies multiplied by the changes in the manufacturing processes. The reviewer is concerned that as more PHEVs are in the market, what will be the effect on the electrical grid? There are parts of the country that are already near capacity to transmit electricity. As many commuters come home from work at 4 – 7 PM, an already tight system (especially with summer air conditioning loads) may be overwhelmed.

There were differing opinions on the role of hydrogen fuel sources. One reviewer stated that hydrogen is too expensive, has no delivery infrastructure and is usually made from other fossil fuels with the corresponding emissions being worse when CO_2 capture is not being used. He adds that storage of hydrogen onboard a vehicle and at refueling facilities still need to be addressed. Following up on this, another reviewer noted that there is a large emphasis on hydrogen-powered fuels cells and the refueling infrastructure. The single laboratory with the most experience in hydrogen and its effects on materials is Savannah River National Laboratory. The high pressure laboratory at SRNL is designed to test high pressure vessels to burst. Their sensor technology can be inserted into these high pressure vessels to make them smart hydrogen storage tanks.

Another reviewer stated that the trends away from hydrogen are very positive. The challenges of infrastructure development and hydrogen storage are most formidable and the probability of success seems very low to him. He adds that the trend away from 21st-Century Truck is a mistake in his view. The truck program should be aimed at safety first, efficiency second and multimodal capacity third. He asks, are cooperative programs with DOT adequate? He didn't hear much about interagency partnerships.

Some reviewers felt there was insufficient data presented to highlight the magnitude of the funding shifts and to identify R&D areas being reduced or terminated in the VT program. Therefore, they said, it was virtually impossible to assess the appropriateness of these trends. One person commented that, as was indicated, funding has not really changed much over the last several years when viewed globally, with earmarks more significant than changes in regular appropriations. The reviewers were led to believe that shifts had taken place on a more detailed level, but no history or justifications of these changes was shared, so he cannot really address this question.

Hydrogen fuel cell vehicles were not seen as a priority to these reviewers.

Another reviewer summarized the changes to this part of the VT program as: (1) a shift in emphasis to commercialization and away from R&D and (2) a reduction of effort on heavy-duty vehicles. In general, DOE's commercialization efforts should flow naturally from progress in the technology development projects and focus first on those technologies in which DOE has invested. Such efforts could include technology demonstrations, market demonstrations, promotion, financial incentives, etc. Beyond that, general commercialization efforts (e.g. PHEV value proposition and integration studies) should be undertaken if additional funding is available. (However, knowledge of the PHEV value proposition and grid integration should be known at the outset to some degree – as a prerequisite to funding any R&D work in the area. Hopefully, the planned new emphasis in this area will build on existing knowledge to a large degree). Both elements of this part of the VT program have received significant funding increases from 2007 to both 2008 and the 2009 request. On a percentage basis, these increases are considerably greater for the Materials Technology element. It is not clear to what extent these increases support the stated goals.

Question 3: Please comment on the current mix of activities in the VT portfolio.

Question 3a: What overall balance of research, demonstration, and deployment in the VT portfolio should be pursued, and why?

Many of the reviewer comments centered upon the balance between funding basic research versus funding demonstration and deployment projects. Generally, reviewers agreed the balance between research, development, demonstration and deployment (RD^3) was critical, with one reviewer commenting that it also depends upon forging the right partnerships with industry. One person commented that the demonstration of a few technologies followed be full-scale deployment is of exceptional importance. A few reviewers felt that they had insufficient information to make a judgment.

One person wrote that, while DOE is being directed to more short-term deployments, he believes that their balance should emphasize research more in concert with industrial work and goals. Another added that he recognizes that there are pressures external to VT to move in the direction of deployment. But the nation, the world, and DOE are in for the long haul in reducing petroleum use by and emissions from vehicles. That perspective, the reviewer states, calls for a robust and well-funded research program. One reviewer added that he believes that the high-risk component of research should be most

A balance between basic research and demonstration work should be pursued, without undue emphasis on one or the other.

emphasized by DOE (government) funding. Another person commented that the critical added-value function for DOE is research that is focused on industry needs and is well suited for application. Demonstration and deployment are critical, he adds, but cannot total more than about a third of the total activity without seriously impacting the value of the Office.

Other reviewers were of a differing opinion, with one stating that research should be 10- 15% to quickly cull the choices for additional funding, and demonstration should be no more than 25% - these are usually a handful of products to demonstrate that they perform and get the "gee whiz" factor up. This reviewer adds that deployment is the most critical phase, as this is where the largest investments on the part of manufacturers must be made and where the most help is needed for rapid deployment of developed technologies. DOE can build some incentives for manufacturers that are first to market with technologies that have specific performance goals and rewards. Another person commented that this is not a basic research program in the NSF sense of that phrase. It should continue to address well-defined goals with milestones. On the other hand, he doesn't believe that it should be a product development program either. Some of the programs he viewed later in the week seemed to be of that type.

Another person commented that the VT program is heavily weighted towards demonstration and deployment. From an overall DOE perspective this is balanced by a strong basic research program sponsored by the Office of Science. He could not tell from the discussions at the peer review meeting whether the principal investigators or the DOE program managers had a good awareness of the Science sponsored basic research program. Certainly, with the VT program more commercialization focused, a good awareness of the SC sponsored basic research programs would be beneficial. One reviewer added that he believed that the DOE funding fraction should be more heavily based in pre-competitive high risk/high payoff programs but with strategic goal relevance that is closely tied with the "relevant" industrial partners.

One person commented that he was very uncomfortable with the description by Mr. Goguen of certain programs characterized as "promotion" of E85 and a "marketing campaign" for light-duty diesel technology. This language, the reviewer notes, if not the programs it refers to, has all of the evidence of the government picking market solutions – just the opposite of what he would expect from an VT that is listening to and assisting industry in technology development.

From a broader approach, one reviewer stated that this is a nearly impossible question to answer. The answer depends on a number of factors, including: the status of critical technologies, both within and outside the DOE R&D portfolio, the business climate, market trends, and the external regulatory environment. And all these factors are continuously evolving. For example, recent major legislative initiatives (EISA and its RFS) could have a significant impact on the nature of the DOE RD&D portfolio. One could argue that regulatory mandates REDUCE the need for DOE investments in certain R&D and commercialization efforts because industry is required to do it anyway.

To some, battery research is critical. To others, development of alternative fuel infrastructure is an important focus.

Regarding specific focuses, one person indicated that the continued development of improved batteries is important to hybridization and all electric vehicles for commuter use. Validation testing at

third party facilities is critical to determine performance vs. claims. He goes on to say that more emphasis must be given to making the entire vehicle safe and lightweight at attractive manufacturing costs. Some of this can also be done with parts consolidation. The balance sheets and market values of domestic auto manufacturers require major cost reductions that can be introduced one vehicle platform at a time. As experience is gained new insights and cost reductions can be applied. This can be a self-funding righteous circle. Possibly government guarantees of loans to convert to lightweight hybrid vehicles will jump start the process. Conventional technologies used today estimate the cost of introducing a new vehicle to the market as over $5 billion and because of capital constraints can take 5 – 7 years to deploy, while Toyota may be in its second or third iteration of a similar vehicle. This budget, the reviewer adds, is off by two orders of magnitude. These three items indicate that most activities be directed to demonstration and much more to deployment.

Another reviewer began by stating that millions of FFVs will be manufactured in the next few years. The deployment of fueling stations to enable these drivers access to the fuel will be critical. There is no value to new car manufacturers of the effects of fuel blends on vehicles five or more years older. This is an area in which VT should lead.

One person stated that the scenario modeling for fuel usage of this briefer was excellent. He also believes that the modeling should include: semi-autonomous and intelligent highway scenarios that "eliminate or at least minimize" the gridlock (and fuel usage impacts) of increasingly dense vehicle environments (urban as well as highway).

Lastly, one reviewer offered a multiple-part response regarding the VT portfolio. He states that, looking at the major external drivers on DOE and VT – namely energy market conditions and recent changes in energy legislation – there is clear interest in more nearer-term outcomes. DOE's historical track record has not been good in this area – this goes without saying, according to this reviewer. However, it does not mean that DOE/VT should not attempt nearer term demonstration and deployment programs. It just needs to be done more smartly. He recommends that VT consider three ideas in this regard.

(1) The first is some form of rapid prototyping initiative, i.e. taking research results and moving them more quickly into engineering development. He would recommend that DOE take a careful look at the DARPA experience in this area, and see if there are lessons learned that can be adapted to DOE/VT.

(2) The second idea is to conduct some planning studies in anticipation of a greater thrust in demonstration/commercialization activities. Three possibilities: (1) analyzing the types of partnerships and demonstration programs conducted by the Japanese and Europeans; (2) doing (or updating) studies of deployment incentives (beyond tax credits); and (3) analyzing (or updating) analyses of opportunities to accelerate fleet turnover (i.e. take greater advantage of technology that already is commercial or near-commercial). These analyses could be very helpful in informing future decisions on the program, and also plans and actions by a new Administration.

(3) The third idea is to develop possible benchmarks for determining if and when demonstration and commercialization efforts are successes or failures. Specific ideas for setting benchmarks may emerge from the VT bus program, or from the studies and analyses described above. It also may be appropriate for VT to conduct some case studies of experiences in other federal or state agencies and programs.

Question 3b: Should VT place more emphasis on deployment and technology integration activities or lessen their emphasis and allow industrial partners to pursue this work? Why?

Reviewers indicated a wide range of opinions regarding VT's role in deployment and technology integration activities. Some people indicated that VT needs to allow manufacturers to do the deployment and integration; industrial partners must ultimately do the work because they know the market, the processes and how to reduce the manufacturing costs and increase the overall quality of the product. One reviewer added that the systems modeling work developed at the national laboratories can enable industry to speed up deployment and system integration. Another person stated that the emphasis is now too short-term and too focused on deployment, and that this will dramatically decrease the impact of the VT if this emphasis is pursued for as much as even two years. Others indicated that industrial partner work was critical and that more emphasis should be made in this area, but expressed concerns about using up DOE's precious funding for short-term industrial demonstrations.

VT should pursue more generic technology development and less company-specific activities.

A major concern of reviewers regarding VT involvement in deployment projects was in those situations where only one corporate entity was involved. One reviewer indicated that, in general, he favors government funding on generic technology enablement, not deployment. Shared demonstrations with many industrial partners involved are again preferable to single company product development. Another person added that there was too much emphasis on deployment in some of the research programs he viewed later in the week. In general, programs primarily conducted within a single company are highly suspect in his view as a part of this portfolio. One other reviewer commented that there should be less emphasis on deployment of specific configurations of engines. These are the things industry can and should do using technologies developed by or with the DOE. He was particularly uncomfortable in discussions during the week in which single companies were working on projects that could not be disclosed with likely competitors. Given the limited VT budget, he would encourage continued emphasis on generic technology development, development and sharing of diagnostic and modeling tools, and multi-company shared demonstrations efforts.

In general comments, one person noted that the Budget Summary for Technology Integration shows this area growing relative to the R&D areas. He added that things do not seem out of balance at the present time. Another review stated that this area is an important element but should probably not be increased. However, the industrial partner element is indeed critical to the overall commercial spin-off potential.

Industrial partnerships are valuable. Experience with these should be shared across DOE. These partnerships should have a deployment element to get technologies to market.

Some reviewers suggested the DOE / VT should take a proactive role in the scenarios where it can be of most benefit. One reviewer wrote that, in general, industrial partners should be expected to take the lead in commercialization. However, this does not mean that DOE should not undertake deployment activities on a selective basis. DOE should undertake deployment activities when and where it has a unique role to play or when industrial partners have not moved forward. Another person stated that industrial partners are critical, and VT is never going to be able to compete with the

DOE and VT should take a proactive role in areas where it has a beneficial or unique leveraging role to play, closing the gap between laboratory and commercial markets.

resources available to the vehicle manufacturers. VT should seek opportunities where its funding will leverage support from industry. One other reviewer commented that DOE efforts on deployment and technology integration should first address critical needs arising from the DOE R&D program – to close the gap between the laboratory and the commercial market for technologies in which DOE already has a considerable investment of taxpayer money. Secondarily, DOE should then undertake only those generalized deployment activities for which a DOE role is critical or unique and which history has shown are effective in transforming the market. DOE should be highly selective and concentrated in its deployment efforts. Successful market transformation requires large investments and it is very easy to spread resources too thin.

The role of manufacturers / industrial partners was also a source of significant interest for the reviewers. One person stated that it seemed over the past three or four decades DOE has experimented with many approaches to deployment and technology integration. The key is flexible partnerships with industry, particularly small companies because they are the most innovative and hungry. The relative share of the funding burden can be adjusted on the basis of individual project or program requirements, but industry should always be required to pay its share. VT has a wealth of relevant experience deriving from PNGV. Are experiences and techniques shared across the Department? What can VT learn from FE, for example? Another reviewer, more bluntly, stated that VT should have a "big stick" nearby to remind manufacturers of the investment in this partnership. Similarly, one person commented that deployment is where the rubber hits the road. Future R & D collaborations with auto manufacturers should have a deployment clause in them so that when the goals of the collaboration are met then these should be in vehicles within an agreed period of time. The penalty may be to revoke some or the entire governmental share of the collaborative funding. High-risk projects can have different terms than lower-risk projects. Why? Too often the developments sit on the shelf waiting for the next major platform change for insertion. By then those that are familiar with the technology may have already moved on to new assignments. One other reviewer wrote that industrial partners should be willing to do more of the deployment work when they identify a technology they believe to be profitable, but noted that technology integration may still require strong DOE input.

Lastly, some reviewers suggested a more proactive role for VT in this area. A reviewer commented that industrial partners are very important, but advanced technology efforts at DOE should not be deemphasized because industries are not necessarily inclined to properly assess these technologies without DOE core funding support. In a similar vein, one reviewer wrote that deployment should be emphasized with the manufacturers. They prefer to remain their comfort zone, even while the company is being downsized. They will keep doing that which they know and feel threatened by revolutionary change. Another reviewer commented that it's all about deployment, stating that we already have a "crippled industry." Others suggested specific roles that the government can play in the deployment activities, with one reviewer writing that the industrial partners need access to loans to rebuild their factories to be ready to incorporate the new systems that are being made available. Most industrial partners have poor balance sheets and may not have access to borrowing funds. Many parts manufacturers have already moved off shore and may need incentives to bring the jobs back to the

USA. A form of loan guarantee made by the Federal Government may be what will have the most impact. Similarly, one person suggested changes in IRS rules to enable corporations to more rapidly write off capital equipment.

Question 3c: How much high risk/high reward research (of the sort that industry would likely not perform on its own) should VT be pursuing?

Multiple reviewers commented on the importance of DOE's role in high-risk/high-reward research, with the general sentiment being that, if DOE does not pursue this type of fundamental work, the high-risk technologies developed will not be properly pursued and/or assessed by the industries themselves. One reviewer commented that DOE should be heavily involved in high-risk/high-payoff efforts with industrial partnership. Another individual wrote that this is the area he believes should receive the major attention. In general, industry consortia working with the Labs is a pretty good model for establishing targets, and the VT is to be commended for this strategy. Another person indicated that difficulty in commenting on this item without information as to relative funding levels within VT. He adds, on the whole, however, it's very important for EERE generally, not just VT, to pursue high-risk/high-reward research as the nation and world are in this for the long haul. One other reviewer stated that high-risk, high-payoff research is indeed important and he believes that the amount of funds in this category should be increased to better reflect the governmental "pre-competitive" nature of DOE's mission.

High-risk research is important since industry is not likely to undertake this work, and it can yield rewards for the nation as a whole.

One reviewer stated that, at one time, EERE did have a high-risk/high-reward research program. Called ECUT, this program was more applied than anything sponsored by the Office of Science, but more fundamental than the core EERE research programs. The Office of Fossil Energy (FE) also used to sponsor such a program. He added that, in the case of FE, they found that a high percentage of the high-risk research programs moved into the core research program and eventually resulted in products that moved into the market place. So, the high-risk research programs were indeed high-reward. Thus, based on experience, there is merit to dedicating a portion of the budget to high-risk/high-reward research. Finally, similar to above, he states that industry in general is unlikely to sponsor such high-risk research even with the prospect of a high reward.

Reviewers generally agreed that DOE should pursue a significant amount of "pre-competitive" high-risk/high-payoff research, with one reviewer adding that it is safe to state that DOE should fund more unique research in general – starting with the highest priority areas of the DOE strategic plan in VT. Another person indicated that he believes that on the order of 10% to 20% of the portfolio of VT should be of this nature (high-risk/high-payoff). The bulk of the portfolio should be focused and implementable R&D, perhaps another 60% to 70%. The remainder, perhaps 20% to 30%, should be deployment and integration. One reviewer suggests a budget of 5% of the total be for pursuing new ideas and conducting Pasteur Quadrant-like research cooperatively with the Office of Science. He suggests a LDRD seed money type program be developed to stimulate new ideas, adding that SBIR is not the same thing. The money could fund projects in industry, academia or in the Labs. LDRD has been enormously productive over several decades. He asks, why not use the idea and expand on it? One other reviewer states that high-risk, high-reward research should always form a credible part of the VT portfolio. In terms of funding, he indicates that 15 - 20% would seem to be a reasonable target

number, depending on exactly how the program defines "high risk, high reward." Does this term include all basic and applied materials, fuels and combustion research, or just the more far-out conceptual projects? The specific magnitude of funding also depends partly on funding levels by the Office of Science in VT-related areas. VT should work closely with OSC to gain as much "basic" research funding as possible in areas related to transportation technologies, pushing the envelope between basic and applied in VT's favor as much as possible.

Multiple reviewers indicated that none of this high-risk/high-reward research should be with the FreedomCAR partnership. One reviewer stated that the FreedomCAR and Fuels Partnership is designed more to be a demonstration and deployment program. The high risk/high reward research should be done outside the partnership. Another stated that, without industry participation, the rate of adoption of new technology will be even lower than it is now. But he adds that the high risk/high reward portion should not be a part of the FreedomCAR Partnership.

High-risk research should be outside the FreedomCAR and Fuel Partnership.

Speaking generally, one reviewer commented that there always will be new ideas for R&D, and he doesn't think anyone can specify all of them at any given time. Instead, what is needed in the VT portfolio is a research program area, or a process, or both, that can anticipate the need for, and support new ideas (most likely investigator-initiated), and assess further R&D opportunities on an on-going basis.

One reviewer asks if anyone is working on wireless energy transmission for quick remote charging of batteries, or if there is a way to use the huge amounts of CO_2 that will be captured from power plant exhausts for making carbon composites for automobiles?

Lastly, another reviewer emphatically states that, regarding high-risk/high-reward, it is critical to couple these two phrases. Generally, he has serious concerns over some of the polymer composites research in this regard. It is certainly high reward if actually adopted. But he does not share the belief held by some advocates that graphite-reinforced composites will make significant impacts on the body-in-white in the next decades. Prior to that, if there is a sufficient reduction in price and improvement in various technologies, there are some highly specialized parts on ground vehicles that could be entry points leading to modest weight savings with modest cost offsets. He goes on to state that, if DOE had a realistic view of the entry path to market (as can be readily followed from the history of composites development in the DOD and eventual tortured transition to significant commercial use by Boeing in the 777 forty or more years later), a different VT program would evolve. He believes, for example, that near-term focus on applications outside of vehicles (e.g. wind power) would focus the R&D, lead to more likely near-term adoption and "incentivize" the development of a carbon fiber industry that is unlikely to evolve if it must wait twenty years or more before significant masses of fiber are actually introduced into vehicles. One thing is almost certain, he adds, the current target of $5-7 production costs do not even begin to include the capitalization costs that industry would need to invest and the infrastructure transformation required to deal with the waste product. He closes by stating that nothing he said here should detract from the quality of much of the research, but he believes that some, perhaps much, of it would not be justified under a more realistic scenario of likely application.

Question 3d: How well does the VT research portfolio reflect the balance of research needs for and the relative importance of the light-duty and the heavy-duty vehicle sectors?

There was some disagreement surrounding the amount of support given to the heavy-duty vehicle program. Multiple reviewers indicated that, while research needs were well represented in the light-duty section, there had been too many cuts in the heavy-duty sections, to the degree that it was now noticeably under-funded. One reviewer stated that more emphasis on heavy-duty trucks is needed and on coupling trucks with rail, but not at the expense of reducing effort on LDV. Similarly, another reviewer commented that light-duty research seems to be covered relatively well, but heavy-duty research is dramatically and significantly decreased below a critical mass needed to provide successful results – at least from within the DOE program.

There have been too many cuts in the heavy-duty budget, perhaps below a critical mass necessary for success.

Multiple reviewers stated that they felt they were not given information regarding the balance of current research needs. One person added that it seems VT is planning to put more emphasis on light-duty vehicles, and that this seems appropriate as petroleum consumption of light-duty vehicles easily exceeds that of heavy-duty vehicles and there are seemingly more opportunities for improvement in light-duty vehicles such as PHEV's, diesel engines for light-duty vehicles (including cars at some point), and alternative fuels. One review followed up by stating that part of the answer depends on the market readiness of each sector to adopt technologies, particularly technologies that may apply to both sectors. This factor, as well as others, could alter the balance that might seem appropriate based simply on aggregate sector fuel consumption. Another person, similarly, commented that it looks the VT program has given up on the heavy-duty vehicle programs. He states that APUs and electrification are very much needed, but does not state by how they should be pursued. Making trucks more aerodynamic is now just a function of collaboration between manufacturers and labs with wind tunnels. Since the trucks and trailers are made in much smaller volumes and fuel efficiency is so important to their operating margin, acceptance of the design changes may be rapid.

Other reviewers felt that the VT research portfolio seemed like it had a good balance between the two sectors, but the absolute funding amount should increase to properly assess the most promising technologies. One person noted that vehicle manufacturers have been reducing their R & D staffs, and that this program is critical to their survival.

The light vs. heavy balance is good, but absolute funding levels for both needed to increase.

One person suggests that the research needs for and relative importance of heavy and light duty need to be considered, but more importantly the heavy-duty sector makes a much more effective area for technology development, so a much stronger emphasis should be placed on developing technology in this sector and then applying it in the light-duty sector, with research portfolio design specifically articulating this strategy. Adding to this, another reviewer states that there appear to be large R&D opportunities in the area of heavy-duty vehicle technologies, but these need to be placed in context with the needs in the light-duty market. Given the consolidation and globalization that has taken place with respect to heavy-duty vehicle manufacturers, perhaps there are further opportunities for leveraging of R&D investments in this area.

Question 3e: Are there areas of research outside the current VT portfolio (such as pure electric vehicles, new fuels, and so forth) that DOE should consider for investments in research funds?

One reviewer briefly mentions that the current VT portfolio should expand to include heavy-duty truck APUs, streamlining, and electrification, while a number of other reviewers that that alternative fuels (especially non-ethanol) needs to be better funded. One reviewer comments that, in terms of fuels, ethanol is receiving all the attention these days at the national level. But ethanol has many problems, and alternatives should be pursued. Another reviewer stated that new funds should go to alternative fuels and advanced internal combustion engines, with unique hybrid engine considerations also a high priority. Similarly, one person commented that alternate fuels (innovative blends) and advanced (unique) vehicle technologies are prime areas for strategically and surgically made DOE research investment opportunities. One other person noted that it appears that a lot of hydrogen R&D has been done or is underway, and it would be appropriate to phase this down. Without a large new source of hydrogen supply, it would appear that hydrogen likely will have a niche role in the near-term and mid-term, e.g. in special applications, such as fleets, or in limited dual-fuel applications.

Additional research areas suggested: truck APUs, alternative fuels, advanced engines, diesel-like combustion techniques, and carbon management modeling scenarios.

One reviewer stated that he felt all relevant research areas seem to be covered, but often not in a sufficient critical mass to make a significant difference in a timely way. He, like the reviewers above, suggests placing a premium on alternatives other than ethanol. Ethanol from corn is getting a lot of bad publicity these days because of rising food prices. While ethanol from cellulose is what everyone is expecting to get us beyond corn, there are many potential environment impacts. The effects of alternative fuel blends on new and existing vehicles needs to be studied. The vehicle fleet takes about 15 years to turn over. The reviewer asks, how will these blended fuels affect these older cars and other internal combustion engines? Similarly, one review asks, will new lubricants be needed with these new fuel blends? How will they affect air quality?

Advanced diesel technologies are also of high importance to some reviewers. One person comments that diesel-like combustion cycles still have by far the most promise for major fuel consumption reduction, in both heavy and light duty, through efficiency improvements with attendant low criteria pollutant and CO_2 emissions. He continues that this is why, worldwide, diesel fuels are in high demand and short supply, and since fuels are traded freely worldwide, this is the reason that diesel fuel is now $0.50/gal more expensive than regular gasoline in the US, even though production cost is around $0.30/gal less for diesel than gasoline. He believes that fuel savings in the U.S. therefore will depend for technical viability on development of clean diesel-like combustion engines and will depend on widespread market acceptance on the simultaneous development of inexpensive fuels to match these cycles. This will require highly saturated hydrocarbon refinery feeds from domestic sources and will require very high volume feed production to press costs down. This technology is the likely the only way to improve both combustion engine vehicle fuel efficiency and hybrid engine vehicle efficiency in very large fleet sizes.

In a similar vein, one reviewer asks, are there cleaner and cheaper replacements for the Fischer-Tropsch process for making diesel fuel? Another person commented that light-duty diesel engines were mentioned (such as the new Cummins/Dodge project) but it was not clear how large the overall

effort was. He adds: diesels are an important pathway for automobiles (not just light trucks) and should be appropriately addressed in the program, including near-term deployment efforts, given the rapidly evolving status of this technology and the huge market uptake in Europe.

One commenter indicated that DOE should enhance the development (already providing good results) of modeling scenarios for carbon management (the reviewer here references the EPA CO_2 Senate Bill) which will have dramatic effects on the fuel efficient/CO_2 tradeoffs throughout the U.S. for many years to come.

Another person stated that the main limitations to pure electric vehicles are the limitations of currently available batteries. To the extent that the R&D on high-energy batteries for PHEVs results in improved batteries for that application, then those same batteries (or modifications there to) are likely to be adapted for pure electric vehicles.

The reviewers disagreed on funding for pure electric vehicles, with one stating an emphatic NO to this category of vehicles, while another person stated that the pieces for pure electric vehicle are in place now, and that VT should continue funding battery and power electronics technology to increase vehicle range. One reviewer, in a multi-part response, states that considerations for new research areas, or areas for additional funding, need to be evaluated on a corporate DOE basis. For example, as noted in the reviewer's answer to an earlier question (see Technology Review, "Plug-In Hybrids: Tailpipes vs. Smokestacks""), unless DOE's investment in demonstrating CO_2 sequestration is successful and results in the wide deployment of CO_2 sequestration, plug-in hybrid electric vehicles, or for that matter all electric vehicles – where the electricity would come from conventional coal-fired power plants with no carbon sequestration – do not reduce emissions over currently available gasoline hybrid vehicles. The reviewer adds that investments in new fuels have the same caveats (he references an attached article from the Economist, "Ethanol and Water Don't Mix," March 1, 2008). This article notes the high demand for water required in current ethanol processes, and states that "A backlash against the federally financed biofuels boom is growing around the country, and 'water could be the Achilles heel' of ethanol…." So, the reviewer concludes, consideration of new or supplemental investments in research requires a strategic and integrated portfolio evaluation.

Question 3f: Comment on the level of DOE's investment in enabling technologies (i.e., those that do not directly achieve petroleum reductions but rather enable the use of other technologies that do achieve petroleum reductions, such as materials, heat and mass transfer technologies, etc.) and the types of projects that should/should not be funded.

Multiple reviewers stressed that the investment in enabling technologies is appropriate and that the overall portfolio mix is about right, with one reviewer adding that the work on materials is paying off "big-time." Multiple reviewers specifically stated that this category of work at DOE is very productive but requires a significant increase in funding to adequately meet the DOE goals. Another reviewer noted that there was a good current overall portfolio in enabling technologies, but warned that decreasing research emphasis for the Government (DOE) is dangerous.

Enabling technology investment levels are appropriate. VT should consider fuel blend impacts, traffic gridlock, truck APUs, and biodiesel from non-food crops.

More specifically, some reviewers pointed to

individual enabling technologies that they felt should be explored more fully. One person commented that VT needs to look at the impact of different blends of fuel and the impact these have on new and old ICE engines, while another reviewer stated that anything VT programs can do to eliminate gridlock will help. One reviewer stated, similarly to their previous comments, that work on APUs for heavy-duty trucks and their electrification should continue. Another person suggested that DOE needs to invest in technologies that make biodiesel from non-food products, such as renewable crops, algal systems, and gasification.

A number of reviewers felt that they were not provided information on the current level of DOE's investment in enabling technologies, but that, from their point of view, such research is very important to continue and there can always be unanticipated benefits. One reviewer stated that, in general, the investment level in enabling technologies must be based on their degree of leverage in achieving the goals. This has to be informed by systems analysis. The conceptual linkage between advances in materials and heat transfer technologies has to be clearly described and quantified in an analytical framework that is consistent among all technologies in the VT portfolio. The existence of such a framework and its routine use to inform decisions, the reviewer adds, was not evident in the Plenary presentations. Another reviewer added that materials always play an important role in any new technology development. He adds that it's difficult to comment on the precise level or percentage of a program that should be devoted to materials, but it is an important part of the VT program.

One commenter stated that R&D on enabling technologies, such as high-temperature materials or carbon fiber manufacturing, is a high priority, in part because of the many areas of applications. However, in view of the many competing demands on VT, this reviewer comments that it is not appropriate that support for these technologies fall solely on VT, or to the VT budget line item. He would recommend that VT initiate a study, with participation of other DOE offices (FE, NE, OS, CFO) to look at options for how the enabling technologies should be managed and funded, including options for putting this work under a separate management structure, or keeping it within VT, but perhaps as a separate budget line item that would have less conflict with VT-specific program objectives. This is especially needed if VT is going to continue the current trend to place a greater focus on nearer-term RD[3].

Enabling technology R&D is a high priority, but not solely the responsibility of VT: other DOE offices should participate.

Lastly, one person suggests VTP should work very closely with BES and OER to crosscut the stovepipes more effectively. BES has made a very good start with its technology problem oriented workshops, but a strong follow-on is required. One area needing strengthening is electro-chemical, electro-physical and electro-biologic research.

Question 3g: Is the VT investment in environmental and health impacts assessments of its future technologies appropriate and useful? Why?

Numerous reviewers commented on the overall importance of VT investment in environmental and health impacts assessments, with comments ranging from it being appropriate and useful to being absolutely necessary. One reviewer added that the assessment of the consequences of the DOE programs was necessary to assure that research guidance provided from the DOE programs does not lead the industry and the country to deliver fuel consumption and emissions reductions with unintended consequences to human health and the environment. These assessments must be done

from the very earliest stages of research and should be an integral part of the VT thinking. Similarly, another person stated that analyses should be done before investments are made, and as technologies are maturing. These kinds of assessments and evaluations could help prevent the kinds of situations described in The Economist article, where water usage for ethanol production may make many sites for potential production facilities unfeasible. This needs to be part of the VT scope of responsibility, but perhaps could be greater leveraged, either with DOE (BER), EPA, NIH and industry. In other words, VT needs to be cognizant of the health and environmental issues of its fuels and vehicle technologies, but perhaps can leverage other research resources to a greater extent. Other reviewers commented that this activity had insufficient funding.

Health impacts work is appropriate, useful, and (to some) absolutely necessary.

Another reviewer stated that the environment is crucial, adding that the transportation sector emits more GHG than power plants, but cleaning up the NOx and particulates is still key to diesel and other compression ignition systems, contributing as much to oil-use reduction (and GHG reductions) as their potential promises.

Multiple comments were made regarding the insufficient amount of information given in this area. One reviewer stated he could not tell from the four plenary presentations, nor from the FY 2009 VT budget request, whether there is an investment being made in environmental and health assessment impacts of future VT technologies. He went on to add that the Plenary presentations provided no information on the amount of investment in environmental and health impacts of future technologies, yet it is critically important that these issues be explored comprehensively, including the impacts of alternative fuels on global food supply and land use. Regarding PHEVs, these studies should include a very realistic and unbiased assessment of impacts on the electric system, in terms of its capital investment and operations as well as emissions.

One reviewer referenced that the February 25, 2008 edition of *USA Today* had an article citing several studies that suggest that PHEVs will increase emissions in regions heavily dependent on coal-fired powered plants. The reviewer adds that it would certainly be best to avoid any future MTBE-like situations where a promising transportation-related technology had problems that could have been avoided if there had been some in-depth studies ahead of time. In the process of going to a hydrogen economy, many pollutants will be released into the air especially when coal is used as a source of the hydrogen. CO_2 capture must also be considered.

Question 4: Please provide any other comments you may have on the overall VT program.

Multiple reviewers commented that, overall, the VT program is well thought out, well managed, interesting, and effective. One reviewer commented that there had been continuous improvement every year. Multiple reviewers, with regards to overall funding for the VT program, commented on the limited financial resources / under-funding of the program. One of these reviewers noted the urgency in reducing petroleum use and CO_2 emissions, noting that he appreciated that, as part of a Federal Agency, VT can't advocate for a different budget than the DOE Request. Another reviewer noted that the review itself was well-conducted and handled.

The VT program is well-managed and effective, but funding is limited.

One reviewer stated that he was generally impressed by the overall quality of the R&D portfolio. He added that this was based upon the quality of the presentation materials, and well as quality of the detailed congressional budget justification write-ups.

With regards to deciding the RD³ strategy for the program, one reviewer commented that VT has turned to models and that these are becoming better tools thanks to the VT investments. He goes on to add that both policy and technology changes need to be modeled. The next administration will be much more interested in managing GHG and will support policies that will tax carbon emissions by some means, and it will subsidize low-emission fuel and transportation technologies. He notes that VT should factor this likely trend into its decisions about the portfolio. VT may have to pay EIA to help VT change and run NEMS to answer the right questions. It looks like the right portfolio of models is being or has been assembled.

Another reviewer added that he was most impressed with the presentation on economic analysis presented by Mr. Patterson. He encourages expansion of this effort in two directions: first, the path of improving and updating models used to reflect new understanding and realities is critical. Second, he recommends adding some modest amount of retrospective analysis to "prove" the cost/benefit value of some VT efforts in past years. Not only is there obvious political value here, but, if properly analyzed, such retrospectives can aid in future program planning and execution.

One reviewer commented that little was said about the other transportation and transport modes. He asks: should aircraft, rail and ships be included? If not VT, who?

Another reviewer acknowledged that VT has a very broad programmatic scope, having to address R&D requirements for different classes of vehicles, and address both fuels and vehicle technologies. He noted that this creates two major management challenges: achieving an overall level of resources commensurate with the program scope, and prioritizing R&D projects within this broad scope. He adds that he is not suggesting that the program be reorganized (except for enabling technologies, which he discusses later), but that he is simply stating that these challenges may be larger for VT than for other program offices in EERE. VT is organized by areas of technology and most of the information is presented in that structure. However, he thinks that there is a need for a better integration matrix that better connects technology organization to end-use markets – light vehicle, heavy duty, etc. Also, he indicates a need for a third dimension of the matrix that identifies the major programmatic thrusts. Although it was not specifically stated this way by the presenters, his take-away from the plenary presentations was that there are three program thrusts: more efficient engine/vehicle combinations, fuel diversification (e.g. ethanol, hydrogen), and electrification. External observers need to understand all three perspectives in order to fully appreciate the program portfolio.

The broad VT program scope creates management challenges in having sufficient resources to accomplish the scope, and prioritizing work appropriately within the scope.

Two reviewers commented on the need for a wider view in approaching some of these different challenges. The first stated that the imbalances and disconnects with the most current research findings worldwide are driven by political guidance that almost always is received with no opportunity

for dialogue and thus does not have the benefit of the technical currency of the VT staff. He adds that a small program budget activity that documents and reports emerging technology findings worldwide for strategy consideration might offer a means to engage a bit more in strategy dialogue with those who provide guidance to VT. This activity should probably also articulate potential unintended consequences of specific strategy directions.

The second reviewer suggested that DOE needs an oil security "czar" who would look comprehensively at the energy problem from all its many aspects, technology, policy, resources, costs, environment etc. He notes that DOE has many of the pieces, and that he hopes DOE will put it all together. One good way to start a comprehensive analysis is to follow the lead of the National Commission on Energy Policy.

Project partnerships and the complicated relations between government and industry entities were also commented on by a number of reviewers. Multiple reviewers noted that funding needs to be increased and manufacturers / U.S. partners need to speed up deployment of advanced technologies on a large scale. One of these reviewers added that this is one of the most critical programs to keep high-paying jobs in the USA, and it needs more funding to broaden the scope. Both government and automotive industry forces were of concern, with one reviewer commenting that it was not clear how much mission-relevant RD^3 the automotive industry is supporting. He adds that they are almost certainly not investing as much as they need to. Another reviewer added that the issue of the government role in energy R&D is becoming increasingly more complex, with perhaps an especially difficult challenge for VT.

Traditional paradigms for government research are being challenged. Energy legislation is sending signals for the government to take a more active role in energy R&D.

In a similar vein, another reviewer wrote that, in general, the traditional paradigm – i.e. government support for technology creation (i.e. basic and applied R&D) and industry leadership in technology application (development, demonstration and deployment) – has become increasingly blurred. For example, in some technology areas (electronics and biotechnology industries), venture capital has become a major source of R&D investment for technology creation, with the expectation that new discoveries will be brought quickly to market. Some industries have reduced their role as R&D performers, and have entered into more partnerships with universities to perform R&D. Finally, the 2005 and 2007 energy legislation, and pending climate legislation, signals Congressional intent for the government to take a more active role in accelerating the R&D process, and towards taking a more active role in commercial demonstration and deployment.

The reviewer adds that, for VT specifically, determining the appropriate government role in vehicle technology R&D is further complicated by the relationships between the government and the vehicle manufacturing industry. The government's primary role is safety and environmental regulation, and so the government-industry relationship is mainly an adversarial one. Also, industry product plans tend to be more secretive than in other business sectors that partner with DOE. This creates challenges in determining if the VT R&D portfolio complements private sector R&D, and especially in assessing whether VT programs can accelerate the pace of technological innovation.

Another reviewer pointed out that one major point that was not addressed in the presentations is that VT R&D must be very cognizant of the optimization challenges in vehicles. A commercially successful new engine or vehicle technology has to be optimized to achieve multiple-objectives: performance, energy efficiency, cost, safety, infrastructure (including fuels), and disposal. This adds to the technical challenges of selecting R&D projects and is especially difficult in commercialization. How these multiple objectives are assessed in R&D project planning was not discussed.

Lastly, and also regarding governmental influence, one reviewer commented that a general impression that emerged from the plenary presentations was a need for better integration of the VT R&D portfolio with new and emerging federal regulatory requirements, including the new CAFÉ standards, the new RFS. and the new EPA rulemaking on tailpipe CO_2 emission standards. In addition, he comments that it is increasingly likely that the next Congress will enact a mandatory greenhouse gas emissions reduction program, most likely through cap-and-trade, which will further complicate the relationship of VT R&D to the commercial market. He suggests that VT needs to more effectively plan and/or articulate the relationship of its program to the changing dynamics of the regulatory environment affecting vehicles and fuels. While the Bush Administration remains opposed to mandatory requirements for greenhouse gas emission reductions, it would appear to be appropriate for VT to conduct studies and analyses of the possible interaction between potential new regulatory requirements and the scope and schedule for VT R&D.

Questions and Answers with the Reviewer Panel During the Plenary Session

Questions from the Reviewer Panel

Q: What process do Project Managers use to measure success to make sure the programs are making progress?

- A: (Ed Wall) The ultimate measure of success is whether the technologies make it to the marketplace and save petroleum. This process of moving technologies to the marketplace, however, can take many years. For example, the Cummins light-duty diesel pickup truck motor was developed using DOE money starting in 1996 and will reach production in 2010.

Q: How are these technologies prioritized?

- A: Sometimes through direction from senior management: there has been some effort recently to reorient the portfolio to nearer-term work to fit the Assistant Secretary's vision. DOE also looks to analytics and its expert judgment to determine where to place its funds. The decisions are often difficult, but must be made on the basis of maintaining emphasis on the biggest petroleum savings areas.

Q: The safety implications of each of the technologies and programs were not mentioned. The technologies will need to be evaluated to ensure that the public safety is not compromised (e.g. lightweighting materials affecting the crash performance of a small car and a large SUV). These new efficient vehicles must be "ultra-safe" for consumers. Also, since we are looking at technologies for 20 years out, what assumptions are being made within the program on carbon management (carbon taxes and the like) to decide on the research focus.

- A: (Ed Wall) Safety is incorporated in each technical area, even if it was not explicitly mentioned earlier. For example using lightweight materials to decrease vehicle weight by 50 percent will be done while also maintaining or increasing the utility to the customer and the safety of the vehicle.
- A: (Ro Sullivan) Similar goal wording appears in the battery technical area. Each of the PHEV contracts addresses safety. VT will now be examining safety more closely now that a portion of the hydrogen program dealing with safety and codes/standards has been moved into the VT budget. It may be a good idea to centralize the safety for both programs in one activity.
- A: Relative to carbon management, VT is not including any carbon taxes or other carbon management concepts in its modeling.

Q: Since it takes quite a bit of time for new technologies to make inroads to the market, and since few vehicles are currently made in very large quantities (market fragmentation), can DOE use its loan guarantee authority to assist manufacturers in making the critical move toward lightweight materials in niche vehicles as a way to help manufacturers through the critical learning period before moving to mass production? Can VT work with OEMs to significantly incorporate lightweight materials on a few niche vehicles (30,000 – 50,000 annual sales) to use as a learning process to give them the experience to reduce the cost to enable use of these materials on other higher-production models?

- A: (Ro Sullivan) Yes, and DOE has worked with OEMs to have lightweight materials incorporated into production models in the past. For example, the engine cradle for the Chevy Corvette Z06 was designed in magnesium to reduce weight, and these vehicles are on the road now. However, the costs need to come down before they can be widely incorporated on typically passenger cars.
- A: (Ro Sullivan) The loan guarantee program will potentially help manufacturers incorporate lightweight materials in their vehicles. VT has submitted such ideas to the proposal process for

loan guarantee projects within DOE, and if these ideas make it to the final proposal process, this will help.

Q: The health and environmental impact of these technologies was not discussed. VT needs to make sure that new technologies do not have unintended consequences and cause harm to either people or the environment.

- A: This will be addressed in detail during a specific Health Impacts session at the merit review meeting: the program addresses fuel and combustion consequences of new technologies.

Q: Ro Sullivan mentioned the downward trend and low funding level for heavy-duty vehicles. What VT heavy-duty programs remain? Will this "pendulum" swing back to heavy-duty research?

- A: (Ed Wall) There have indeed been shifts in recent years in the heavy truck area. VT has attempted to maintain the funding for core projects with the largest petroleum reduction impacts (combustion and aerodynamics) even though the overall funding has decreased. VT has cut back on other areas, such as medium-duty hybrids, that do not use much fuel and thus will have less potential impact. This specific application is already being addressed in the market through hybrid vehicle options from Eaton and Oshkosh. Heavy vehicle lightweighting is not being addressed directly as the petroleum savings are limited to second order effects (i.e., more cargo will be carried if the vehicles are lighter) and these materials have cost considerations in these applications. Advances in these materials, low-cost carbon fiber for example, for light-duty vehicles can reduce the costs of these materials and benefit the medium- and heavy-duty vehicles once the materials are available.

Q: The portfolio seems to be very well balanced, but can be refocused because of political input (PHEVs and biofuels, for example), that may not have been included previously, or were not a primary thrust. Many of these new directions don't involve dialogue among interested stakeholders. Could DOE develop a program that captures new directions and their impact on strategic directions and document this? There isn't currently any way to open a dialogue on this at present.

- A: Staff do track advancements and developments worldwide and maintain their knowledge base. VT has recently initiated work to identify and evaluate potentially disruptive technologies with three entities that have worked with DOD and the CIA. Also, VT had a $1 million PHEV assessment several years ago, and were thus ready to quickly make the leap to a major PHEV program when it became a White House focus.

Q: The plenary reviewers are asked to assess the balance of DOE programs, but do not have enough information, especially budgetary, to adequately review the programs and projects to determine whether the research and funding shifts from year to year is appropriate. Subtle shifts have been made, and it is difficult to determine the magnitude of these.

- A: (Ed Wall) VT staff will get the reviewers a detailed full budget breakdown. Directions for the program are shown in the areas of emphasis discussed in the budget requests and in the response to that request by Congress. (For example, Congress emphasized hybrids in its last appropriation language.) In general for 2009, funding levels have been flat except for a $7M increase for battery development and a $3M increase for non-petroleum based fuels. The shifts in projects within the programs are not captured at this level. As noted earlier, $31M of additional funding in the 2009

request came from moving several hydrogen programs to VT. Funding trends between 2007 and 2008 were similar.

Q: The suite of models used in the program (and their capability) is amazing. Gasoline PHEVs were part of the discussion, but was a diesel PHEV evaluated? It was not shown in the presentation. Also, how close are we to the goals of PNGV (80 mpg)?

- A: (Phil Patterson) We don't get to the 80 mpg goal with any of the technologies we've examined. The fuel economy values used come from the Argonne National Lab PSAT model. Diesel HEV and diesel PHEVs are certainly possible. The model may not show any significant sales because it is accounting for the fact that the diesel fuel pool may be used up by other vehicles, with not enough additional fuel to allow for diesel HEV/PHEVs to have a significant presence.
- A: (Ro Sullivan) VT has tested all of the PHEV conversions and has seen above 100 mpg in some, but this is not accounting for electric energy use to charge the pack.

Q: Is there an Oil Czar within DOE looking at all aspects of oil use?

- A: (Phil Patterson) No, that's an issue, as many sectors using oil are not currently being addressed.

Q: The current best estimate is that diesel fuel costs $0.30/gallon less than gasoline to produce, but costs $0.50/gallon more than gasoline at the pump, because of world diesel demand and the imbalance of refinery capacity in the U.S. The rest of the world is moving faster than us on diesel fuel, and this is straining capacity which will likely result in increased diesel fuel costs. How does the VT work influence this? This issue will be a limitation for light-duty diesels.

- A: (Phil Patterson) The refineries in the U.S. are set up to produce more gasoline than diesel. Because fuel demand is a global system, some of the diesel fuel is exported, while gasoline is imported. As time goes on this problem, and the price difference, will get worse, especially as the heavy-duty sector (almost entirely diesel powered) is growing quickly. This is a complex situation.

Q: The modeling looks impressive, but has VT evaluated the values and estimates used as inputs to determine if they are accurate? Have studies been done looking at alternative research portfolios to show the potential impacts of other technologies getting to the market at all, or sooner, based on higher funding and activity levels? What is the effect of a change in investment on a change in technology?

- A: (Phil Patterson) A risk model is being done now for the first time. In general, as funding for a technology increases, the risk decreases and the probability for success increases due to the additional R&D and marketing. Kevin Stork is the VT staff member who is leading this effort, but similar efforts are being done across EERE.

Q: What about the rebound effect (increased fuel efficiency resulting in increased VMT and reduced fuel savings): are there plans to examine the magnitude of this effect?

- A: (Phil Patterson) The UC Irvine work is sufficient to estimate this effect at present. This effect is relatively low at this time. Changes result from the general increase in affluence of the nation.

Q: Is the impact of intelligent highway/automated vehicles (i.e. Intelligent Transportation Systems [ITS]) on fuel (reductions in gridlock and the like) being modeled?

- A: (Phil Patterson) Not yet, but this could be represented somewhat by reducing VMT for passenger cars. Mode shifting for transport is not modeled. The modeling team would like a list of suggestions from the reviewers on these ideas.

Q: In reference to DOE marketing and promotion of technologies, this is tied intimately to policy/subsidy efforts. To what extent will these get integrated?

- A: (Phil Patterson) Programs like Clean Cities help this by making these new technologies more attractive: this effect is being modeled now.
- A: (Ed Wall) There is interest in understanding the policy activities with the greatest impacts. Harvard recently conducted a study of hybrid purchases by interviewing hybrid owners to determine what mattered most to these purchasers (fuel cost was third, based on the preliminary information). Studies such as this can inform policy makers to get the best "bang for the buck". UC Davis has conducted a STEPS multipath analysis program to get at similar information. Studies on driver psychology have indicated that fuel economy displays (such as on the Prius) have a positive impact on fuel efficiency because drivers seem to drive less aggressively (creating a kind of competition on how high they can get the display to go).

Q: As hybrid transit buses are becoming more popular and widespread, is VT including these advances in the modeling?

- A: (Phil Patterson) Transit bus fuel usage is so small compared to the overall fuel usage, that it does not show up on the chart, so including the impact of hybrids would not be worth the effort. It is useful to keep aware of this sector, however.

Q: What is VT doing on ultracapacitors? How much funding is being put toward this?

- A: (Ro Sullivan and Tien Duong) VT continues ultracapacitor work with a small effort (less than $1M annually) that is focused on evaluating commercially available ultracapacitors. Historical benchmarking of these devices has also been done back in the late 1980's and 1990's. DOE funded research by two companies, but that work has been completed. The main reason DOE has not pursued more research is that ultracapacitors have very poor specific energy (<3 Wh/kg) and energy density (<3 Wh/liter), making packaging difficult. DOE has looked at asymmetrical capacitors, but these are very expensive, especially when compared with lithium-ion batteries. There are, however, opportunities for ultracapacitors in urban medium- and heavy-duty vehicles with frequent stop/start duty cycles that require large amounts of power, but not necessarily energy, to accelerate the vehicle. They can be included in stop-start systems that provide idle shutoff for the vehicle to save fuel.

Q: A recent Supreme Court ruling required EPA to develop CO_2 regulations in the next year. However, it may be difficult to add a CO_2 standard on top of the Renewable Fuel Standard (RFS). What is VT doing to assist and how will this affect future decisions on technologies and funding to meet these requirements?

- A: (Ed Wall) VT supplied data to EPA, but the form of the CO_2 standard seems to be shifting to be included in the new RFS, rather than being separate legislation.

- A: (Phil Patterson) CAFE and CO_2 standards are in competition since both are essentially fuel economy standards.

Q: EPA must legally do something on carbon dioxide emissions from vehicles. What are the technology tradeoffs between CAFE, RFS, and CO_2 legislation, and how does this affect diesels?

- A: (Phil Patterson) CO_2 legislation may hurt diesels, since carbon taxes will drive carbon out of fuels, and PHEVs powered by carbon-free (i.e. renewable) or low-carbon generated electricity will have a lower CO_2 footprint than diesel.

Q: How will long-term emission studies on new and old flex fuel vehicles (FFV) have on future FFV implementation?

- A: The big challenge was set by the 36B gallon biofuel mandate by 2022 in the RFS. This will put a huge amount of biofuel into the transportation sector. FFVs have been in the fleet and have been effectively used on E85 where the fuel is available (typically near the production in the Midwest). The RFS will represent a step change in the amount of fuel and even though the E85 fueling infrastructure is being improved, it is doubtful that E85 and FFVs could use all of the additional biofuel. Currently only E10 and E85 are considered and accepted for use in vehicles. Intermediate blends between E10 and E85 are not approved fuels for non-FFVs. This is why the DOE is evaluating the effects of lower level intermediate blends (e.g. E10-E20) on the legacy fleet of vehicles not designed to use ethanol, to determine the effects on the vehicles and emissions. Emissions increases will be a showstopper, so analysis of this effect is included. In addition to the legacy on-road engines, there are millions of engines in small handheld equipment (e.g. weedwhackers, chainsaws, etc.), lawn equipment, golf carts, and many other applications, so the effects of these higher ethanol blends on these engines are included. DOE has put together a test program to make the right decisions on intermediate blends on emissions and utility.

Q: Half of the advanced materials budget is on carbon-fiber and carbon fiber components, but VT has been working on these materials for a long time with very little progress relating to commercial applications. What justifies the risk (not the opportunities) to the expense?

- A: (Ro Sullivan) A risk study was just completed by a 3rd party for carbon fiber from low-cost carbon precursors and conversion technology. The initial goal for low-cost carbon fiber was $3/lb, but the goals have been adjusted recently to $5-7/lb based on the cost study. The study showed that low-cost precursors and low-cost production could meet that revised target.

Q: What is the current earmark level?

- A: (Ed Wall) The Vehicle Technologies Program was moved from the Interior to the Water Committee for FY 2006. A total of $16M in incremental funding was provided to cover earmarks, but this was offset by $24M in earmarks ($8M had to be made up with existing funds). 2007 was a year of a continuing resolution, so no new earmark projects were added. The 2008 budget that was shown in the presentation earlier did not include earmarks, which were an additional $18M in a separate package over and above the budget.

Q: What are the VT thoughts on the carbon legislation being considered on the Hill? The bill probably won't pass this year, but may do so in 2009 or 2010? What about the cost of electricity under a carbon constrained world (might it increase 50 percent)?

- A: VT has made a significant investment in PHEVs, keeping the sensitivity of both electricity and petroleum pricing in mind, even if electricity prices may rise more rapidly in the future than gasoline.

Q: Need to include the increasing cost of electricity in modeling efforts. Oil prices may slow or stagnate, while electricity prices may increase to the point that it does not provide an advantage. Another consideration is electricity supply, as there hasn't been much investment in generating capacity leading to the question of whether electricity will be available to meet future demand.

- A: (Phil Patterson) Agreed.

Q: Has the VT considered using stack gas, sequestered CO_2, or the atmosphere as a CO_2 feedstock for carbon fiber?

- A: No, but it's certainly possible. However other fields are using stack gasses to "feed" algae being grown for fuel and food.

Q: What fraction of the VT budget is devoted to "way out" proposals?

- A: The SBIR and STTR programs are designed to answer this need, with a standard holdback from all VT line items to fund it. This program has produced some success, most notably with A123 Systems which was started with an SBIR grant.

Questions from the General Audience

Q: Regarding the modeling predictions, since garbage in = garbage out, have the VT modelers revisited models from 5 or 10 years to evaluate how close the predictions were to what actually happened?

- A: Yes, historical predictions have been informally evaluated, and in many cases the predictions did not materialize in the market in the same way.

Q: How will post-election changes that could push the R&D vs. deployment pendulum away from the current deployment focus affect the VT portfolio? Is VT ready for a shift if it happens? Also, what are VT thoughts on corn ethanol versus other renewables to meet RFS goals?

- A: The program is very adaptable. VT is well positioned to move back towards a more R&D focus if needed, since they have not moved away completely from R&D, but rather moving some focus to deployment. Relative to the corn ethanol question, the new EISA legislation specifies only "biofuels" while limiting the use of corn ethanol to 15 billion gallons. To be successful we will need breakthroughs in cellulosic technology.

2. Applied Battery Research

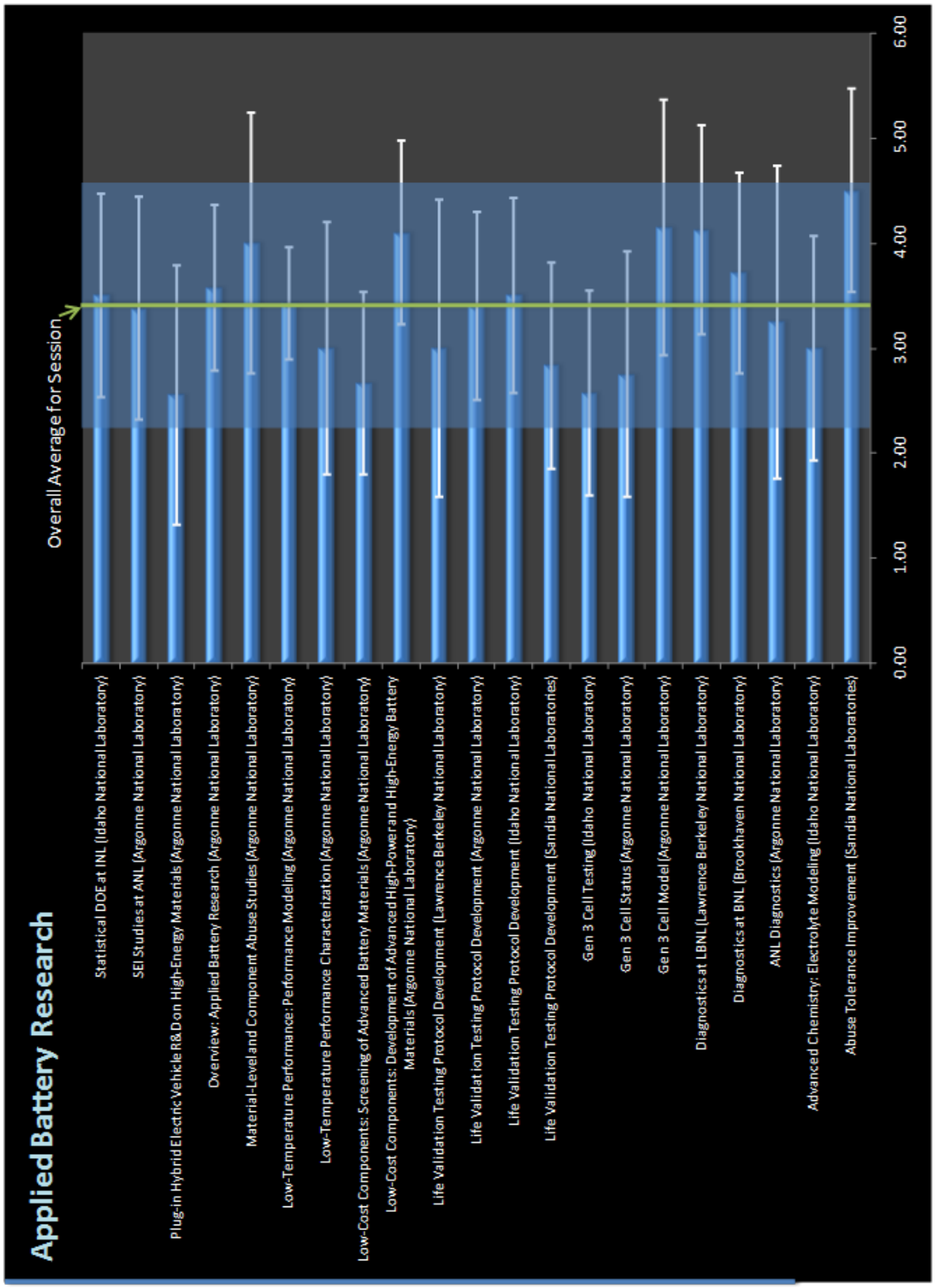
Introduction

Applied battery research focuses on addressing the cross-cutting barriers facing the lithium-ion systems that are closest to meeting all of the technical energy and power requirements for hybrid electric vehicle (HEV) and electric vehicle (EV) applications. In addition, the applied battery research activity concentrates on technology transfer to ensure that the research results and lessons learned are effectively provided to U.S. automotive and battery manufacturers. The work concentrates on four research areas: battery system development and electrochemical diagnostics, battery testing and electrolyte development, spectroscopy and microscopy diagnostics, including X-ray diagnostics, and abuse evaluation, accelerated life test protocol development, and statistical analysis. Several types of batteries have been investigated for use in EVs and HEVs, among them lithium-aluminum-iron-sulfide, nickel-metal hydride, lithium-ion, and lithium-polymer. Lithium-ion systems come closest to meeting all of the technical requirements, but they face four barriers: calendar life, low-temperature performance, abuse tolerance, and cost.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
2-4	Abuse Tolerance Improvement (Pete Roth, Sandia National Laboratories)	4.50	0.97
2-8	Advanced Chemistry: Electrolyte Modeling (Kevin Gering, Idaho National Laboratory)	3.00	1.07
2-12	ANL Diagnostics (D. Abraham, Argonne National Laboratory)	3.25	1.49
2-15	Diagnostics at BNL (W-S Yoon, Brookhaven National Laboratory)	3.71	0.95
2-18	Diagnostics at LBNL (F. McLarnon, Lawrence Berkeley National Laboratory)	4.13	0.99
2-21	Gen 3 Cell Model (Dennis Dees, Argonne National Laboratory)	4.14	1.21
2-24	Gen 3 Cell Status (Gary Henriksen, Argonne National Laboratory)	2.75	1.16
2-28	Gen 3 Cell Testing (J. Christopherson, Idaho National Laboratory)	2.57	0.98
2-31	Life Validation Testing Protocol Development (V. Battaglia, Lawrence Berkeley National Laboratory)	3.00	1.41
2-34	Life Validation Testing Protocol Development (I. Bloom, Argonne National Laboratory)	3.40	0.89

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
2-37	Life Validation Testing Protocol Development (J. Christopherson, Idaho National Laboratory)	3.50	0.93
2-41	Life Validation Testing Protocol Development (Ed Thomas, Sandia National Laboratories)	2.83	0.98
2-44	Low-Cost Components: Development of Advanced High-Power and High-Energy Battery Materials (Khalil Amine, Argonne National Laboratory)	4.10	0.88
2-48	Low-Cost Components: Screening of Advanced Battery Materials (Andrew Jansen, Argonne National Laboratory)	2.67	0.87
2-51	Low-Temperature Performance Characterization (Andrew Jansen, Argonne National Laboratory)	3.00	1.20
2-55	Low-Temperature Performance: Performance Modeling (Dennis Dees, Argonne National Laboratory)	3.43	0.53
2-58	Material-Level and Component Abuse Studies (Khalil Amine, Argonne National Laboratory)	4.00	1.25
2-63	Overview: Applied Battery Research (Gary Henriksen, Argonne National Laboratory)	3.57	0.79
2-66	Plug-in Hybrid Electric Vehicle R&D on High-Energy Materials (Jack Vaughey, Argonne National Laboratory)	2.56	1.24
2-70	SEI Studies at ANL (D. Abraham, Argonne National Laboratory)	3.38	1.06
2-73	Statistical DOE at INL (Kevin Gering, Idaho National Laboratory)	3.50	0.97
	Overall Session Average and Standard Deviation	**3.41**	**1.15**


Applied Battery Research
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Statistical DOE at INL (Idaho National Laboratory)
SEI Studies at ANL (Argonne National Laboratory)
Plug-in Hybrid Electric Vehicle R&D on High-Energy Materials (Argonne National Laboratory)
Overview: Applied Battery Research (Argonne National Laboratory)
Material-Level and Component Abuse Studies (Argonne National Laboratory)
Low-Temperature Performance: Performance Modeling (Argonne National Laboratory)
Low-Temperature Performance Characterization (Argonne National Laboratory)
Low-Cost Components: Screening of Advanced Battery Materials (Argonne National Laboratory)
Low-Cost Components: Development of Advanced High-Power and High-Energy Battery Materials (Argonne National Laboratory)
Life Validation Testing Protocol Development (Lawrence Berkeley National Laboratory)
Life Validation Testing Protocol Development (Argonne National Laboratory)
Life Validation Testing Protocol Development (Idaho National Laboratory)
Life Validation Testing Protocol Development (Sandia National Laboratories)
Gen 3 Cell Testing (Idaho National Laboratory)
Gen 3 Cell Status (Argonne National Laboratory)
Gen 3 Cell Model (Argonne National Laboratory)
Diagnostics at LBNL (Lawrence Berkeley National Laboratory)
Diagnostics at BNL (Brookhaven National Laboratory)
ANL Diagnostics (Argonne National Laboratory)
Advanced Chemistry: Electrolyte Modeling (Idaho National Laboratory)
Abuse Tolerance Improvement (Sandia National Laboratories)

Abuse Tolerance Improvement (Pete Roth, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments were all positive. One reviewer said "Absolutely. This work is of paramount importance. Please fund them to the maximum!" Another person simply stated that abuse tolerance improvement is very important for the DOE Battery program, while another noted that safety is a key requirement for a practical cell. A related comment stated that abuse tolerance is critical to the safety of battery packs in PHEVs and HEVs and that this development is state-of-art and will greatly support the implementation of new vehicles battery systems. One reviewer felt that the presenter provided a better description of the project goals than in Dr. Amine's talk. They felt that the effect of materials on thermal runaway and looking at overcharge hazards goes towards achieving the goals identified. Another commenter remarked that this work has identified degradation mechanisms of gas and heat-producing reactions in lithium ion rechargeable cells, and has identified and developed advanced materials or combination of materials that minimize the sources of cell degradation during abuse events, thus enhancing safety and supports the overall DOE objectives. Another reviewer commented that this project provides critical and timely observations in key areas, specifically including gas generation and generation sequence characterization, forced internal short response characterization, overcharge response characterization, and separator abuse response characterization, among others. The final reviewer noted that Roth has gathered data that will be useful to battery manufacturers to produce safe batteries for HEVs and PHEVs, which will reduce the use of oil for transportation.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Comments to this question were generally positive. One person pointed out that the Sandia group has always done very thorough and credible work using very well-thought out experiments. Another person noted that to deploy any technology, enhanced safety is required; thus the work by Pete Roth and group at Sandia shows that they do have a good strategy. One commenter also agreed that the work plan and strategy are very good, adding that significant data has been generated and that correlation of this data to future work may help in the choice of less hazardous materials. Another person felt that the researchers had good focus on separator safety and evaluation of internal shorts to address manufacturing defects. Another reviewer indicated that the key barriers have been identified and studied with an adequate scientific and technological approach looking at the study of the mechanisms of the thermal runaway and overcharge, at the analysis of the effects on cell behavior (gas and heat generation) of new materials (anode, cathode and electrolyte). Another reviewer agreed, stating that the project has made significant progress in overcoming barriers to the identification and/or characterization of the mechanisms of gas and heat-producing reactions. One person acknowledged that Roth et al. have developed excellent tools for gathering data from lithium ion cells during abuse conditions. They noted that these data will be useful to battery manufacturers to help them develop safe cells for HEVs and PHEVs. The final reviewer commented that besides manufacturing defects (which cannot be studied in the program), the PI has selected a good array of materials to test for abuse tolerance. They pointed out that one item that has not been studied is the chemical change with cycling leading to decreased abuse tolerance; and suggested implementing this to look at cycled chemicals and changes that may affect the reactivity of components.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer simply stated that they always look at SNL for providing the definitive results on cell/pack behavior. They added that their work cannot be overemphasized. Another person noted that the researchers have very good facilities for testing various abuse scenarios and have rendered good interpretations of the scenarios. They acknowledged that studies and comparison of different systems have been done, as well as gas generation studies and the work on separators, which is new this year, is a great addition. One person pointed out that the researchers (1) demonstrated Thermal Abuse Response in High Power Cells with broader range of materials ($LiCoO_2$, spinels, $LiFePO_4$, (2) characterized electrolyte composition and additives that reduce peak thermal runaway reactions, (3) identified sequence of gas generation during overcharge showing H_2 as the first gas released, (4) characterized Role of Commercial Separators in Cell Abuse Response and showed improved high temperature melt integrity for new commercial separators, and (5) showed comparable response to voltage breakdown both at material and cell level which can lead to internal hard shorts and thermal runaway. One person noted that the project gives scientific and practical answers to the problem of abuse tolerance with interesting solutions. They pointed out that the large scope of the analysis covers most of the materials used in the ATD program. The reviewer felt that the collaboration with ANL is not well described and that some optimization and better collaboration on similar analysis would be preferable. One person acknowledged that Sandia's work, as always, has been excellent. The collaboration between Dr. Amine's work and Dr. Roth's is obvious; however, more collaboration should be carried out with Dan Abraham's group to study the abuse tolerance of the materials used for high cycle life and calendar life for HEV and PHEV as in cells using the Gen3 + additive materials. The use of a spark may hinder the actual results. For example, in the iron phosphate test, the presence of a spark during the release of a flammable electrolyte causes a flame; however, if there is no ignition source, there will be no flame as the iron phosphate will not produce oxygen and will not spontaneously ignite. This would produce excessive gassing and smoke, but rarely a fire. One reviewer has very detailed comments, stating that Dr. Roth has been a leader in developing practical methods for characterizing cell safety, and his work has been very useful for the battery developers. It would be particularly useful for future work to focus on developing improved methods for characterizing component safety - both heat generation and gas generation. The existing techniques (ARC, DSC) are useful, but suffer from problems with reproducibility, especially for gas generation. The reviewer was very pleased to see Sandia trying to develop methods to characterize cell response to an internal short, since this is a very important area, particularly given all the present discussions in regulatory agencies on this subject. They noted that the methods presented seem to rely on starting at a high initial temperature, or overcharging the cell to 20 V, however they encouraged future work to focus on developing better methods to generate internal shorts. One person commented on the important findings showing safety relative to $LiCoO_2$ benchmark, but even more important is their realistic testing of a total cell to supplement ARC and fundamental studies. They added that the real-time gas analysis and linkage with ARC/DSC studies and partnership with ANL is really paying off. They felt that the PI has effectively addressed reviewers' requests for science and understanding, not just data and results. The reviewer noted that the researcher's technology leading insights on separator behavior and the best assessment of the impact of manufacturing defects the reviewer had seen. The final reviewer commented that Roth has not developed the capability of analyzing his data in a modern manner, which would consist of comparing his data to models that could be used to predict the outcome of his experiments.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person noted that insights from the test will help companies identify and mitigate the unsafe conditions of a cell, which will lead to safe battery systems. Another reviewer commented that while increased thermal stability is an improvement, it may need to get to a point where there is no thermal runaway or fire to be able to be used in the HEV and PHEV. One reviewer indicated that the findings from this work in the area of identification and characterization of mechanisms of gas and heat-producing reactions provide significant and valuable advancement of knowledge in this area, which is directly transferable to the marketplace. Another person pointed out that this task's value comes in developing best methods for evaluating cell and component safety, and then teaching those methods to cell and component producers.

One person had detailed comments, stating that like ANL's work, it is not yet clear which of these safety approaches will "win" in the market place, but this work is critical in getting realistic abuse data and understanding on real cells. They noted that their work has led emphasis to industry efforts to improve separator safety. The reviewer pointed out that safety of defect cells (soft/hard shorts) will be key in moving to a practical cell; such defects will inevitable be part of the population of any mass produced cells from time to time. The reviewer commented that they are still not happy with the lack of safety goals from the car makers. They caution that they do not need complete safety since, they believe, that 10,000 or so cars catch fire in the U.S. every year, along with quite a few gas stations, so by saying you want a "safe" product is far too “wishy-washy” as an engineering and program goal. One reviewer observed that most of their work are of analytical nature and were unsure how much of them can be directly transferable; however, the knowledge they provide to developers from their work is invaluable in designing a safer battery. They concluded by mentioning that techniques they have developed to evaluate separators could be transferable. The last person cautioned that some solutions require better evaluation (economical? and existing process compatibility) to verify their transferability to the marketplace. The final reviewer mentioned that Roth has been working with separator manufacturers to help them develop their separators; however, he has not developed tools that could be used to predict the effect of design changes in the cell or in the components of the cell.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

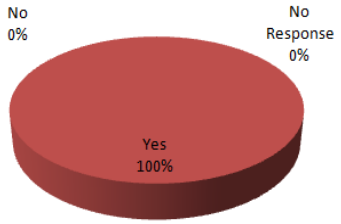
One person simply stated that the group has performed excellent work for the funding obtained. Another reviewer was very positive of the group’s progress, highlighting that the testing is very tedious, time-consuming and resource-intensive, and that the group should be funded more. One person felt that it was quite hard to make an estimation of the resources when an important funding is already in place ($750K) in respect to the important experimental work done and planned. Another mentioned that the amount of resources in the areas of this project devoted to identification and characterization of mechanisms of gas and heat-producing reactions should be increased. One reviewer questioned whether the PI has enough resources to do a significant number of replicates, since cell-to-cell variation in this type of testing is usually quite large. The final reviewer had dissenting a opinion stating that the funding for program is excessive relative to the results produced.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

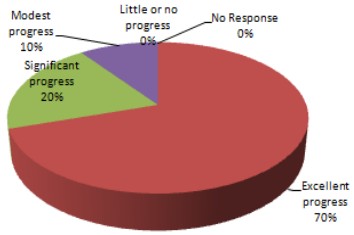
There were no expository comments for this question: refer to the graphic on the next page for this project’s summary score.

Project: Abuse Tolerance Improvement

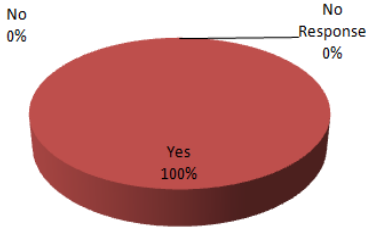
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



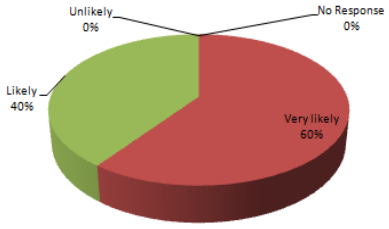
Question 3: Characterize the technical accomplishments and progress toward goals.



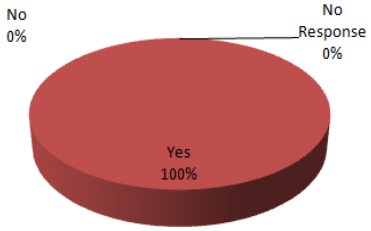
Question 2a: Are the goals of the project technically achievable?



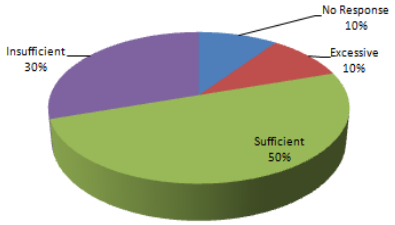
Question 4: How likely is the project team to move technologies into the marketplace?



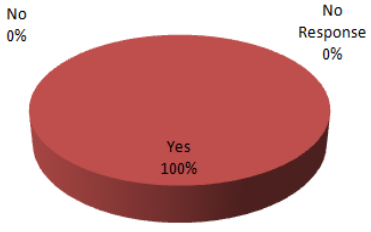
Question 2b: Have the technical barriers been identified and addressed?



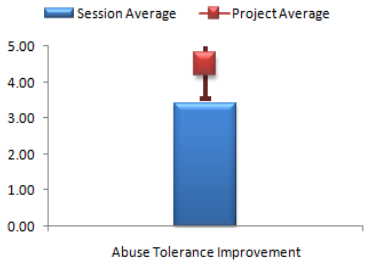
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Chemistry: Electrolyte Modeling (Kevin Gering, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were generally positive. One reviewer stated that low temperature performance is very important, while another person similarly remarked that low temperature behavior of li-ion batteries is still a key target for the DOE program. One other reviewer commented that electrolyte properties are key to obtaining good ionic conductivity at low temperatures. So focusing on electrolyte transport properties and modeling will actively support the improvement in low temperature performance of li-ion cells. Another respondent indicated that useful modeling of li-ion electrolytes can provide useful information towards improving cell performance in general and towards potential improvements in low temperature performance more specifically. Additionally, this work may help to better determine the root causes for limitations in li-ion electrolytes. One reviewer indicated that Gering's work on modeling electrolytes will reduce the time needed to develop electrolytes for lithium ion cells for HEVs and PHEVs, thus reducing oil use. The last reviewer stated that this was nice work, but added that recent lab work by Jansen shows that the electrolyte properties are probably not the problem for low temperature performance.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that the use of an already developed and validated model AEM is a reasonable approach to look at the low temperature mechanisms at the anode. In this way, the behavior can be analyzed and technical barriers better identified. One individual commented that, as mentioned above, electrolyte and ionic transportation in the electrolyte is a critical aspect at low temperatures to obtain good performance. Hence focus on this aspect will provide good insight into factors affecting low temperature performance. Another reviewer noted that Gering's electrolyte model has already been used successfully for electrolyte optimization studies. He has recently extended his model to include transport modeling and transport through cell separators, which will provide help to cell developers. One person stated that actual improvements in Li-ion electrolyte performance may not be directly achieved within the scope of this project, but the output of this project may be helpful towards overcoming the identified barriers through other future research activities. Another reviewer commented that the work is quite interesting, but this reviewer is not sure it is the factor that is responsible for the poor low-temperature behavior. Andy's results show no big dependence on electrolyte composition. Similarly, one person noted that this is nice work, but recent lab work by Jansen shows that the electrolyte properties are probably not the problem for low temperature performance.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the use of binary salts is a good approach. Transportation of the ions and their diffusion has been included in the desolvation model. Variation of concentration profiles with respect to spatial distance and time is a good factor to be taken into consideration. The information on the concentration profile comparisons between 30°C and -30°C provides valuable data. Another response indicated that a useful estimation of the limitations in li-ion electrolyte and/or separator systems on high-rate or low temperature performance can better guide the direction of future

development activity with regards to separator development versus electrolyte solvent composition development versus salt composition/concentration development. One other person wrote that Gering's work has lead to a deeper understanding of how the electrolyte affects cell performance. Cell developers have used this understanding and his computational tool to predict the effect of changing electrolyte components on the performance of the cell. It is expected that his recent work will continue to contribute to improved cell performance based on developing electrolytes using his modeling instead of using a trial and error experimental approach. To contrast, one reviewer remarked that the results are interesting but of a limited impact in giving solutions. The porosity of the separator may improve the situation but other affecting mechanisms are not analyzed. Another reviewer indicated that it is really not clear what this task has done that is of actual use to the battery community. The presentation describes a lot of basic transport modeling, and asked how that is providing any new insight. Similarly, one other respondent wrote that the modeling is very good but some of the results are a bit hard to understand – this really needs a much more in-depth review. This is a very hard topic to explain in such a fast format. The final reviewer commented that the researcher's rigorous nature of work deserves credit. But this reviewer is not sure that this is getting us to the final goal. This reviewer thinks that the time has come to call it a day and focus on something else.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent indicated that the AEM transport model takes into account ionic and bulk transport properties, desolvation of lithium, etc. It is a good model that considers the electrolyte properties, which will provide significant insight into low temperature performance. Another reviewer noted that Gering's work may be used to reduce the development time for improved electrolytes for lithium cells as advances are made in the active materials which may require different electrolytes from those commonly used now in lithium ion cells. One response stated that technology transfer is mainly done through publications. One reviewer commented that deployment will only occur if they find a solution. This reviewer adds that there are currently no results to generate such an interest. Another reviewer indicated that this task has yet to publish any papers describing the mysterious electrolyte model that has it has advertised for several years now. That makes the task appear more like snake oil than science. Would this model stand up to peer review? This task would be much more useful if it published a library of transport properties for electrolytes, accompanied by documentation of how the measurements were done and what is the measurement error. It would be sufficient for the library to be password protected for participants in the USABC program. This reviewer added that, if the measurement of these properties has been funded by the DOE ATD program, then the results should be available to everyone in the USABC program. One final reviewer said this is nice work, but recent lab work by Jansen shows that the electrolyte properties are probably not the problem for low temperature performance.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer indicated that this is good work for the funding obtained, while another wrote that the funding for Gering's work is sufficient. Another person commented that, for the level of funding that this task is presently receiving, it should be publishing more results in peer-review papers and/or a USABC library. Another reviewer stated the project requires more effort to accelerate results. In contrast, one respondent indicated that he or she would not fund this anymore. One other reviewer acknowledge that he or she had supported this work before as it had a novel desolvation theory that might have explained the cell problems at -30°C. However, the data shows the problem is related to interfacial issues that do not change much even with major changes in the electrolyte. Certainly, a

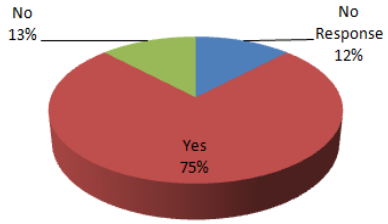
separator effect seems irrelevant. Therefore, this reviewer has to question the utility of continuing this work unless it can be used to guide Andrew Jansens' work.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

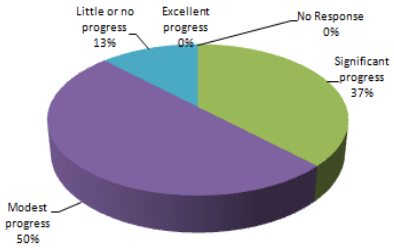
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Chemistry: Electrolyte Modeling

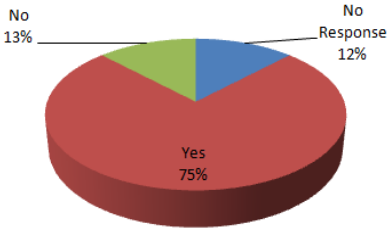
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



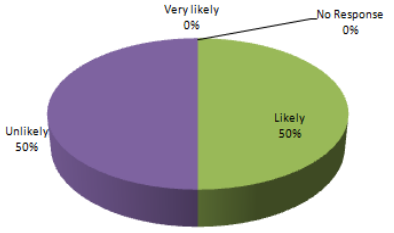
Question 3: Characterize the technical accomplishments and progress toward goals.



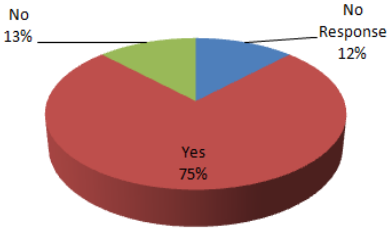
Question 2a: Are the goals of the project technically achievable?



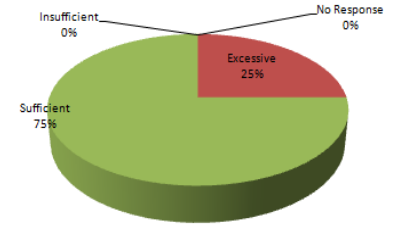
Question 4: How likely is the project team to move technologies into the marketplace?



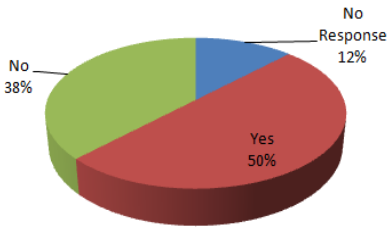
Question 2b: Have the technical barriers been identified and addressed?



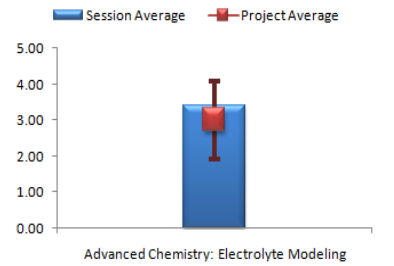
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



ANL Diagnostics (D. Abraham, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person simply stated that the project is critical to understanding and progress. Another commented that the project helps to better understand the cell behaviors. One person indicated that the project is another basic brick supporting lithium battery development for 15-year calendar life. Another remarked that determining the mechanisms limiting life is in line with the DOE goals for the PHEV program. The last person commented that the project will lead to more rapid development of batteries for HEVs and PHEVs thus reducing oil use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer simply noted that the researcher has shown sound approaches to attack the issues. Another person acknowledged that the researcher has worked in close collaboration with some universities and tries to understand the results in depth. One reviewer felt that the researchers showed a very good approach, although they thought that a lot can be learned by tear downs of commercial power tool batteries. One person noted that the researcher's approach to understanding capacity loss and aging of cells has lead to a deeper understanding of the data obtained at ANL and at INL. One person felt that the multi-institution approach has allowed the team to well identify technical degradation barriers. They added that the project shows solutions to overcome barriers; however, a limitation seems to be the absence of comparison with other chemistry and engineering test results (such as those discussed in the Battery Development Projects with developers projects). The final reviewer highlighted that the project plan is to identify the life limiting factors by studying the various components of a cell including electrode, electrolyte and separator studies. The reviewer added that the results from the study will be used to improve materials to extend the life of the battery to 15-years as required for the PHEV. The last reviewer cautioned that the scope of the project may be too large. They suggested that future work may be more productive if focused more on only one of either (1) diagnostics of cell aging, or (2) life improvement through cell configuration (additives, electrode design, etc.). If focus is on 1.), then incorporation of similar studies of widely available mass-produced cells of the most relevant configurations should be included.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person simply stated that the researcher's solid presentation showed good work. Another person noted that the project tries to find the reasons behind the results obtained. One person commented that the results are interesting but the evaluation is not sufficient because it is mostly limited to in-house cells. One reviewer commented that the researchers have shown good consistency of effect of additive across various electrode vendors. The reviewer felt the approach was very good, and noted the use of reference work and XPS. However, the reviewer was a little disappointed at the relatively low amount of progress since the 2006 review, adding that they expected more. Another person commented that the researcher has used analysis tools to understand the cell data from various vendors. They concluded by observing that the work is leading to improvement in the design and fabrication of cathodes in particular that will probably last longer. The last reviewer had detailed comments, mentioning that different methods have been used under this study: the first method

involved a study using electrodes from different manufacturers; the next method evaluated Gen 3 cells made by ANL, and the third method studied Gen 3 cell with an additive (fluorinated LIBOB). The reviewer noted that the use of the additive has shown to reduce impedance growth with cycling. They suggested that the researchers need to carry out long-term cycling at temperatures and loads seen for the PHEV. They indicated that accelerated aging tests are good to make quick improvements, but baseline cells should be placed on long-term test. They concluded by mentioning that the researchers need to also work with Sandia to obtain safety test data since the Gen3 with the additive looks promising.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reactions to this question were mixed. One reviewer commented that the project provides key fundamental information, but that the progress just needs to be accelerated in some way. One person acknowledged that the use of additive to the Gen 3 cells shows promise for technology transfer and commercialization if it can meet the long life required. Another person commented that the work shows that an additive reduces the resistance build-up in cells and can lead to longer life; the utility of this additive is clear and may be used by battery vendors to improve the life of their cells. One person observed that the industry collaboration is quite limited and the plan for technology transfer is not clear. The last reviewer pointed out that this project involves analytical work, which is of interest to developers, but not necessarily of licensable nature.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

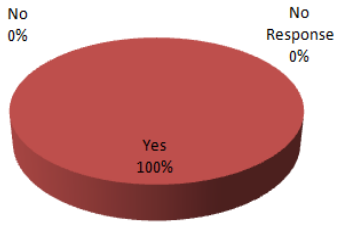
One reviewer simply noted that the funding for this project is sufficient, while another mentioned that extensive work was carried out for the funding received. Another reviewer thought that the staffing is acceptable and the quality is good, but wondered whether they are being diverted too much by other duties. The last reviewer, however, felt that the presentation gave no clear indication of the effort, so an adequate evaluation was not possible.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

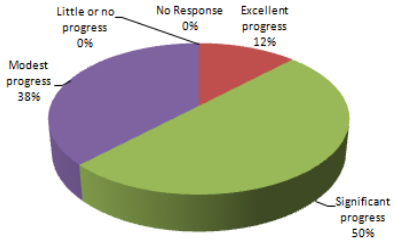
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: ANL Diagnostics

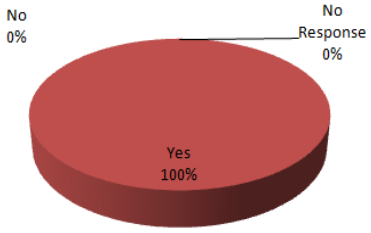
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



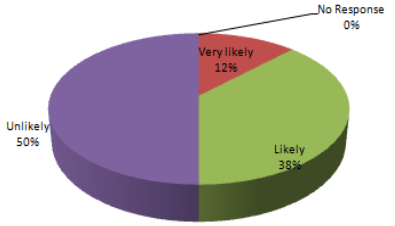
Question 3: Characterize the technical accomplishments and progress toward goals.



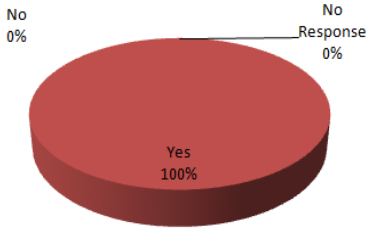
Question 2a: Are the goals of the project technically achievable?



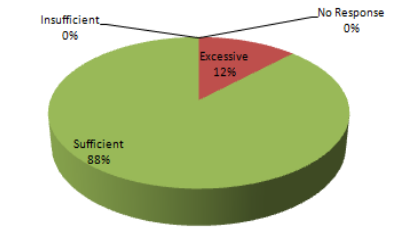
Question 4: How likely is the project team to move technologies into the marketplace?



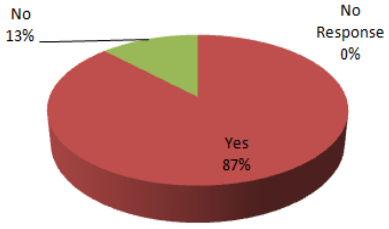
Question 2b: Have the technical barriers been identified and addressed?



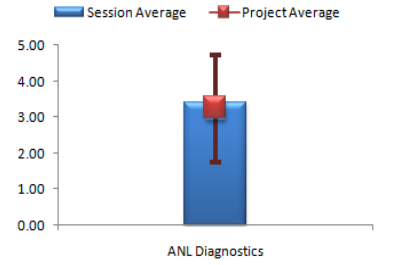
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Diagnostics at BNL (W-S Yoon, of Brookhaven National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were positive overall in this section. One reviewer stated the diagnostics work is relevant to DOE objectives of better performance and safer batteries, while another respondent commented that in-situ work is very relevant and helps support fundamental experimental work and modeling studies. Adding to this, one other person wrote that in-situ work provides significant data on the products obtained during the charge/discharge process and can be correlated back to improving or changing not only the components but also operating conditions. One reviewer noted that the studies of how a crystal structure decomposes are important for the improvement of materials, which subsequently leads to improved safety and cycle life. One person stated Yoon's work will lead to a better understanding of the use of low temperature additives for lithium ion cells. This work will lead to faster development of better lithium ion batteries, thus bringing HEVs and PHEVs to the market faster, and thus reducing the need for oil.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that there is a good plan going forward. One respondent added that the introduction of new diagnostic techniques for in-situ evaluation is a very good approach to improve the knowledge of degradation mechanisms of electrode materials of lithium batteries. Another individual stated that Yoon's use of X-ray tools to study in-situ phenomena that occur during aging of lithium ion cells is useful and should lead to a better understanding of the degradation mechanisms that occur during use of the cells. The last person wrote that no mention was made for the purpose of the study – the main goal was to obtain cells with a 15-year life for HEV and PHEV applications.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer wrote that the results are complete and complementary to those on anode studies, adding that the evaluation of cathodes is important as well. Another reviewer said that there are outstanding results on many systems showing the interplay of charge rate on stability. In particular, this reviewer liked the understanding and interpretation of their data and linkage with the other labs (Berkeley and ANL). This reviewer suggests this work be expanded to look at charge voltages as well. One other reviewer stated that Yoon's work has provided X-ray results showing that structural changes in LG spinal cells occur due to high discharge rates. He has showed that cycling changes the structure of the cells to a greater extent relative to high temperature storage. The data obtained in this project will be useful to battery manufacturers. For example, Yoon's X-ray data shows the utility of using a surface coating such as MgO. One individual remarked that good work has been carried out. A lot of work has been carried out that provides very good data on the transients formed during the discharges at high rates as well as high temperatures. The data on the cobaltate does not correlate with known data. Cobaltates are known to release oxygen at higher voltages more readily due to the instability of the crystal structure at higher voltages. TRXRD indicates that only the nickel is unstable both in the surface and bulk according to the data presented. There may be other factors that induce this and that needs to be expressed. Another reviewer commented that the group appears to be studying old electrodes that are already known not to be used in batteries that are state of the art li-ion

battery technology. One final reviewer wrote that the work is more of the same compared to what has done in the past. Nevertheless it is solid good work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent commented that the group is doing good work that is critical for improvements in understanding life of Li-ion cells. One reviewer remarked on the good results, noting that there are easy to understand and very relevant to cell designers. One person stated that improvement of materials leads to better product. Another individual simply wrote that the technology transfer is ok. One final reviewer said Yoon's work will be useful to battery manufacturers to help them understand better how the Gen-2 and Gen-3 cells function. For example, Yoon's work indicates that the use of Ni in the cathode should be minimized due to the degradation in the cathode material due to Ni.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

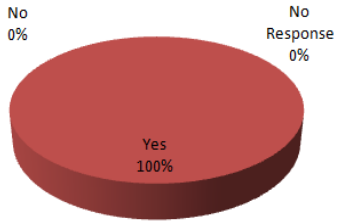
Multiple reviewers indicated that the current resources are adequate or sufficient, suggesting that they remain at the same level. One other reviewer noted there is a good volume of work for the funding provided. One final respondent stated the work is very good, adding that the group can do good work with what they have. This reviewer especially likes the new ability to study XRD of complete cells.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

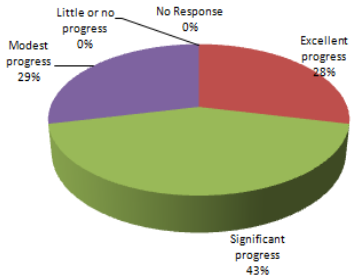
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Diagnostics at BNL

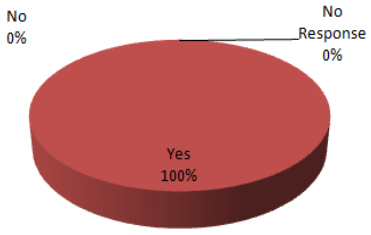
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



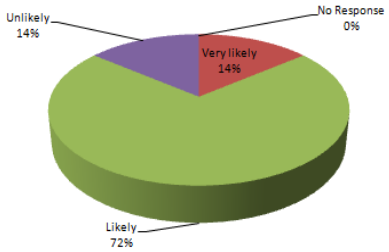
Question 3: Characterize the technical accomplishments and progress toward goals.



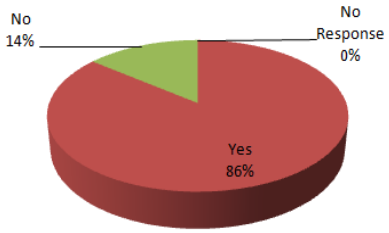
Question 2a: Are the goals of the project technically achievable?



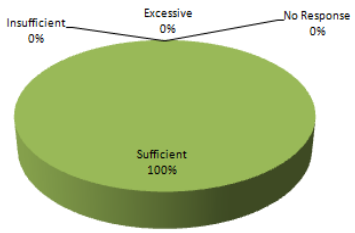
Question 4: How likely is the project team to move technologies into the marketplace?



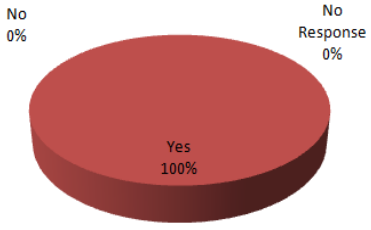
Question 2b: Have the technical barriers been identified and addressed?



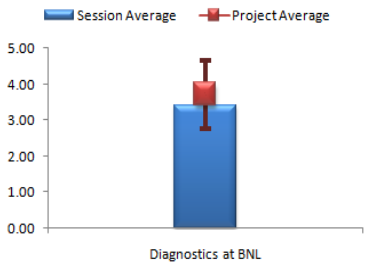
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Diagnostics at LBNL (F. McLarnon, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this question were all positive. One reviewer simply stated that the project is key to understanding electrode chemistries. One person noted that the project's diagnostic work supports the DOE objective of longer lithium life. Another person added that diagnostic studies of fresh and cycled cells provide a lot of data to make improvements in materials used in the cells. One reviewer pointed out that understanding the degradation mechanisms on a detailed level is important for cycle and calendar life. The last person noted that the researcher's work will lead to a better fundamental understanding of lithium ion cells that will help produce better batteries more rapidly to reduce oil use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person simply noted that the project tackles relevant problems. One person acknowledged that the use of spectroscopic, microscopic, X-ray, chromatographic, and related techniques to characterize cell components are considered to be good strategies for deployment. Another person commented that this diagnostic work is of critical importance because it addresses the fundamental mechanism of the formation process and the results of the study will be useful to those who are developing explicit formation mechanisms. Another reviewer commented that the proposed diagnostic approach is likely to conveniently address the key technical issues reducing life and improving performance of Gen-2 lithium cells. The reviewer added that as a design tool it may assist cell development and formation process optimization, but the extension to other chemistries is not clearly addressed. One person suggested that the project will improve the cycle life performance of the cells if the results of the diagnostics are used to make improvements to future materials used. One person acknowledged the great work, but indicated that if safety is a desire for study (which was part of the objectives of the barriers slide) DSC or ARC on aged materials and the correlation should be studied, noting that it was not obvious whether this was the case from the presentation. The last person commented that the project would be more useful and would benefit by including a scope which was not limited to only the Gen-3 chemistry, but which also included chemistries and materials from cells from significant mass-producers of li-ion consumer cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person simply noted that the project includes solid materials characterization studies. Another person observed that this project is basic chemical analysis tools such as Raman spectroscopy to determine the components that exist at the surfaces of the materials in the cells that are used, for example, to produce Gen-2 cells. One reviewer acknowledged that the project provided key information on anode SEI characteristics, and demonstrated important differences between Gen-2 and Gen-3 cathodes. Another person noted that the determination of the molecular weight of some components of the SEI via GPC is one particularly useful aspect of this work. One person commented that the work is of high quality with results giving significant advancements in the degradation and formation processes comprehension. They added that the extension of the approach to other chemistries will be of extreme importance for other activities in the Battery Program. Another

reviewer pointed out that this study is being carried out simultaneous to the work done by D. Abraham and provides data on how good the materials are that Dan is using, for example, the stability of the Gen-3 cathodes are confirmed with this study. One reviewer indicated the anode surface studies were interesting and that the cathode studies on homogeneity are useful and the results on Gen-3 quite promising. The last person had detailed comments, stating that the researchers have made good use of complementary diagnostic techniques to carefully develop a consistent understanding of failure mechanisms. They add that regarding anode studies of growth of disordered carbon regions over the course of aging and the hypothesis that stress causes the disordering; it would be very useful if you could try to validate this hypothesis by looking at anode materials that may have different stress properties, e.g. particle size or degree of turbostratic disorder. They were not sure why the researchers believe that a Sn coating on carbon would improve the stability of the SEI layer, given the known issues with volume change in Sn.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer commented that the main result for technology transfer is the optimization of the SEI. Another person indicated that the researchers used advanced spectroscopic techniques and novel artificial degradation method and attempted to suggest pathways for improved SEIs. One reviewer commented that the data and analysis from the diagnostic tool is efficiently being used to correlate the results from the experimental data provided by ANL. They point out that continuous interaction with both groups can provide good progress into understanding the use of new materials and changes. One person asked whether the non-uniformity the researchers indicated was incorporated into the ANL model, and if not they asked if this is possible to do. The last reviewer had detailed comments, stating that the results from this project indicate that the surfaces of the electrodes change with time. They acknowledge that the workers developed an argon-ion sputtering technique to simulate the aging process on carbon. It is not clear that this approach is useful relative to the actual formation process that occurs in the cells. They felt that this approach may lead to a better understanding of how the impedance of a cell changes based on damage to the carbon anode material; however, the utility of this approach is not clear relative to the formation process. The reviewer concluded by stating that the work on the cathode seems to be of limited value.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

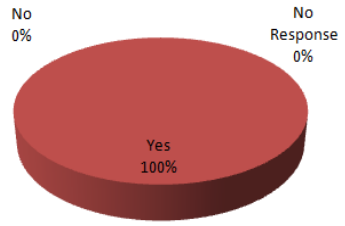
Reactions to this question were mixed. One person stated that the resources should be kept on same level. Another agreed, stating that the resources seem adequate to the work done and planned. Another person also felt that the work performed seems to be making good use of the funds and seems to be done in correlation to other experimental work. One reviewer felt that the program seems to be adequately staffed, but added that it needs "real" cells from ANL. The final reviewer remarked that the funding for this project is excessive relative to the utility of the results.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

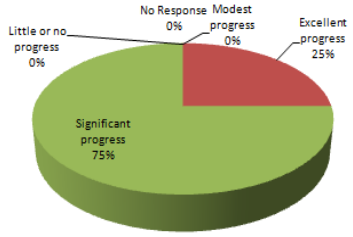
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Diagnostics at LBNL

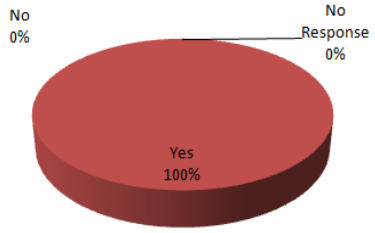
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



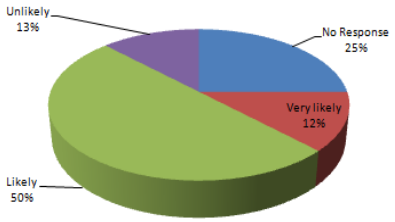
Question 3: Characterize the technical accomplishments and progress toward goals.



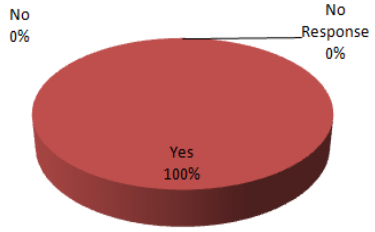
Question 2a: Are the goals of the project technically achievable?



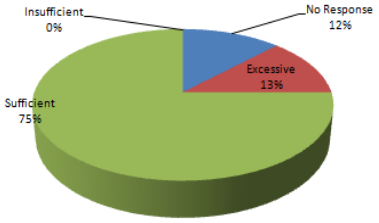
Question 4: How likely is the project team to move technologies into the marketplace?



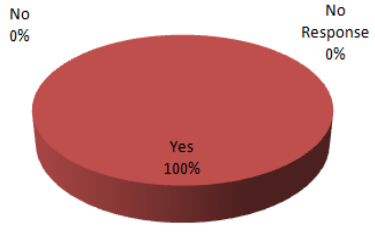
Question 2b: Have the technical barriers been identified and addressed?



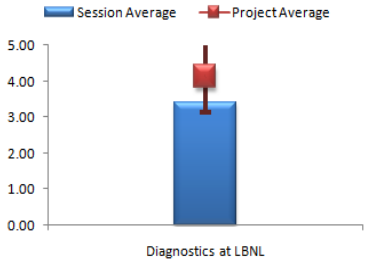
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Gen 3 Cell Model (Dennis Dees, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that it supports lithium battery improvement, while another person commented that Dees' work will lead to a better understanding and more rapid development of batteries for HEVs and PHEVs, thus reducing oil consumption. Another reviewer indicated that we need a fundamentals-based model like this more than a data-fitting model to understand what is going on inside the battery. One final reviewer stated modeling should be an integral part to designing cells, predicting their behavior, and then verifying whether the model works or not by testing real cells.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent simply commented "good," while another wrote that Dees' work is useful because of his in-depth contributions toward understanding the mechanisms that occur in lithium cells. Also, his work on the four-probe method should help users better understand the results from their experiments using this device. Another reviewer suggested that the project should include studies of cells produced by a significant mass-producer of consumer cells in its scope. One final reviewer remarked that the model is following adequately the cell development from Gen2 to Gen3. This reviewer asks: is it possible to extend the use of the electrochemical models to cell chemistries different from Gen-type?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer indicated that Dennis does very high quality work, and this reviewer is confident that his work will lead to a good resolution of these issues. Another person stated there is a good use of complementary experimental data to validate the model, and also a good use of the model for hypothesis testing to increase fundamental understanding. One other reviewer commented that Dees' careful work is an asset and will lead to a better understanding of the degradation mechanisms, which will lead to better cells that last longer. Adding to this, one reviewer commented that there is very nice coordination with experimental work. There is also a good use of four-probe DC data to supplement the modeling effort, along with a very realistic appreciation of what the data can and also cannot tell us. There is good progress overall. One person remarked that the modeling seems useful in a mechanistic way and addresses an important part of cell stability – the cell impedance as a function of storage, cycling, and duty cycle. It would be best applied to commercial well-manufactured cells for validation, however, because of the noted problems with cells made especially for ANL. One final reviewer noted that the results are only preliminary on Gen3 and require more test work. This reviewer asks: can the model be validated by enlarging testing work in the rest of the battery program? Is there any relation to thermal behavior and correlation with models developed at NREL?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer indicated that a good solution to these issues will be of interest to developers, while another respondent commented that the group is addressing and explaining key problems. One other person stated that, if the modeling is validated, it could find a number of uses in commercial cells. Another reviewer wrote that Dees' work is being used widely to help developers understand the

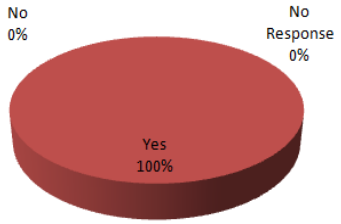
degradation mechanisms in lithium cells. One respondent wrote that the key value from this project is to publish papers disseminating the lessons learned, both in terms of modeling techniques and methodologies, and the best way to use experimental data to validate the proposed mechanisms in the model. The PI is doing a good job of publishing papers and should do more. One person stated that the use of the electrochemical model is of general value, but its transfer to the market cannot be directly considered. One final reviewer remarked that the technology transfer to the marketplace may be unlikely as long as the main focus of the project is on the Gen 3 chemistry only.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented that the group is doing very well with what they have, while another person stated that the work seems well organized even if no clear indication about resources and uses are described. One individual added that Dees' work is funded in an adequate manner. The final reviewer suggested that the resources for the project may be excessive given that the scope is limited to only the Gen 3 chemistry.

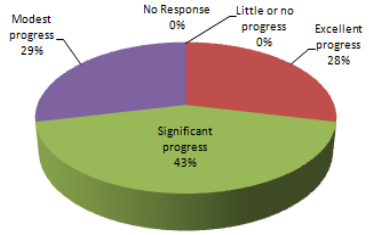
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Gen 3 Cell Model

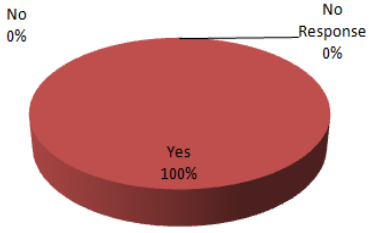
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



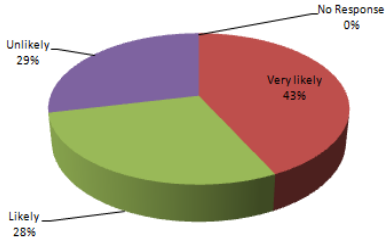
Question 3: Characterize the technical accomplishments and progress toward goals.



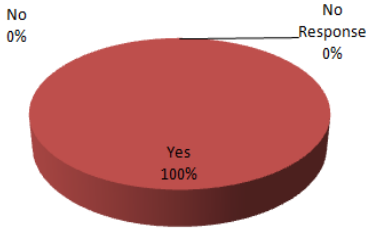
Question 2a: Are the goals of the project technically achievable?



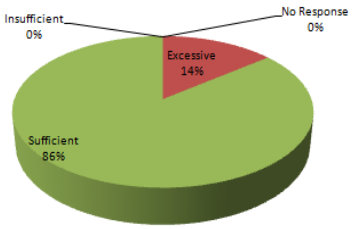
Question 4: How likely is the project team to move technologies into the marketplace?



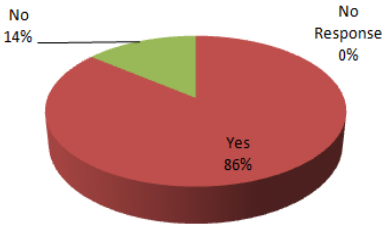
Question 2b: Have the technical barriers been identified and addressed?



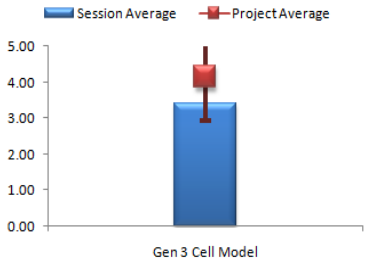
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Gen 3 Cell Status (Gary Henriksen, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer indicated that the research is designed to illuminate work on batteries for PHEV, while another person added that the project focuses on the fundamental lithium batteries objectives in the DOE program. One respondent stated that building cells with the materials studied is critical for final validation of those materials selected. Another reviewer remarked that this project is critical understanding and knowledge generation. One other reviewer indicated that Henriksen's Gen-3 cell studies may lead to more rapid development of lithium ion cells for HEVs and PHEVs, which will result in the reduction of oil consumption. To contrast, one final reviewer noted that the formulations and materials selected for Gen3 cells are not state-of-the-art, and one of the materials is no longer manufactured.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that there is good cooperation and working relationships with suppliers and customers. There is a nice plan in place overall. Another reviewer indicated that Henriksen is well aware of the need to deploy the results of their work. He and his coworkers are helping battery developers by testing their cells and sharing the results of the tests with the battery manufacturers. One individual wrote that the cell fabrication and testing is an intermediate step in identifying scientific and technological solutions for more application-oriented lithium batteries. Another reviewer commented that the strategy seems sound, but the group needs to secure excellent cell manufacturing to enable sound conclusions. Multiple reviewers commented on the decision to make in-house 18650, with one reviewer remarking that this will significantly reduce the chances of success. It takes time to learn how to adjust critical parameters for electrode making and cell assembly, a skill set that the national laboratories do not have. It would have been better to stay with developers for this build. Another reviewer added that the goal of developing the capability at ANL to make 18650 cells could potentially be a huge resource sink with little benefit. There are many factors that affect the performance of cylindrical cells. It is of limited value for DOE to invest the resources needed to learn those manufacturing techniques; therefore, the results of studies with these cells would be subject to the quality of manufacturing. DOE's resources would be better spent focusing on fundamental mechanisms that affect all battery developers. One final reviewer wrote that, to develop state of the art formulations, you need much larger sample runs of combinatorial compositions that are statistically significant as well as a high throughput testing capability. The labs should partner with industry to work on a much more significant effort to work on larger and more statistically significant analysis. This should include high throughput formulation studies carried out by industry and testing and analysis carried out by the National Labs. The labs do not have the knowhow on state of the art formulation development. The compositions studies are useless. Formulation is what cell manufacturers do for a living. It is also unreasonable to assume a national lab can assemble state of the art cells by hand or with semi-automated equipment with the small cell assembly setup as Mr. Hendriksen is proposing ANL procures. Industry should work on combinatorial formulation studies and National Labs should work on analysis, testing, and validation. This reviewer closed by remarking that the calendar life test data is unreliable since reproducible, high volume, and high quality cells produced by a real pilot production line were not used in the study.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer wrote that the project shows a reasonable approach without significant risk or drawbacks in completing testing work, while another person commented that the overview shows the PIs have made some important progress. One other respondent noted that Henriksen's project is focused on improving safety and other attributes of lithium cells. One reviewer stated that the team has clearly worked very hard and moved quickly – but is it moving in the right direction? To follow up on this question, one reviewer adds that it appears that most of the work is of routine type and does not lead to any specific meaningful recommendation for future work that will lead to addressing DOE's main objective mentioned above. Another respondent felt that there is no new technology here and little results from the testing. One reviewer stated that the progress of this project is fundamentally limited by the lack of interaction and cooperation with a significant mass-producer of Li-ion cells, while one other person wrote that the presence of leaking cells from a major part of the effort from one of the suppliers indicates a setback in the effort. This reviewer adds that results from such cells are suspect and unreliable.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses to this prompt were mixed overall. The first response stated that material studies have a reasonable chance of marketability if sound cell results can be obtained. One reviewer said Henriksen's contributions to improve safety may lead to useful results. Another respondent commented that this is mostly routine analytical work. One person felt that the chemistries used should be also referred to more conventional, commercial formulations to improve transferability. One reviewer indicated that some of the work is proprietary to the developers worked with. This limits the bigger deployment to multiple companies and significantly reduces the ability to transfer to market. This reviewer added that DOE will need to strike a balance in proprietary projects and non-proprietary, which is not an easy balance to make. Another response suggested that National Labs should be focused on fundamental research and not competing with industry. Having the National Labs assembling full size cells is not a good use of their skill set, and the labs should work with U.S. cell manufacturers (EnerDel, A123, JCS, etc) to have cells assembled for them. One final reviewer asked: with the recent plethora of high power li-ion cells for power tools, is there anything to learn by looking (small effort only) at these? For example, this reviewer indicates that manufacturers often have proprietary electrolyte additives for safety and cycle-life that can be gleaned by analysis on these cells. Overall this is a good plan, but very U.S.-centric.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

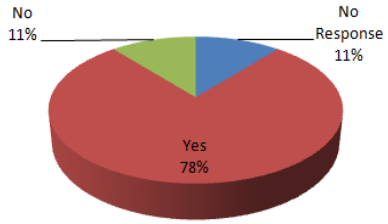
One reviewer commented that the new dry room should be very helpful. Another person felt that funding for this project is sufficient. However, funding should be reduced for those projects that are not making significant progress. Other comments were less positive. One reviewer stated the evaluation still remains difficult due to the limited description of planning and resources, while another indicated that it is unreasonable for ANL to do cell assembly. Adding to this, one individual noted that the funding for the dry room and equipments is not sufficient to build good cells, as far as the equipments go It will likely fail due to variance in the cells' build, and false negatives and positives will be obtained. Another person stated that manufacturing of quality 18650 cells requires substantial resource investment beyond what is considered in the scope of this project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

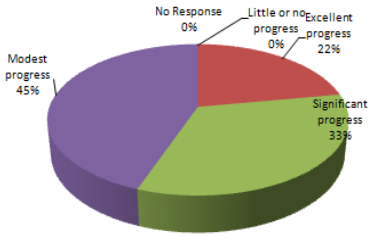
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Gen 3 Cell Status

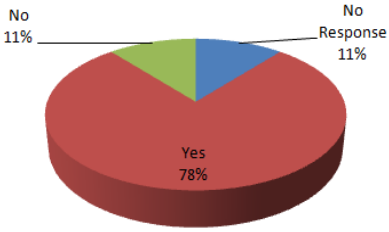
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



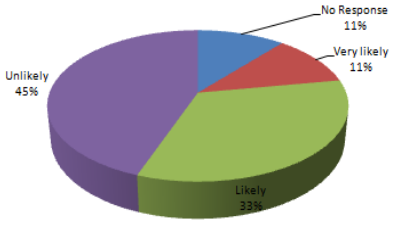
Question 3: Characterize the technical accomplishments and progress toward goals.



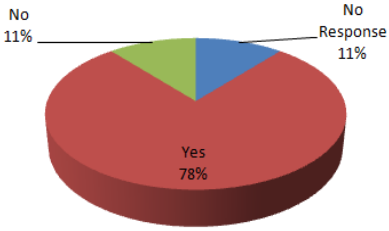
Question 2a: Are the goals of the project technically achievable?



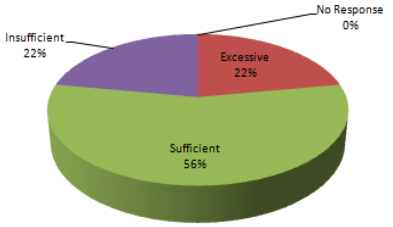
Question 4: How likely is the project team to move technologies into the marketplace?



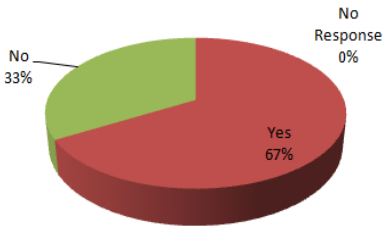
Question 2b: Have the technical barriers been identified and addressed?



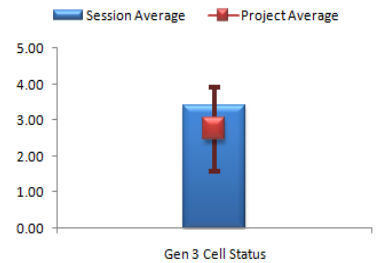
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Gen 3 Cell Testing (J. Christopherson, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
All responses in this section were generally positive. One reviewer stated this project supports lithium battery development in the DOE program, while another (similarly) noted that the project serves as a support activity to overall DOE objectives. One other person commented that the goal of the program is to understand the life-limiting mechanisms and enhance battery lifetimes, which is in line with the objectives of the DOE program. Another added that studies of full cells using the identified materials are critical to the success of the program. One reviewer wrote that life testing and modeling is critical for implementation – this reviewer cannot wait to get real life testing even in final product, let alone in R&D cycles. One final reviewer remarked that the testing of cells being carried out at INL will help develop cells for HEVs and PHEVs, and thus reduce oil use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent indicated that the project scope is to carry out testing on cells developed at ANL, with no significant technical barriers. Another reviewer stated INL's testing program will lead to a better understanding of the degradation in lithium cells.

One other person said the project plans were to conduct accelerated aging on cells made by battery manufacturers (materials were provided to them for cell manufacturing), conduct tests on more samples, perform diagnostic analysis on torn-down cells that had undergone cycling, and use statistical methods for analysis of results. One reviewer commented "good," adding that this is straightforward testing and appears to be well performed. However, the researchers have not had success due to bad cells. The methodology used for the measurements are good; however, since no baseline is available from the manufacturers there is no way to assess the failed cells. If that baseline was available some additional knowledge could have been gained on the cell builds. The goals are therefore not fully achievable with the strategy chosen. One final reviewer asked: why even bother evaluating cells from a set that has leakers – even the non-leaking cells are highly suspect. This reviewer added it is always important to run a control – look for differences in cells and testing.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer indicated that testing is an integral part of the program if li-ion batteries are going to make it into applications. Another person commented that, as a support activity, the project has provided timely and well-documented life cycle observations of Gen-3 cells. One person noted the results are online with planning. Some more comparison and evaluation of the cells' degradation with respect to the previous generation would be of value. Another person commented that they do not trust the data as presented, and that the program needs a lot more work. One other person remarked the analysis of the data obtained in this project seems to be very thin. The experimental design was not clearly stated. The use of fewer replicates will reduce the value of this work. One reviewer noted that Gen-3 cells with and without an electrolyte additive were tested. The methods used for accelerated aging are good, but the use of different manufacturers is not a good idea. This will not provide a good comparison as different manufactures have different methods of coating, calendaring and formation.

The PI needs to zone in on one manufacturer and the present experience may provide the basis for selection of one such company. The high temperature tests are good but the temperature needs to be below the decomposition of the electrolyte. The cell leakage eliminates the use of that manufacturer for future work. Another response stated that the studies on degradation show very rapid degradation. This is a failure and no real conclusions can be drawn based on leaking cells and fast degradation. No baseline cell established with the cell manufacturers, which hinders the ability to study if the fast degradation seems is due to the materials or due to the actual cell build itself.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses to this prompt were generally negative. The first response stated that there are no direct market implications, while another reviewer commented that this is not new technology. Accelerated aging tests under high loads and using high temperatures is a common method. Another person stated that the results from these tests are inconclusive. One reviewer stated there are no good cell data, due to leaking cells and fast degradation, while another reviewer added that data reproducibility is questionable; using suspect cells is no good – better to get no data than misleading data.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

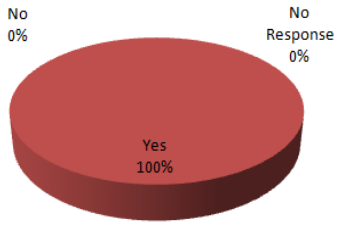
One reviewer commented that there is good work for the funding provided. Good data is provided by this group and this lab is an excellent resource for testing. Another person stated that the effort is not described but there is no evidence of problems. One respondent did not agree with the decision to keep testing at a small scale to cover a wider range of chemistries – you need to have valid data especially at early stages of R&D where you are going to make major decisions on which chemistry to pursue. This needs more resources to do valid testing. This is not a reflection on the PI – they are doing what they can, not what needs to get done! The final reviewer indicated that the results from this project seem to be limited to data that was gathered without much prior planning concerning the analysis of the data.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

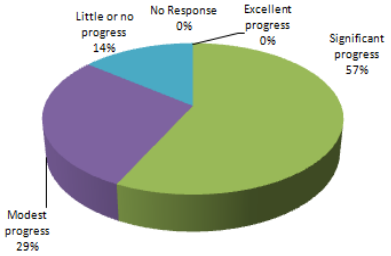
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Gen 3 Cell Testing

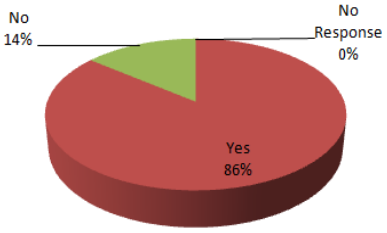
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



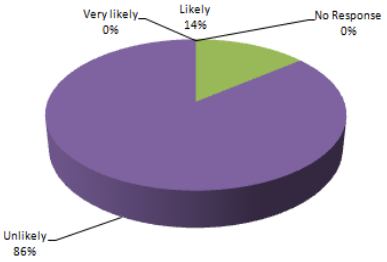
Question 3: Characterize the technical accomplishments and progress toward goals.



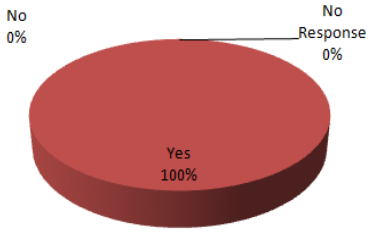
Question 2a: Are the goals of the project technically achievable?



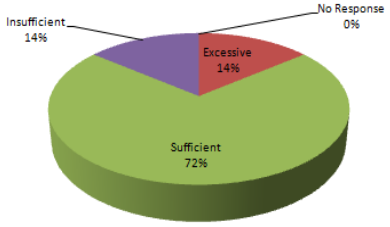
Question 4: How likely is the project team to move technologies into the marketplace?



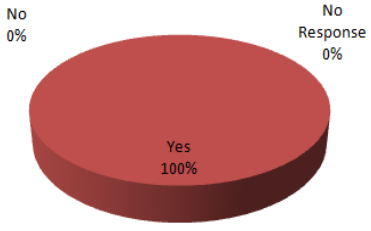
Question 2b: Have the technical barriers been identified and addressed?



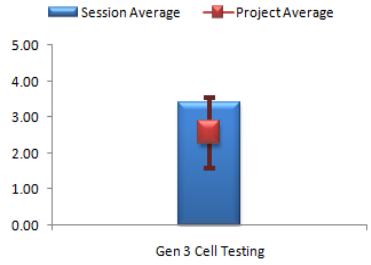
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Life Validation Testing Protocol Development (V. Battaglia, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that calendar-life prediction is very important. Another stated that the development of test protocol is important to verify the achievement of the DOE objective regarding lithium battery performance. Similarly, one other reviewer wrote that making cells with optimum performance is in line with the long life requirement for the DOE PHEV program. One reviewer stated Battaglia et al.'s work will lead to better batteries and allow the realization of HEVs and PHEVs. This work will, in turn, help to reduce oil consumption. One final reviewer indicated that similar methodologies have been developed and have been widely employed for some time within the industry for the general process and methodology addressed in this work. However, understanding the general methodology may be useful for new developers who may be entering the market in the future.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that this is a good plan to attack this important but daunting task. Another person wrote that the life test protocol and life estimation software and manual development are part of an integrated effort combining proper expertise and experimental activities in various labs. One other respondent stated that the project goals are to understand the role component and to get the best electrode configuration and use this information in a full cell by making improvements based on the studies on individual components. One final reviewer added that Thomas' contributions to this effort will provide confidence in the results published by this group because of his background and knowledge of model development based on statistical analysis. However, the group should strive to use physics-based models because the utility of their empirical models is limited to the data set used to develop the model. It is surprising that Thomas' methodology has not apparently been used by Bloom et al. to analyze Bloom et al.'s data. Perhaps this has been done and not published yet.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated this is a very challenging task but the researchers are doing a good job in advancing this technology. Another individual commented that the results so far achieved are very interesting with very good progress in the way of a reliable statistical tool for life prediction. More evidence of the validation work should be presented with the level of confidence for the various chemistries and accelerating factors. One person remarked that the effect of battery models on the predicted life should be better clarified and analyzed. Another reviewer noted that the first step in the team plan is to study the component materials using diagnostic and characterization methods. Then the materials are studied using half-cells and then completed cells. In the meantime, modeling programs based on structure of the electrodes as well as system level modeling is carried out and the information fed back to optimize materials and systems used. It is a good method of optimizing but this reviewer did not see the difference between this work and the work carried out in the basic research area. There needs to be a demarcation between the two projects, and they need to make the best use of the funding obtained. One other reviewer commented that progress is too slow in this project. The lack of using a physics-based model is unacceptable. The results from the mechanism studies seem to be ignored by these empirical model developers. The final reviewer indicated that the

presenter wrote "by studying electrode formulations, different electrode designs, and newly developed materials, battery developers, automakers, and the DOE will have an increased knowledge of the limits of classes of technologies." The above is a very general statement, and no specific recommendation is found in the talk. This reviewer added that progress is very slow.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer indicated that this research has direct relevance to the market, adding that there is a currently no solid model to estimate and validate life. One reviewer wrote that the TVLT software tool, after complete validation and extension, may have a market application for battery developers and users. Another person commented that good progress has been made but no new technology was presented. One reviewer noted that this group may develop tools that will be useful to battery developers; however, the basic tools developed have been available from MATLAB for many years. One final reviewer wrote that this work has long way to go before it can be applied to any meaningful life verification of batteries.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

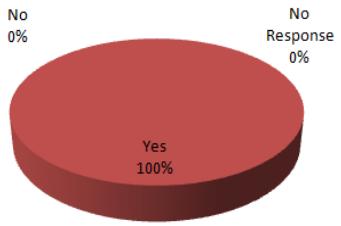
One reviewer commented that the involvement of multiple labs is an excellent approach in tackling this important issue, while another person added to this, stating that the integration of various National Labs is a way to optimize resources. To contrast, one respondent stated that the group could do more for the funding obtained. One final reviewer felt that funding for this project is excessive relative to the results presented. This reviewer added that these workers do not seem to be aware of other work in this area such as the SAFT model.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

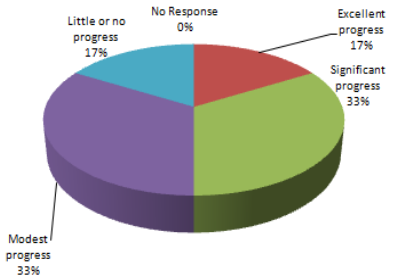
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Life Validation Testing Protocol Development

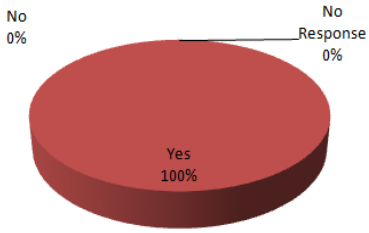
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



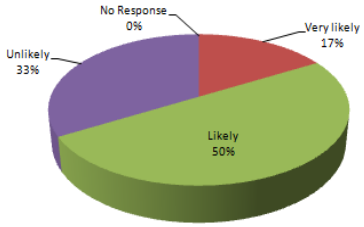
Question 3: Characterize the technical accomplishments and progress toward goals.



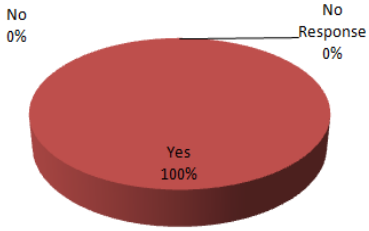
Question 2a: Are the goals of the project technically achievable?



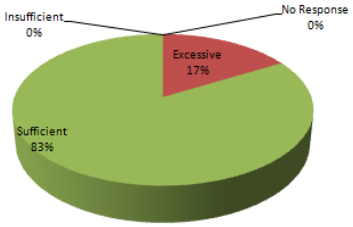
Question 4: How likely is the project team to move technologies into the marketplace?



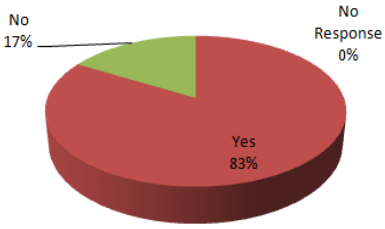
Question 2b: Have the technical barriers been identified and addressed?



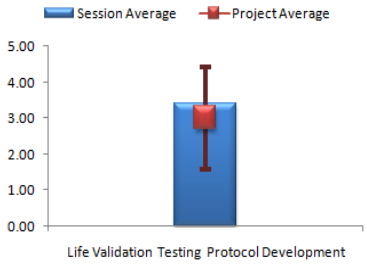
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Life Validation Testing Protocol Development (I. Bloom, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that the development of test protocol is important to verify the achievements of the DOE objective on lithium battery performances. Another person indicated that the project provides an independent evaluation of non-DOE work to determine how DOE can use this information in their program. One other reviewer noted that Battaglia et al.'s work will lead to better batteries and allow the realization of HEVs and PHEVs. This work will help reduce oil consumption. One reviewer said similar methodologies have been developed and have been widely employed for some time within the industry for the general process and methodology addressed in this work. However, understanding of the general methodology may be useful for new developers who may be entering the market in the future.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer wrote that the life test protocol and life estimation software and manual development are part of an integrated effort combining proper expertise and experimental activities in various labs. Another respondent stated that the project plan was to use the FreedomCar test protocols and accelerated aging test protocols to study and to project life and also provide support for the update and validation the manual used for PHEV testing. One reviewer commented that Thomas' contributions to this effort will provide confidence in the results published by this group because of his background and knowledge of model development based on statistical analysis. However, the group should strive to use physics-based models because the utility of their empirical models is limited to the data set used to develop the model. It is surprising that Thomas' methodology has not apparently been used by Bloom et al. to analyze Bloom et al.'s data. Perhaps this has been done and not published yet. In contrast, one other reviewer felt that the current state of accuracy of the methodology is not clear from the presentations. In order for the methodology to be significantly deployed and/or accepted, demonstration and documentation of the accuracy of the model may be necessary and should be possible. The reviewer added that there appear to be plans to accomplish this in the future, and obtaining cells of industry-standard reproducibility from a significant mass-producer of li-ion cells may be necessary and may require cooperation with a significant mass-producer.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the results so far achieved are very interesting with very good progress in the way of a reliable statistical tool for life prediction. Another person stated the first part of the program to benchmark the performance of commercially available cells is a good start. Battery level testing using batteries made by other manufacturers was also carried out. The manual written by INL was validated while carrying out the above tests. The use of 40°C to 45°C for testing is very good as it will not cause ambiguous results due to very high temperatures that would cause decomposition of the electrolyte. The method used for testing is consistent. This reviewer recommends working with local and well-known battery manufacturers. One reviewer stated that more evidence of the validation work should be presented with the level of confidence for the various chemistries and accelerating factors. Similarly, one individual though that the effect of battery models on the predicted life should

be better clarified and analyzed. One final reviewer indicated that progress is too slow in this project. The lack of using a physics-based model is unacceptable. The results from the mechanism studies seem to be ignored by these empirical model developers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent remarked that the TVLT software tool, after complete validation and extension, may have a market application for battery developers and users. One reviewer noted that the method of testing is not new. However, this reviewer added that the manual that is being written in collaboration with INL may have great technology transfer as well as marketing prospects. One respondent commented that this group may develop tools that will be useful to battery developers; however, this reviewer added that the basic tools developed have been available from MATLAB for many years.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

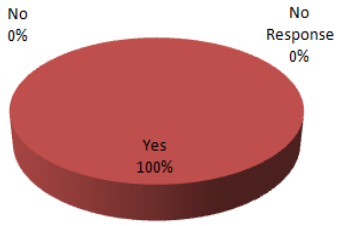
One reviewer stated that the integration of various National Labs is a way to optimize resources. One other person stated there is good work for the funding obtained. One final reviewer felt that funding for this project is excessive relative to the results presented. This reviewer added that these workers do not seem to be aware of other work in this area such as the SAFT model.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

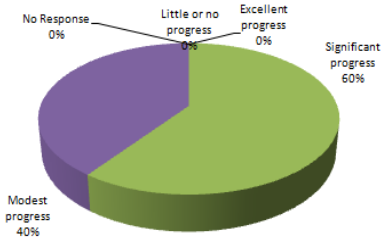
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Life Validation Testing Protocol Development

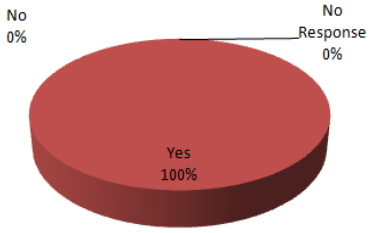
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



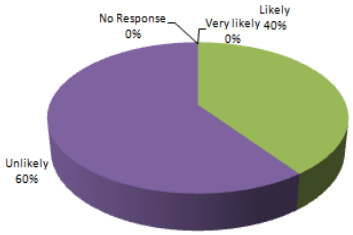
Question 3: Characterize the technical accomplishments and progress toward goals.



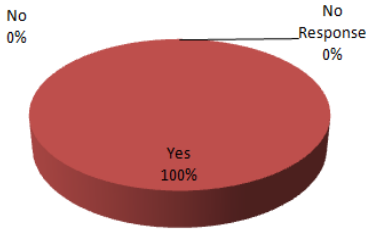
Question 2a: Are the goals of the project technically achievable?



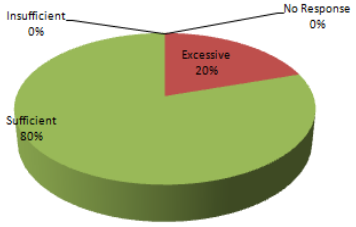
Question 4: How likely is the project team to move technologies into the marketplace?



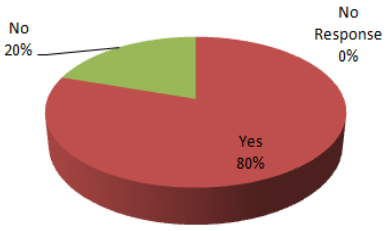
Question 2b: Have the technical barriers been identified and addressed?



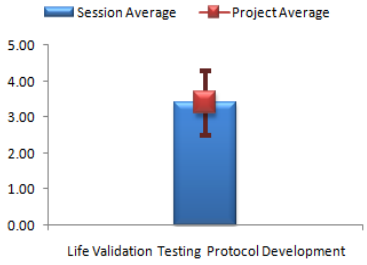
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Life Validation Testing Protocol Development (J. Christopherson, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer simply commented that the group is doing good work, while another stated that calendar-life estimation is an invaluable tool for the application of lithium-ion batteries. One other reviewer noted that the development of a test protocol is important to verify the achievements of the DOE objective on lithium battery performance. One reviewer noted that Battaglia et al.'s work will lead to better batteries and allow the realization of HEVs and PHEVs, which will in turn help reduce oil consumption. Another person remarked that there is a good cycle process in place. The group is working to develop a model, validate the model, check the results, check assumptions, make changes and go through the cycle again. The group plays an important role in a program where a technology's readiness for transition to production is being studied. One reviewer stated similar methodologies have been developed and have been widely employed for some time within the industry for the general process and methodology addressed in this work. However, understanding of the general methodology may be useful for new developers who may be entering the market in the future.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent indicated that the life test protocol and life estimation SW and manual development are part of an integrated effort combining proper expertise and experimental activities in various labs. Another reviewer stated that the matrix assumed for the model is good and a lot more comprehensive than in previous years. This is a good effort to work on completed cells rather than just materials. One person remarked that Thomas' contributions to this effort will provide confidence in the results published by this group because of his background and knowledge of model development based on statistical analysis. However, the group should strive to use physics-based models because the utility of their empirical models is limited to the data set used to develop the model. It is surprising that Thomas' methodology has not apparently been used by Bloom et al. to analyze Bloom et al.'s data. This reviewer adds that perhaps this has been done and not published yet. One response stated that this seems a good plan, though it was hard to follow in such a short presentation. The battery sample size still seems very small to this reviewer. One other reviewer indicated that he or she would answer "maybe" to the above questions. This task is ambitious in scope. The task is certainly very important - we need to find a way to forecast cell life from limited data and to develop accelerated life testing methodologies. The problem, of course, is that it will take time to know whether the forecasting and acceleration methods work. Since degradation mechanisms are chemistry-specific, this task would be of most use if they looked at multiple cell chemistries, rather than focusing on Gen-2 or Gen-3. The last reviewer felt that the current state of accuracy of the methodology is not clear from the presentations. In order for the methodology to be significantly deployed and/or accepted, demonstration and documentation of the accuracy of the model may be necessary and should be possible. There appear to be plans to accomplish this in the future, and obtaining cells of industry standard reproducibility from a significant mass-producer of li-ion cells may be necessary and may require cooperation with a significant mass-producer.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer thinks that a good foundation has already been established and further validation and refinements are necessary to make this model robust. Another person added good work, and indicated that the group needs to have more variations in SOCs as well as depth of discharges (DoD). The DoD also affects long term cycle life. The group also needs to collect DoD information with respect to temperature. One other respondent stated that the results achieved so far are very interesting with very good progress in the way of a reliable statistical tool for life prediction. More evidence of the validation work should be presented with the level of confidence for the various chemistries and accelerating factors. The effect of battery models on the predicted life should be better clarified and analyzed. One reviewer remarked that, in the talk a large number of things have been proposed to be done, but this does not come to any specific conclusion or accomplishment so far. Lessons learned are proposed to be incorporated in the revision of the TVLT manual, but the overall progress is slow. Another respondent wrote that this task is doing a good job of trying to get a handle on a very difficult problem. It is important that the PIs keep their statistical models grounded in physics, by staying in communication with the other tasks in the DOE programs that are trying to understand the physical mechanisms that affect life. One reviewer added that it was hard to judge actual progress from the talk. The work seems well-designed and poised to generate useful data, but this reviewer could not judge the value returned to date. One final reviewer stated that progress is too slow in this project. The lack of using a physics-based model is unacceptable. The results from the mechanism studies seem to be ignored by these empirical model developers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer indicated that developers will immensely benefit from this work, while another reviewer added that the plan seems good and developers want and need this sort of information, so transfer should be easy – there is a lot of pull from customers. One person suggested that the TVLT software tool, after complete validation and extension, may have a market application for battery developers and users. Another commented: good work on actual cells compared to work on models. The changes made have been evaluated and introduced into future models and validated again. To contrast, one reviewer remarked that this group may develop tools that will be useful to battery developers; however, the basic tools developed have been available from MATLAB for many years. One final reviewer stated that his or her main concern with this task is, who is it benefiting? This comment applies to many aspects of the DOE's programs and not just this particular task. The U.S. National Labs publish lots of information about batteries from developers in the USABC program. In general, these publications are of highest value to the Asian competitors of the U.S. companies. In contrast, while Asian (Japanese, Korean, and Chinese) governments are funding battery development at a much higher level of investment, those governments do not publish the results to the rest of the world. It would be of more use to U.S. battery companies if the U.S. National Labs tested and reverse-engineered batteries from the leading Asian companies (Panasonic, Sanyo, Samsung, etc.) and published those results. The U.S. DOE labs provide a valuable test resource to U.S. battery companies, but that resource's value would be maximized if the test results were kept confidential for the U.S. companies, or at least published only upon approval from the companies.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that this is appropriately a multi-lab effort, while another noted that the integration of various National Labs is a way to optimize resources. One reviewer indicated that the funding is sufficient for the work carried out. Another individual noted that this task requires lots of

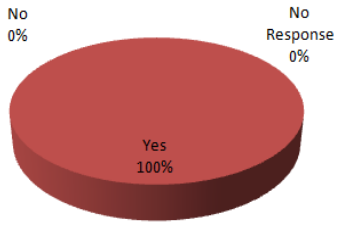
cycler channels to generate enough data to be of use. Similarly, one reviewer felt that the sample size still seems small for the amount of work required to get good data. Also, this reviewer asks, can any of the actual testing be outsourced and let the national labs focus on data interpretation? One final reviewer commented that the funding for this project is excessive relative to the results presented. The reviewer added that these workers do not seem to be aware of other work in this area such as the SAFT model.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

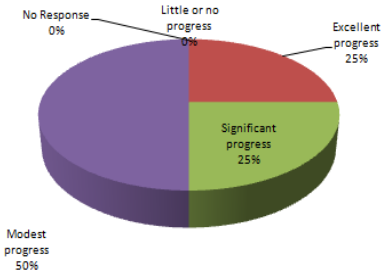
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Life Validation Testing Protocol Development

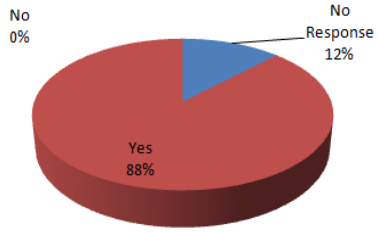
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



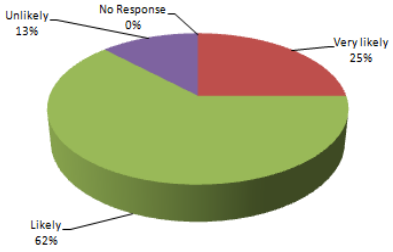
Question 3: Characterize the technical accomplishments and progress toward goals.



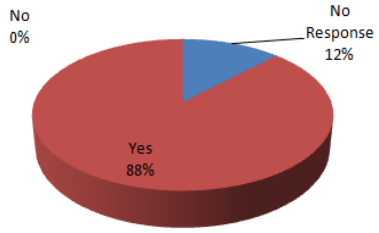
Question 2a: Are the goals of the project technically achievable?



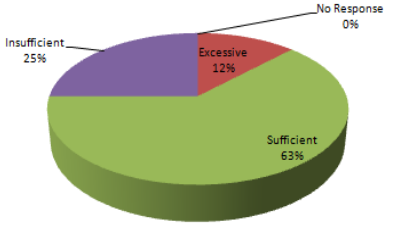
Question 4: How likely is the project team to move technologies into the marketplace?



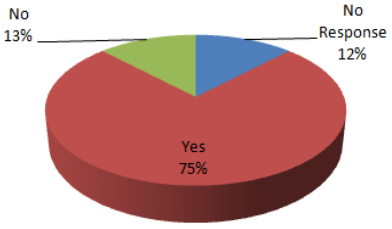
Question 2b: Have the technical barriers been identified and addressed?



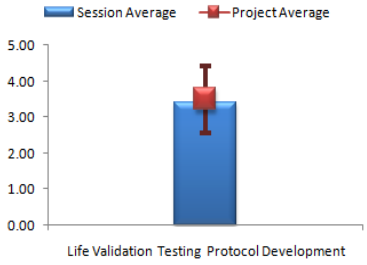
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Life Validation Testing Protocol Development (Ed Thomas, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that the development of test protocols is important to verify the achievement of the DOE objective on lithium battery performances. Another person added that Battaglia et al.'s work will lead to better batteries and allow the realization of HEVs and PHEVs. This work will help reduce oil consumption. One respondent stated that the models developed are correlated to work performed by J. Christopherson. The model should help in understanding if the chemistry is ready for transition into the market for a 15-year life. Adding to this, one reviewer noted that similar methodologies have been developed and have been widely employed for some time within the industry for the general process and methodology addressed in this work. However, understanding of the general methodology may be useful for new developers who may be entering the market in the future. Additionally, the inclusion of specific error and variance effects as studied in this project may be useful, even in the existing industry which may already be employing similar general processes and methodology. The last person did not see the utility of empirical models as this stage of development. It does not really add to knowledge, and instead looks like mostly a fitting/extrapolation model. This reviewer would prefer to put an emphasis on Dees' fundamental model.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the life test protocol and life estimation software and manual development are part of an integrated effort combining proper expertise and experimental activities in various labs. Another reviewer commented that the model is using or looking for practical goals such as end-of-life criteria, etc. The estimate of life based on the data provided and the uncertainty in the model provides significant data on the life of the particular chemistry studied. The model can be used by all battery users to predict battery life. One person remarked that Thomas' contributions to this effort will provide confidence in the results published by this group because of his background and knowledge of model development based on statistical analysis. However, the group should strive to use physics-based models because the utility of their empirical models is limited to the data set used to develop the model. It is surprising that Thomas' methodology has not apparently been used by Bloom et al. to analyze Bloom et al.'s data. Perhaps this has been done and not published yet. Another reviewer indicated that he or she does not trust empirical models to have anything but a very narrow range of utility. Adding to this, one final reviewer stated that the current state of accuracy of the methodology is not clear from the presentations. In order for the methodology to be significantly deployed and/or accepted, demonstration and documentation of the accuracy of the model may be necessary and should be possible. There appear to be plans to accomplish this in the future, and obtaining cells of industry-standard reproducibility from a significant mass-producer of Li-ion cells may be necessary and may require cooperation with a significant mass-producer.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that this is a good model for predicting life of battery. The new factor of memory effects is a significant factor that should be studied. It has not been studied much and not much information exists in the literature on this. Since several combinations can be used, a statistical analysis should be performed to choose the factors that would most affect the life such as effect of

thermal environments and high SOC on cycle and calendar life at various stages of the initial life of the cell. Another person commented that the results so far achieved are very interesting with very good progress in the way of a reliable statistical tool for life prediction. More evidence of the validation work should be presented with the level of confidence for the various chemistries and accelerating factors. The effect of battery models on the predicted life should be better clarified and analyzed. Following up on this, one person indicated that the uncertainty in the life prediction appears to be high. Methodology is applied only to cells - may not be same for the packs. One respondent wrote that the work is technically fine and the PIs obviously know their stuff, but in view of the small sample sizes and cell-to-cell variability this reviewer does not think the data quality justifies such a model. Much of the variability seen may actually be from "special causes" and not reflect the random variation inherent in the design. This kind of model might be more relevant in the future once a system is better designed and once consistent data can be obtained. One final reviewer stated that progress is too slow in this project. The lack of using a physics-based model is unacceptable. This reviewer adds that the results from the mechanism studies seem to be ignored by these empirical model developers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent commented that the TVLT software tool, after complete validation and extension, may have a market application for battery developers and users. One other reviewer said that model validation with models used to understand experimental data is an excellent tool to better predict calendar and cycle life for batteries. In contrast, one reviewer wrote that this group may develop tools that will be useful to battery developers; however, the basic tools developed have been available from MATLAB for many years. Another respondent commented that he or she does not trust empirical models to have anything but a very narrow range of utility. As a developer, this reviewer would not value this work – he or she would prefer to just look at the data. However, the group's plans to look at memory effects etc. are good if DOE continues this work. This reviewer still thinks the 100 18650 cells for future model validation is too small a sample size.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

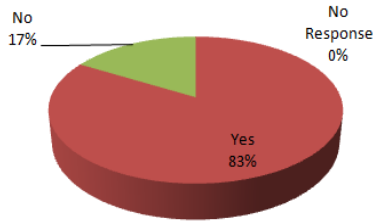
One reviewer stated that the integration of various National Labs is a way to optimize resources, while another person commented there is a good volume of work for the funding obtained. In contrast, one respondent does not see the utility of empirical models at this stage of development. This does not really add to knowledge, and instead looks like it is mostly a fitting/extrapolation model. This reviewer would prefer to put emphasis on Dees' fundamental model. One final reviewer added that funding for this project is excessive relative to the results presented. These workers do not seem to be aware of other work in this area such as the SAFT model.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

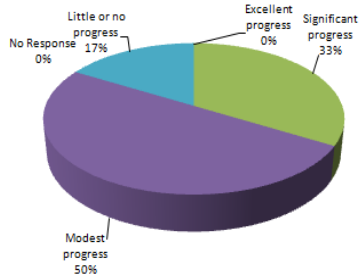
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Life Validation Testing Protocol Development

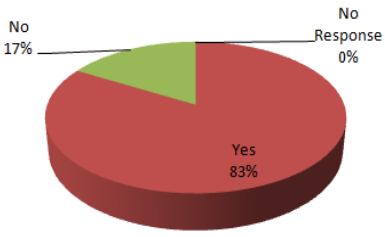
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



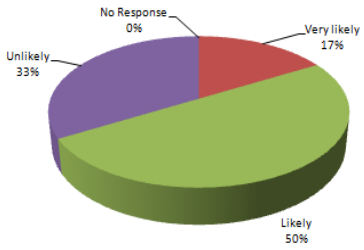
Question 3: Characterize the technical accomplishments and progress toward goals.



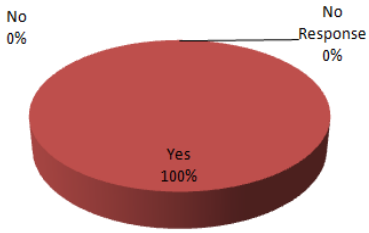
Question 2a: Are the goals of the project technically achievable?



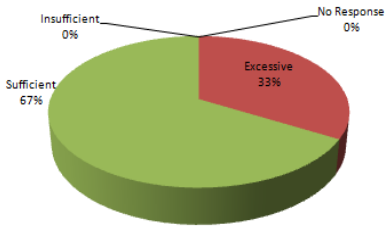
Question 4: How likely is the project team to move technologies into the marketplace?



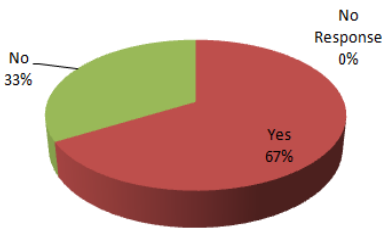
Question 2b: Have the technical barriers been identified and addressed?



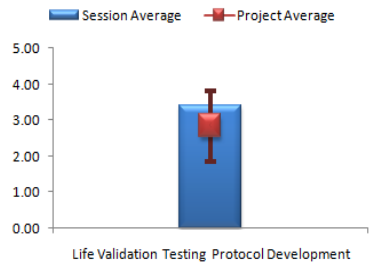
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Cost Components: Development of Advanced High-Power and High-Energy Battery Materials (Khalil Amine, of Argonne National Laboratory)

Reviewer Sample Size

This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

Multiple reviewers commented on the need for higher energy and lower cost materials for PHEVs. One person stated that this project is necessary to advance the state-of-the-art, while another reviewer noted that the project addresses the key aspects of cost reduction and increased stability of Li batteries. One response stated that low-cost components reduce the overall cost and increase the safety of batteries for HEV and PHEV. Following on this, one person wrote that Amine's work on this project will lead to less oil consumption due to the use of HEVs and PHEVs in the near future. One final reviewer indicated that this activity provides information on electrode active materials with some unique attributes and which may be of use for theoretical consideration. This reviewer added that the review of the practicality of various processing methods for some of the materials discussed in this work is useful for any potential considerations beyond theoretical.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The first reviewer stated that this project addresses the use of coatings for electrode materials to decrease the issues at the surface of the electrodes, while another person commented that there is a good rationale for 1/3, 1/3, 1/3 NMC material. Similarly, one respondent noted that the coating strategy is promising. The high voltage for the "1/2" materials is probably not practical, but nevertheless the material has great promise for the future also for HEV systems and not only portable systems. The co-launch of portable and HEV can give significant cost advantages, especially in beginning of HEV or PHEV launch, where material needs are small and pricing would otherwise (without the use in portable applications) be high. This is a good launch approach for the materials maker, which would stabilize the supply base for that component. The same strategy could be used for the anode materials and should be looked into; well done. Another reviewer remarked that Amine's work on the $LiC_2O_4BF_2$ additive is significant and will lead to improved anodes in lithium ion cells. His work that has produced the ANLCC cathode material will lead to rapid development of cells for HEVs and PHEVs because of the high voltage capability of this cathode material. Also, the cathode AlF_3 coating will lead to safer cells. One reviewer wrote that the approach is a following of the previous project (11286) with a clear perception of the technical barriers and adequate strategy to find solutions. It is not clear how the low cost target is addressed in the project. Another person suggested that close cooperation with a significant mass-producer of Li-ion cells or Li-ion materials would be necessary for useful deployment of this project's findings. One reviewer is not fully convinced by the work related to AlF_3 coating. If the coating is not conformal, and it is porous, eventually it will lose its protective character. However this reviewer is intrigued by the absence of power loss even though the coating is 20 nm! They need to verify this by long-term high temperature storage.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One respondent indicated that this work showed that the AlF_3-coated on different cathodes (NMC, NCA, NM, $LiCoO_2$) have lower impedance, better cycling characteristics at high temperature, improved safety, and reduced metal ion dissolution when compared to uncoated cathodes. Another

person commented that the work related to the high energy material is outstanding. This is an exceptional result and should be of great importance to PHEV development. One individual stated that Amine's AlF_3 cathode coating provides better capacity retention with cycling. This process will probably be adopted by battery manufacturers to extend the life of their cells or to reduce the cost of cells, assuming their original cells were able to meet the life requirements. Similarly, one reviewer stated that this is good basic research to show the effect of coatings on the cathode particles. The surface studies have shown that the coatings are effective in maintaining the structure of the cathode crystals. DSC results show a delay in the onset of thermal runaway but it does not show any inhibition of thermal runaway. The charging to higher voltage may look good at this point, but safety tests on completed cells need to be carried out to determine its true safety. Collaboration with Sandia will help understand the safety of completed cells. Another reviewer stated that, as demonstrated in the investigator's other talk, this program is well thought out and reflects the many trade-offs that are involved in such work. This reviewer is not sure that ANL should be developing their own additives without first looking at what is already in use by industry, but they do appear to have been very successful. Ability to improve packing density of ANLCC is very good. AlF_3 coating quality looks very good indeed. The uneven AlF_3 coating of non-spherical particles might actually be an advantage if the thinner coating were on edge planes where lithium ions are going in and out of for some materials. (This is reported for the olivine, although not sure the olivine needs AlF_3 coating.) One person commented that the cycle tests were not compared on the same basis, C/2 vs. 1C etc., making it hard to judge the actual cycling improvements with AlF_3 coated material. The data on cobalt shows unusually low cycleability, which puts cell design in question for the cycleability; however, besides these items, this is very good work. The AlF_3 coated materials is significant progress on the nickelates. One reviewer wrote the technical results are well justified with complete characterization results, but added that the economical part of the target is not presented. The final decision will be also based on economical considerations. It is suggested to include cost analysis of the materials used and on the processes needed to introduce them. One final reviewer indicated that there is no clear route for the materials identified in this work to make their way into actual applications relevant to HEV systems. Cost aspects of any of the materials discussed or of the related processing methods is unknown based on this work. Safety improvements apparently achieved through AlF_3 coating look positive, but more evidence of abuse response in configurations closer to actual applications would be a desirable aspect of any potential future work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer noted that they have already licensed the technologies, while another stated that there are already in place agreements to transfer results to the marketplace. One reviewer commented that Amine's cathode coating process will probably be adopted immediately by battery producers because the coating improves the life of the cells. This coating will also improve the safety of the cells. One other reviewer added that the materials look attractive for PHEV, but obviously needs more safety work as is already planned. The publication rate of the group is also impressive. One respondent noted that the co-existence of a cathode with portable solutions gives cheaper materials in mass production and easier to hit cost targets, especially in the beginning of development, and especially for PHEV. Another reviewer commented that there are other Universities working on similar coatings. There needs to be collaboration to optimize technology transfer and marketing. One final reviewer wrote that this task has developed interesting new materials for Li-ion batteries and is to be commended for its work on materials invention. It is very good that this task recognizes the importance of synthesis conditions to affect particle morphology which in turn affects materials performance. However, the L333 material and Ni-Mn materials appear to be ready for

commercialization – which is not the role of the national lab. This reviewer added that much of the talk sounded like a sales pitch, not a scientific presentation.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

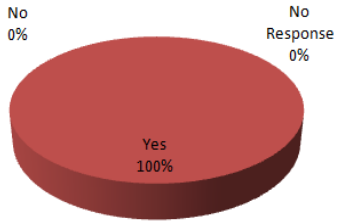
One reviewer stated that the resources seem adequate to the efforts, while another commented that there is good work for the funding obtained. Similarly, one person wrote that it appears that funding is on the right level. One other reviewer stated the group is doing very well and well positioned for follow-on work at ANL and Sandia. One respondent noted that Amine's work is producing rapidly useful results in the form of improved materials for the anodes and the cathodes in lithium ion cells. His research program should be expanded by a higher level of funding to enable him to produce even more advances in lithium ion cell technology. To contrast, the final reviewer indicated that scale-up and optimization of materials synthesis processes is not the role of the national lab. That work, if it is to be done at a national lab at all, should be funded under work-for-others contracts, not DOE.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

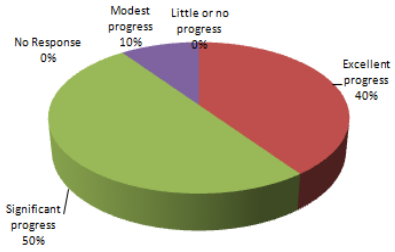
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Cost Components: Development of Advanced High-Power and High-Energy Battery Materials

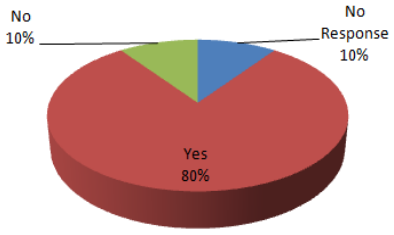
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



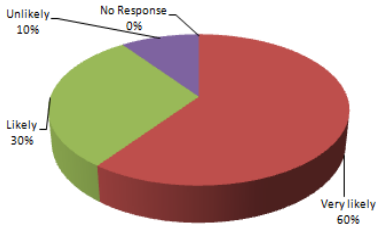
Question 3: Characterize the technical accomplishments and progress toward goals.



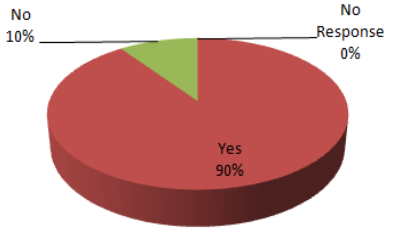
Question 2a: Are the goals of the project technically achievable?



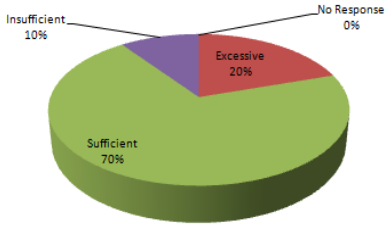
Question 4: How likely is the project team to move technologies into the marketplace?



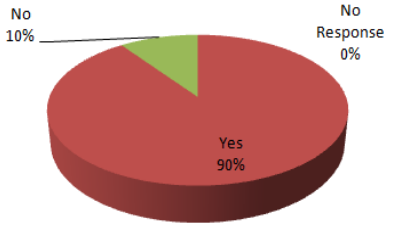
Question 2b: Have the technical barriers been identified and addressed?



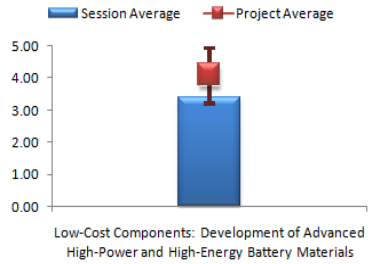
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Cost Components: Screening of Advanced Battery Materials (Andrew Jansen, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that this is an important to advance to next generation cells, while another person indicated that cost reduction is another key objective of the DOE Battery program. One other reviewer stated that new lower cost materials are critical to achieve the cost targets of the program. Similarly, one response noted that the program is still far away from its cost goals, so we need this type of work. Another commented that Jansen's work may lead to better batteries for HEVs and PHEVs, which would in turn reduce the consumption of oil. One reviewer felt that there is little transfer and communication of this valuable info to the rest of the U.S. battery community. The presentations are not enough. There should be full open access to this data for U.S. developers. One final reviewer stated that low cost material studies will help reduce the cost of batteries for the HEV and PHEV, but it is necessary to understand if the low-cost materials will provide the same performance as those in the market. Their safety also needs to be well understood before they can be used to manufacture the future cells.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that this is a good approach, if very dependent on what materials come available. Another respondent commented that Jansen's screening studies may help deploy better battery materials. Hitachi SMG anodes may be worthy of additional study. The same can be said about Hitachi's soft carbon anode material. One other person was not sure how they identify candidate materials. They are inevitably somewhat at the mercy of vendors. Having said that, ANL seems to have good contacts in the program, and they are recognized worldwide as a place to get materials validated. Thus, this reviewer thinks their evaluation program is a reasonable screening method. One reviewer response stated that the approach is consistent with the identified barriers and the available budgets. The selection of commercial materials will require a better approach: raw material costs must be considered in terms of cost-effective materials able to reduce specific and life cycle cell costs. In addition, the materials used in other battery subprograms should be considered in the overall evaluation. One final reviewer felt that, with the choice of new low cost materials in the market, this goal is very achievable. Continuing investigation of the materials from different suppliers is good work. At some point, a decision will have to be made to choose one and make improvements for that particular system.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that these are good studies and necessary to be abreast of new technologies, while another respondent stated that the technical progress is adequate to the type of experimental survey. More correlation to cell and battery development in the battery program would be advisable. Economical analysis must support technical work. One other person indicated that some of the results look pretty promising. The level of screening is adequate for a first look before going into the more costly and extensive studies on safety, etc... Impact of packing density is recognized as an issue. This makes the cells bigger and indirectly heavier (more electrolyte, packaging). One person remarked

that Jansen's project has shown that some materials from ConocoPhillips, for example, may meet the needs of HEVs and PHEVs battery manufacturers. One reviewer stated that there is a good approach, but added that the researchers need to zone in on a system -cathode / anode and electrolyte that will keep down the cost and provide the required performance for both cycle as well as calendar life. Another response indicated that the data acquisition appears to be OK, but the project may want to focus a little bit on sub-optimizing electrode formulation. A low conductive Mn-phosphate for instance will require a bit more carbon. This could help put the theoretically promising materials in better light, something that can stimulate more developments and optimization from the material's manufacturer. One final reviewer remarked that the project provides an independent evaluation of electrode materials. The same information should already be widely available to significant developers of mass-produced li-ion cells, and the activity of this project may be completely redundant on this basis.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that, although technology transfer is not possible under this work, the study may provide insight into a choice of components that would be better suited for the HEV and PHEV applications and could be of marketable quality. Another respondent commented that there is some possibility that this work might have a minor influence on material selection to a developer who was not yet in the marketplace but who might be entering the market at some point in the future. One response indicated that the technology transfer is mainly internal to the program and to material developers. Analysis of the impact on DOE Battery Program cells/chemistries may give more value to the activities. Adding to this, one reviewer felt that the collaboration is not open enough, adding that there is no price ($/kg) reference. One person remarked that deployment is not in nature of this work. One respondent wrote that the technology is coming from the outside, but if any of these get incorporated into the main program it will accelerate implementation. This is generally to be viewed as a low LOS program to cover our bases and an insurance policy. One final reviewer stated that Jansen's results may be used by ConocoPhillips, e.g., to convince battery manufacturers that they have anode material worthy of evaluation. The Mn olivine material does not have the needed capacity and should not be tested any further.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

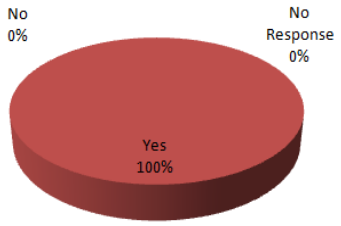
One reviewer stated that adequate studies are being carried out for the funding level, while another commented that funding for this project is sufficient. One other reviewer indicated that the work done is appropriate for the funding received, and this reviewer challenged the PI with finding more materials and stimulate discussions with material's maker on regular basis. One response commented that the resources seem adequate in view of the limited list of available materials that meet the cost requirements. Again, this should be viewed as a low level activity to give vendors a chance to bring new materials to the program. But care must be exercised in deciding which materials to evaluate so as not to divert too much effort from the main program thrust. The program seems to have a good balance. One person remarked that the cost analysis should integrate the technical one. The final reviewer added that, although the quality level of the work in this project is adequate, the basic focus of this project seems unnecessary.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

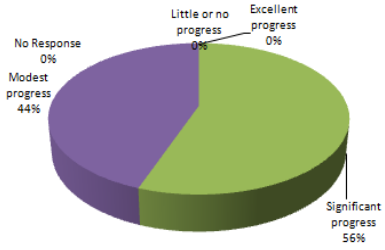
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Cost Components: Screening of Advanced Battery Materials

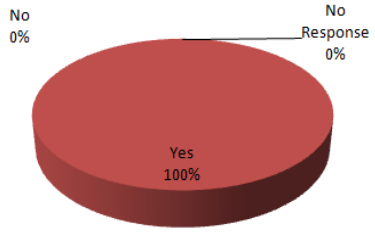
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



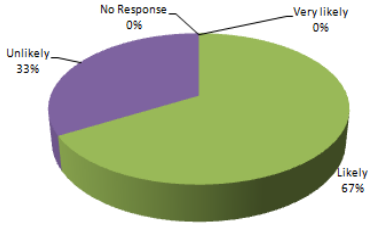
Question 3: Characterize the technical accomplishments and progress toward goals.



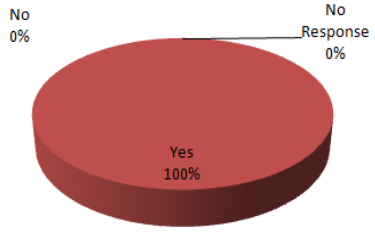
Question 2a: Are the goals of the project technically achievable?



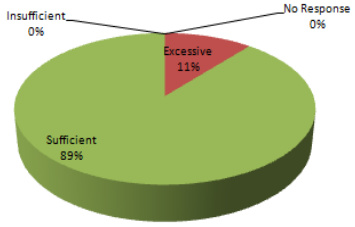
Question 4: How likely is the project team to move technologies into the marketplace?



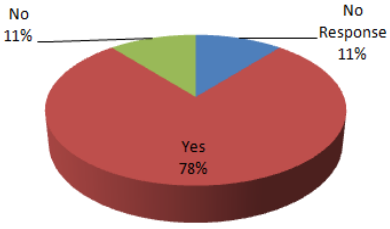
Question 2b: Have the technical barriers been identified and addressed?



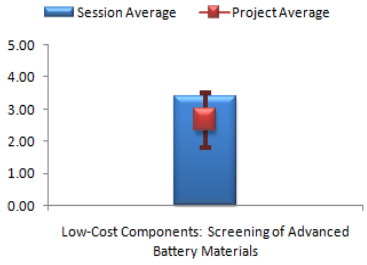
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Temperature Performance Characterization (Andrew Jansen, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer noted that low-temperature performance is very important for vehicles, while another added that the low temperature studies are functional to reaching DOE targets for lithium batteries. One respondent noted that low temperature power performance is still the performance metric that dictates battery size, weight, and cost (also safety is easier the smaller the battery can be made). Another reviewer added that Jansen's work on low temperature use of lithium-ion cells may lead to reduced oil use if he can improve the performance of these cells at low temperatures, which would speed up the development of lithium-ion cells for HEVs and PHEVs. Another person stated that improvement in our understanding of low temperature performance limitations or phenomena may aid the achievement of improvements in low temperature performance by developers, and in turn, this may lead to the ability to reducing the size of li-ion battery pack systems, which may sometimes be oversized relative to room temperature power capability in order to better approach low temperature engine crank requirements in HEV applications. The last response remarked that low temperature studies are critical as this information is needed to not only understand limiting mechanisms, but also to understand issues related to performance in low temperature environments. This reviewer added that the group needs to better define what the low-temperature goal is and what the needs of the HEV and PHEV markets are.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the strategy is very simple: screen major components to identify performances at low temperature and find alternatives. The technical barriers identification will be the result of the project. One reviewer added that this work showed that surface modifications do not have a significant effect on low temperature performance. One other respondent commented that the experimental data was explained well with theoretical equations. The increased power characteristics with increased surface area have been studied well. In contrast, one reviewer asked: what are the goals anyway? This reviewer was confused by the general task of improving low-temperature performance, adding that they should instead highlight the USABC targets (0°C, -10°C, -20°C etc.). One other reviewer asked: can't the Dees modeling help guide this work more? The author gave a fairly long list of things to examine. This reviewer thinks the model should help prioritize Andy's work, even though it cannot provide the "answer." One final reviewer added that Jansen's work has shown that it is unlikely that lithium ion cells will be able to provide low-temperature service without increasing significantly the surface area of the active materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that this task has done an excellent job of carefully designing experiments, analyzing the results, and creatively thinking about what to do next. While no "magic bullet" has been found, this task has done an excellent job of laying out the real hurdles in trying to improve the important problem of low-temperature performance. The work should also include other times besides ten-second impedance, such as one- and sixty-second, as these times are also of interest for HEVs and PHEVs. Another respondent commented that this work has showed that surface

modification of graphite and soft carbon does not affect the low temperature performance. Also, it showed the impedance response at low temperature is dominated by Butler-Volmer kinetics and not diffusion. Another person commented that the researcher has done excellent work, but it is a challenging task and this reviewer is not sure we see the light as of yet. Another reviewer added to this, stating that the group has done a lot of good work to understand what the problem is or, more correctly, what it is not. This was good work, although this reviewer was not sure that the real cause of the -30°C polarization is yet known. The reviewer adds that, without this understanding, it is difficult to have confidence that any of the proposals will help overcome the problem. Another respondent stated that the results are in line with the broad characterization planned in the project but are not yet able to give clear answers for the identification of technical barriers solving the low temperature problem. Another reviewer wrote that this activity provides some useful background regarding the nature of the limitations in low temperature performance in Li-ion systems. However, there does not appear to be any strong evidence that further work in this project will result in fundamental improvements in low temperature performance. Future work should focus only on more detailed study and investigation of the root causes of low temperature performance limitations. One reviewer commented that several variables have been studied. Different carbons (with different surface area), surface modifications, etc. have been studied to determine performance improvements at low temperatures. The electrolyte plays a significant role in the transportation of the lithium-ions. Hence this should be studied in more detail. It is a good choice of future work with the low temperature ionic liquids. The aqueous system is not a good idea as it is well known that this chemistry experiences large losses in performance in the presence of humidity. Aqueous systems may require large modifications of the cathode and anode. Working on a wide temperature range electrolyte or cell is more of a challenge and may be more useful than just a low temperature operating cell. One final reviewer wrote that Jansen's work has shown that the low temperature performance of lithium ion cells may not be sufficient to meet the needs of HEVs and PHEVs. Consequently, this reviewer thinks that his study should be ended unless significant results can be obtained in the near future based on exploiting some of his proposed future work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Results to this prompt were mixed overall. The first reviewer stated that, if the results are good, they will find immediate application. Another person commented that technology transfer is claimed for a novel electrolyte. One other reviewer added that, if the low-temperature issues are overcome, then it will have a very high likelihood of being used in the market. This reviewer added that, low temperature electrolytes do exist, as shown by the Jet Propulsion Laboratory with the Mars rover batteries. One person was not convinced that -30°C is even a real problem. Furthermore, this reviewer suspects that solutions, even if found, will involve other trade-offs in more important areas that will preclude implementation. One final reviewer stated Jansen's work shows clearly that the commonly used materials in Li ion cells prohibit the use of these cells at low temperatures. He should document as completely as possible what the lowest temperature would be for the use of lithium ion cells in HEVs and PHEVs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

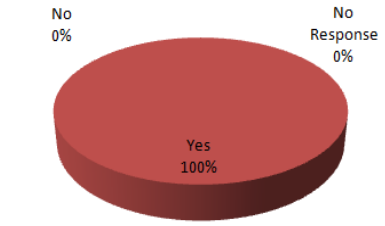
One reviewer remarked that the resources seem to be adequate to the planned work, while another added that adequate work has been carried out for the funding obtained. One other person commented on the good teamwork between Dees and Jansen. The final reviewer disagreed, stating that funding for this project is excessive based on the results obtained.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

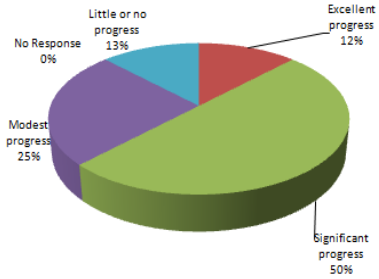
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Temperature Performance Characterization

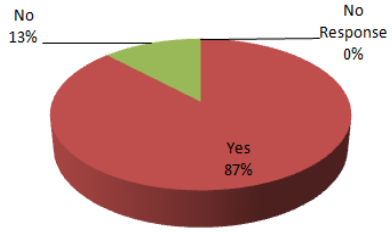
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



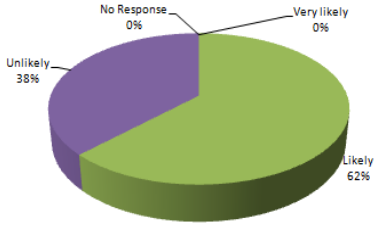
Question 3: Characterize the technical accomplishments and progress toward goals.



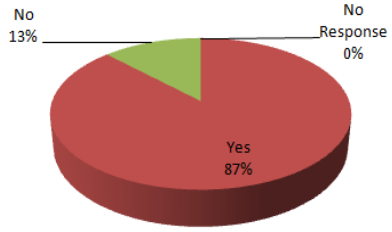
Question 2a: Are the goals of the project technically achievable?



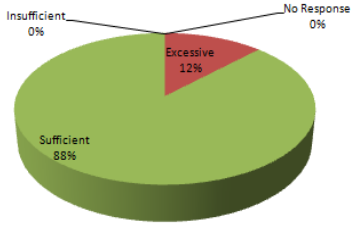
Question 4: How likely is the project team to move technologies into the marketplace?



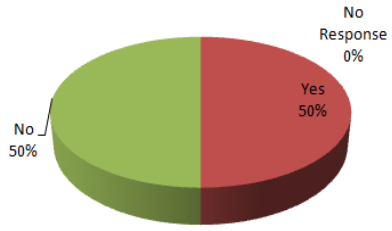
Question 2b: Have the technical barriers been identified and addressed?



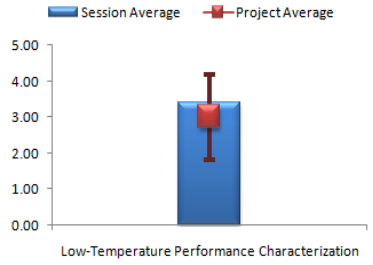
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Temperature Performance: Performance Modeling (Dennis Dees, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were generally positive. One reviewer wrote that the work is very pertinent to the overall objective, while another respondent added that low temperature behavior of Li-ion batteries is still a key target for the DOE program. One person commented that low temperature power performance is still the performance metric that dictates battery size, weight, and cost (also, safety is easier the smaller the battery can be made). One other reviewer indicated that Dees' work on low temperature performance may lead to improvements in the lithium ion cell for use at low temperatures. If successful, this reviewer added, Dees' work may lead to the reduction of oil by using lithium ion cells at low temperatures in HEVs and PHEVs. The final reviewer noted that it does address the issues with low temperature performance of Li-ion cells, but added that the goals can be better defined to depict how low the temperatures need to be.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that lithium metal deposition is a key problem and worthy of being well studied. One reviewer stated that the projects plans for investigating / quantifying lithium deposition at low temperatures appear to be sound and success in this area will provide useful information. Another response indicated that the approach is very sound and the PI is working very well with Andrew Jansen and the lab people. One other reviewer remarked that Dees' approach may yield results that might / will help us understand what happens at low temperatures. His approach is yielding useful information about the mechanisms that occur at low temperatures. One person indicated that his or her answers to this deployment strategy are "maybe." One final reviewer noted that the electrochemical model is good. It takes into account all the steps in the intercalation process and the limitations in obtaining 100 percent energy efficiency. The limitations of modeling are well understood. If the parameters used in the model are not reasonably close to reality, the model can either provide completely false data that can or cannot be detected. Having experimental data to correlate to the modeling helps understand if the data from the models is way off.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that Dees' results indicate that his approach may lead to a deeper understanding of the processes that occur at the anode on charge in particular. Another reviewer commented that good work is being carried out with the modeling, especially in understanding the limitations of the model and correlating it to experimental data. The calorimeter work will substantiate the results from the modeling work. Modeling the performance at low temperatures can also provide some insight into what changes need to be made with the materials or electrolyte to get better performance at low temperatures. Adding to this, one person remarked that there is a good use of modeling to show self-consistent approaches between impedance and pulse behavior of the anode - an extremely challenging task. This reviewer agrees with the presenter that impedance rise at low temperatures is the main issue, as this will invariably tend to drive the electrode into lithium plating. One reviewer stated that the progress seems to be limited and quite slow according to the presented results, while another respondent was still not fully convinced that the objective will be met.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent stated that this project is very relevant to developers. Another reviewer noted that good modeling methods are critical to understanding as well as supporting the experimental data. Good models help in designing not only the cells but also the batteries. One reviewer commented that there was no evidence of significant technology transfer until now. Another reviewer was hoping that the understanding that a fundamental-based model provides could be used to guide the selection of experiments to try and fix the problem that Andrew Jansen is planning, as he has too many things listed to look at quickly. As discussed by another reviewer, the -30°C requirement itself really needs to be challenged more, but it is not the job of the PI's to do this. The final reviewer began by acknowledging that Dees' work is very useful. However, this reviewer adds, it is unlikely that this project will lead to higher performance at very low temperatures (-30°C). This project should be discontinued even though it may help move lithium ion cells into the HEVs and PHEVs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

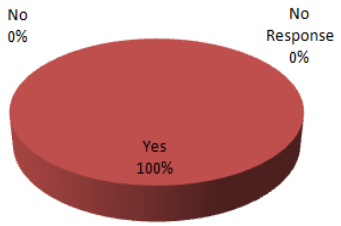
One reviewer stated that the project seems to be adequately supported and with enough resources, while another commented that the funding is sufficient for this project. One other person added that this is good work for the funding obtained. One reviewer stated the PI is extremely able and does an excellent job at leveraging the lab people.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

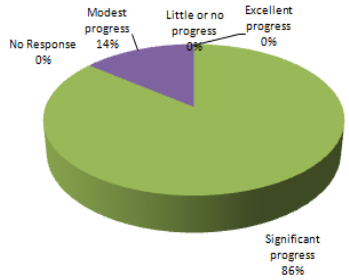
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Temperature Performance: Performance Modeling

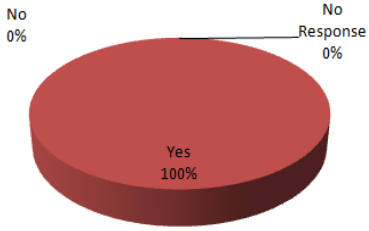
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



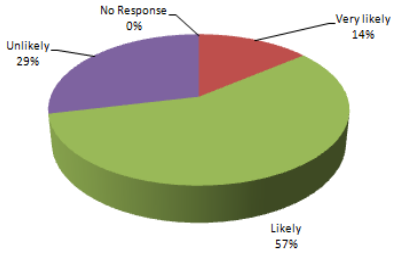
Question 3: Characterize the technical accomplishments and progress toward goals.



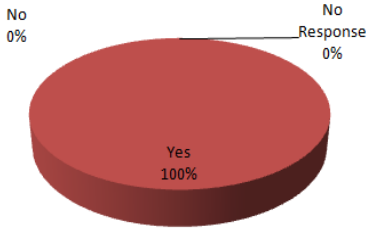
Question 2a: Are the goals of the project technically achievable?



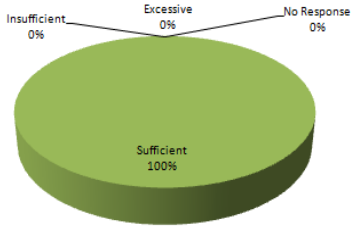
Question 4: How likely is the project team to move technologies into the marketplace?



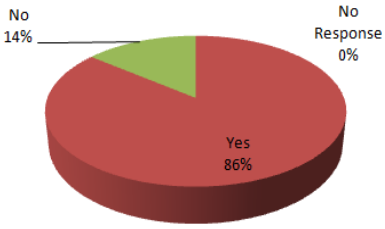
Question 2b: Have the technical barriers been identified and addressed?



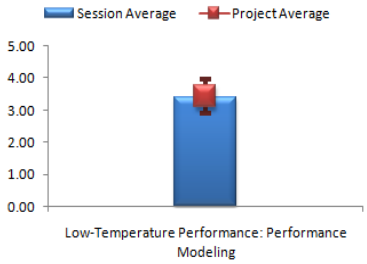
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Material-Level and Component Abuse Studies (Khalil Amine, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments to this question were generally positive. One reviewer felt that Amine's work is leading to new batteries that are being developed further in industry (e.g. EnerDel), adding that this work will lead to HEVs and PHEVs, which will reduce dependence on foreign oil. Another person remarked that it is important to know the material behavior to understand the cell behavior. One reviewer noted that screening and basic characterization of electrode materials in this work definitely supports the DOE objectives. Several comments were focused on the abuse tolerance aspect of the work. One person pointed out that abuse tolerance of materials is a key objective of the DOE battery program. Another reviewer remarked that the increase of abuse tolerance on the component level is important for the safety of li-ion batteries. They added that breakthroughs here can lead to safe high capacity materials and pathways for increasing safety and temperature tolerance in large systems. One reviewer had detailed comments, stating that the safety of this chemistry dictates the use of this chemistry in batteries for the future vehicles and that developing materials that have abuse tolerance is important. They added that the use of electrochemical shuttles under overcharge conditions is a good factor to be studied for the biggest hazard that is associated with li-ion batteries and that the industry needs to have goals on what can be tolerated. They concluded by stating that is it no fire, no venting, what types of heat generation is acceptable and so on. One reviewer pointed out that safety is critical for these large battery applications, but that this aspect is often underappreciated and did not get the emphasis it deserved in the keynote speeches, etc. The final reviewer was more critical of the work, stating that in general, much of this work is redundant with work already reported by others in the past. However, they added that investigation of specific heat generation sources/characteristics in olivine cathode li-ion cells and in titanate anode li-ion cells is of some value. They also felt that work towards specific quantification of the relative heat generation from the anode is of value.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Comments to this question were all positive. One person simply stated that the researcher has used very sound methodologies to understand the issues underlying the electrode reactivities. Another agreed, stating that the approach is of very high level with outstanding and complete investigation able to understand abuse material capability and improve stability. One reviewer noted that the coating strategy is a good approach that has been used by a number of development companies and that it will likely work for improved reactivity. The reviewer added that the program needs to address how much of an improvement that is required to be significant for the battery developer. They felt that is a good approach to use the 18650 cells which will help qualify this on cell level. One person indicated that the researcher's plans seem good, but a key will be linkage to Sandia's testing. They were glad to see the non-flammable electrolytes continue to get attention; although the full cell results for these that they have seen are not very good. Another commented acknowledged the researcher showed good data on the heat generation with the different cathodes and anodes. They stated that it was not clear from the presentation whether an understanding of this heat generation will help in the choice of suitable materials. They pointed out that even though low surface area carbon is recommended, that

recent work is focused on nano-materials and high surface area, and that a balance may have to be found between the need for more active surface area and the heat generation encountered. The final reviewer commented that Amine's work has lead to a new anode (titanate) and may lead to a new cathode. His work has already produced valuable results and his approach consists of using the data obtained at ANL and other National Labs to develop novel approaches to solving problems (i.e., breaking through technical barriers). They concluded by observing that his work on using AlF3 to coat cathodes may lead to significant improvements in the safety of lithium ion cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer noted that Dr. Amine has verified the role of cathode materials on thermal abuse (w/SNL) and concluded that, (1) oxygen released from cathodes reacts with electrolyte solvents to produce heat, and (2) spinel generate low heat compared to layered or olivine cathodes during high rate cycling. One commenter remarked that Amine has demonstrated his ability to develop material to break through technical barriers and on track to continue to do so. The reviewer felt that this work may lead to a safer $LiFePO_4$ cell for example. Another reviewer felt that the experimental work has been able to progress significantly and efficiently in identifying clear mechanisms for improving abuse stability by analyzing SEI formation and the effect of various materials (anode and electrolyte additives), reactivity between separator and cathode. They added that the researcher has proposed technological solutions to overcome overcharge (redox shuttle), even if the concept is not new and is not critically compared with previous similar solutions. They felt that some of the results need more verifications of compatibility with expected HEV and PHEV applications. One person felt that good progress has been made in determining heat produced for the different cell components. Some of the data provided is similar to that shown in 2006 such as the VC and LiBOB data. Information on the use of titanate is new and good; the redox shuttle is also a good choice for study. Another person remarked that they really like the fact that the researchers can explain their data, not just reporting results. They added that generally the PI continues to do outstanding, innovative (patented additive) and well-targeted work. In addition, the use of a wide variety of methods and techniques to answer mechanistic questions is great. They concluded by stating that the presentation was excellent and that the PI has raised awareness of anode safety aspects, especially in large packs. Another reviewer noted that the project provides some new insight into li-ion abuse response mechanisms and into some specific parameters which affect the abuse response. They added that if the project is continued, the bulk of the focus should be on advancing the understanding of li-ion abuse response mechanisms and characteristics. They felt that the development of materials-based improvements to li-ion abuse response characteristics should not be included as a part of this project if this project is continued. One person felt that the project has proceeded fine and has solid data and good theories around it. The reviewer asked whether the project has verified if there is an issue with Mn dissolution or not. If not, they felt that this should be verified, as it would be perceived as a potential showstopper. A study on this would remove doubts around this and not hinder the commercialization.

One reviewer pointed out that the researcher showed that an additive significantly reduces the self heat from SEI on the anode and increases the activation energy of reaction with electrolyte. The cells containing $Li_4Ti_5O_{12}$ was found to generate very little heat when charged and discharged at very high rates. It was demonstrated that thermal characteristics were improved with AlF_3 coated cathode materials, via surface stabilization. They were very pleased with the conclusions, describing them as excellent. Another reviewer agreed that the researcher has done a great job, commenting that he has performed cutting-edge work on understanding electrode reactivities. They felt that the studies are thorough and very well thought out. The reviewer noted some reservations about the work on redox

shuttle, stating that people have looked at these materials over the years but they all invariably are of lower rate capabilities having no relevance to HEV applications, and potentially even too low for PHEV. They concluded by stating that they were surprised that these materials are being investigated since BATT had similar programs under Tom Richardson. Two reviewers raised some questions and concerns regarding the work. One person pointed out that the PI gives an incorrect interpretation of the meaning of heat generation during charge/discharge in the calorimetry results, noting that there is a strange confusion of heat of decomposition versus heat from cell impedance. They concluded by suggesting that perhaps the PI would benefit from conversation with his modeler colleague Dr. Dees so that he can avoid making erroneous public statements. The final reviewer suggested that it would be helpful if the plots would show error bars or multiple cell replicates, to get a better sense for the statistical confidence in the difference shown between different materials. They acknowledged that DSC is an important technique, but unfortunately it is known to be poorly reproducible. They felt that it would be helpful to see what reproducibility is achieved in this work. In general, this also is an area where help from the National Labs is needed to publicize best practices for test methods. They agreed that the work on the effect of surface treatment of graphite on safety is very interesting - the investigation of fundamental mechanisms is what is most useful from the National Labs, much more useful than advocating the particular IP patented by the PI. The reviewer asked whether future work will consider anode materials produced by multiple suppliers in addition to Hitachi; for example, will the future work consider materials produced by U.S. producers of anode materials (e.g. Superior Graphite and Conoco-Phillips)?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments to this question were mostly positive. One person simply stated that the work might lead to novel/improved materials with direct relevance to developers. Another felt that there are a variety of results with potential impact on market products. One person indicated that it is not yet clear which of these safety approaches will "win" in the market place, but ANL is looking at the most promising ones. They added that even if their work will not in detail be carried forward, something based on this type of work will have to be incorporated into a viable, safe product. One reviewer reiterated that again, Amine's team has produced a material that is now used by EnerDel. They pointed out that during his work Dr. Amine keeps in mind the need to move the material from the lab to the marketplace. They concluded by stating that his redox process for protecting Li ion cells during overcharge will probably be adopted by battery manufacturers. One person commented remarked that the factors studied should be looked at closely to determine which of these will be incorporated into future cells and that the collaboration with cell manufacturers will help to take this to the next level of implementation in real cells. They pointed out that a lot of smoke was generated with complete cell disassembly during overcharge abuse of cells with olivine cathodes at NASA. They asked whether the heat generation observed in the olivines be correlated to that data; there was not much fire but a lot of smoke and gas; enough to cause cell disassembly. The final reviewer, however, felt that the portion of work in this project devoted to materials-based improvements in li-ion abuse response characteristics would be better re-directed towards better understanding the abuse response mechanisms and characteristics.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One person noted that the effort is large with an adequate budget. Another felt that the researcher has produced good work for the funding obtained. One person noted that the researcher generated a lot of data for the money, which is nice to see. They noted that the solid collaboration with materials supplier (Hitachi Chemical) is good for the program as tailoring is allowed which allows testing of

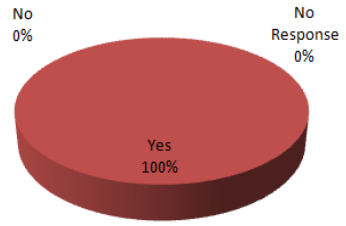
hypotheses, critical for success and guidance of efforts at materials developers, which eventually leads to better batteries. Another reviewer highlighted that the PI has accomplished a great deal since the last review and is obviously, very effective at leveraging partnerships. They added that it is a pity he cannot be cloned. The final reviewer simply stated that Dr. Amine's progress could be improved by providing more funding for his projects.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

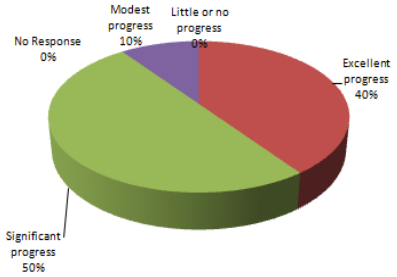
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Material-Level and Component Abuse Studies

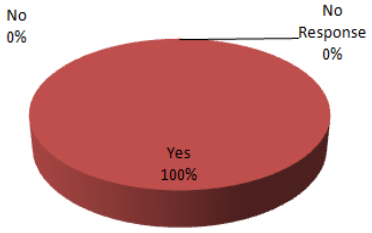
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



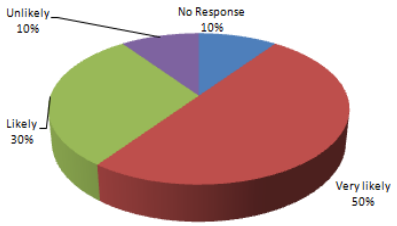
Question 3: Characterize the technical accomplishments and progress toward goals.



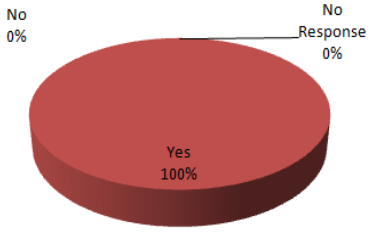
Question 2a: Are the goals of the project technically achievable?



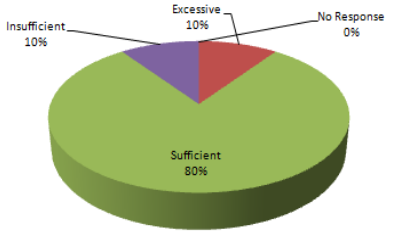
Question 4: How likely is the project team to move technologies into the marketplace?



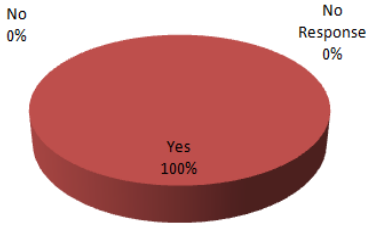
Question 2b: Have the technical barriers been identified and addressed?



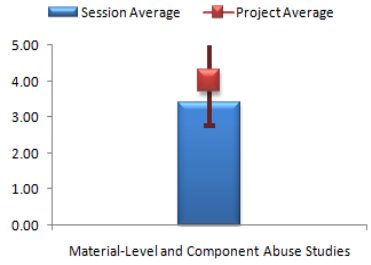
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Overview: Applied Battery Research (Gary Henriksen, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this program clearly supports the key objectives of battery development, while another person added that this program is comprehensive and will lead to better batteries. One response noted the studies of materials are important, and so are the various generation cells; once successful, key component choices will be available as a benchmark to the industry. The detailed published information is useful for comparative studies carried out at various efforts at battery manufacturers. The final reviewer noted this was an overview of the DOE vehicle technologies goals and the team's plans and collaborations to reach that goal.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that there is good teamwork and strategy to meet the PHEV goals. The goals are very challenging, especially the safety and 15-year life. One reviewer, similarly, wrote that there is good management and plan going forward. Another person indicated that Henriksen's program is comprehensive and has already led to the titanate cell, which is being developed further by EnerDel. Another response noted that the program is aimed at analyzing and verifying key enabling factors of lithium batteries: improved performance in most wanted operating conditions, abuse tolerance, and reduced costs. There are areas of potential overlapping with NREL activities on thermal behavior and modeling/diagnostics, which are not included in the list of National Labs collaborations. They concluded by noting that the recommended collaboration on modeling and diagnostics was particularly interesting. Another reviewer remarked that some of the efforts are hindered by the limited availability of good cells. It is not clear that the 18650 cells to be built for the "thicker" electrodes anticipated to be used for PHEV applications, with current degradation methodologies, will be successful unless factors such as stack pressure is taken into account. If this is not addressed within the PHEV program there is risk of failure, which is why the "no" is checked. Otherwise, for all other aspects, those boxes should be checked with "yes". One final reviewer stated that focus on materials development in many projects may not be successful in the absence of significant cooperation and interaction with significant mass-production manufacturer(s) of li-ion consumer cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the results show clear progress well aligned with the expected outputs and the investigations planned. One response commented that the materials development is very good, especially on the metal oxide side, while another noted that several very important findings have been identified, and the group is looking at the right materials. One other reviewer noted that the overview indicated that the team had made good progress toward achieving the PHEV goals. A very good summary of the team's involvement was provided by the speaker, and a good example was set by the Team Lead in keeping to the time limits. One reviewer suggested that the lack of significant cooperation with significant mass-production manufacturer(s) of Li-ion consumer cells may result in a lack of focus on the most pertinent and critical issues to practical implementation. One final reviewer acknowledged the data and analysis has been used to make significant contributions to cell

development. However, this reviewer adds that some projects have not made significant progress since the last review in August 2006.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer noted that the results are directly transferred to battery developers and market products. Another respondent commented that the presentation indicated that all the work being carried out was evaluated for technology transfer and marketing. One other reviewer wrote the project team could provide valuable input and support towards those already in the marketplace and potentially to those entities which may enter the marketplace in the future. One reviewer, similarly to those above, noted some transfers are already taking place. Another person remarked that, again, ANL's titanate work has already resulted in a potentially useful cell for HEVs and PHEVs. The last person wrote that the program has traditionally been somewhat limited by the fact that the generational cells are focusing on a few materials only. The success within this area is therefore limited by the ability of the materials supplier to supply a material that is effective for the HEV conditions. It is a good idea to now move into a variety of materials for larger benchmark studies. A well-executed statistical design of experiments for these materials will be key to success. This reviewer added that the national laboratories have the expertise to do this.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

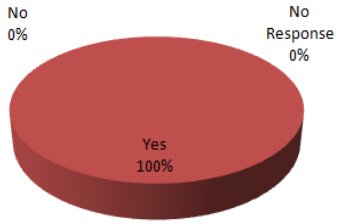
One reviewer felt that there was good work for the funding received, while another said that the funding for this program is sufficient. However, this reviewer added that funding should be reduced or eliminated for some projects due to a lack of significant progress. One other reviewer stated that the technical resources of the project are sufficient to achieve some success with a more limited and defined project focus and are insufficient to achieve success with the current project scope which is much too wide. One respondent indicated that the survey shows very large activities with little information about resources implications, which makes this evaluation difficult. The final reviewer noted that degradation is highly dependent on the mechanical stability of the electrode array. When going to high energy, trade-offs on binder and higher densities are needed (important for PHEV). This calls for optimization of these mechanical aspects, which is different from the electrochemical and chemical degradation mechanisms. Ways of measuring this mechanical degradation should be developed and resources will be needed, equipment and staff.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

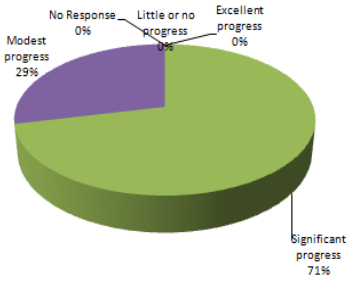
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Overview: Applied Battery Research

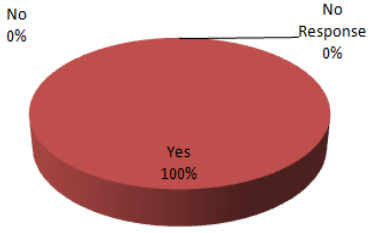
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



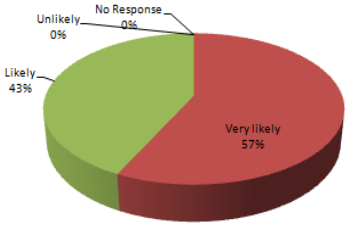
Question 3: Characterize the technical accomplishments and progress toward goals.



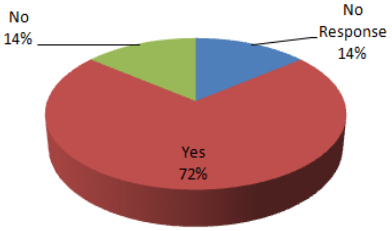
Question 2a: Are the goals of the project technically achievable?



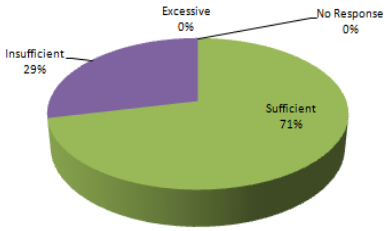
Question 4: How likely is the project team to move technologies into the marketplace?



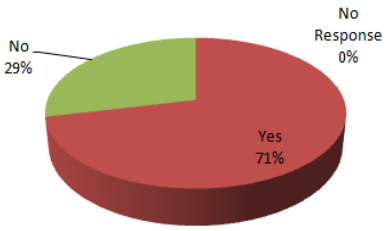
Question 2b: Have the technical barriers been identified and addressed?



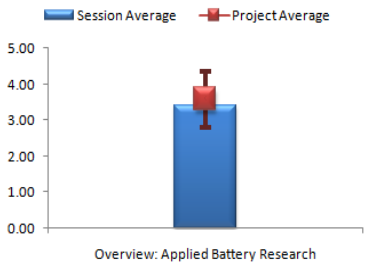
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Plug-in Hybrid Electric Vehicle R&D on High-Energy Materials (Jack Vaughey, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the project has good goals – greater than 200 mAh/g for 100 cycles between 4.5 V to 2.0 V. This goal is significant and will benefit not just the vehicle technologies program but also the commercial market as well as other government agencies. Higher energy density materials will reduce the mass of the batteries. Another reviewer stated that the industry needs this for long term true EVs, and this could also be used for PHEV if safety issues and poor cycle life can be overcome – both are very difficult goals. Similarly, one person noted that this is a high risk project, which if successful would accelerate the development of lithium metal anode cells which have a much higher energy density. This project would result in the reduction of oil consumption. Another respondent stated the work on the metal oxides is very worth the exploratory nature and all comments below are therefore related to Thackarey's presentation. This reviewer added that the other programs will be hard to deliver in a reasonable time frame. Many reviewers indicated additional hesitation or concerns regarding this project. One reviewer was surprised that this became an ATD project (adding that the work on cathodes by Mike is just fine). Another response stated that this can only be a long-term project since the studies funded by DOE over the years have not led us anywhere. It has great potential but no immediate resolution in sight for the problems and should be left to the BATT program. In the same vein, one reviewer noted that similar and extensive work has already been conducted on numerous occasions in the past and over a significant time period. One final reviewer added that the project considers Li metal anode for HE PHEV Li Batteries. This reviewer felt that this seems like an old story with limited impact in the short-term.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer wrote that this project, if successful, may enable the use of Li/S cells, for example, in HEVs and PHEVs. This would be a significant advance. Another person stated that Thackeray has come up with a great approach to get a new high performing material, and funding should follow. This project is a little bit longer term, but well worth pursuing. Approach for activating the crystal structure is sound. Optimization of particle size and formulation will enhance the cyclability of these metal oxide materials. Opportunities also exist to limit the voltage range for performance. Lots of flexibility available and the PI is well positioned to solve these. One other reviewer commented that the goal to achieve greater than 200 mAh/g at the material level is not a difficult one. Currently, materials providing as high as 260 mAh/g have been tested and proven by University (Dr. Manthiram) as well as some government agencies (NASA - JPL). The choice of material based on theoretical capacity is a good start, but if it cannot meet the high cycle life requirement, the parameters may have to be changed to meet the goals of the program or to optimize the cyclability of the materials studied. A good work plan should be developed to indicate how that goal will be achieved. One person said that both lithium metal and new cathodes projects are high risk but worthwhile. Initial results from cathode study shows proof of concept and there has been a lot of work on protected lithium surfaces recently. However, while Thackeray is obviously well positioned to do the cathode work, this reviewer is not sure about the anode work. One reviewer remarked that the project has identified the

barriers but the strategy is not clearly specifying the final cell targets. It is not clear how these barriers and proposed solutions find space in the ongoing ATD activities, even if there are examples of present commercial development (not only HQ but also BATSCAP in France, and subsidiary Avestor in Canada). Another person commented that we probably have over 30 years of history of funding for a rechargeable lithium battery without success. Just recently, the lithium batteries installed by AT&T at UPS and made by Avestor using polymer electrolytes, etc. (with USABC funding) use very old ideas and they did not work. They are going to replace all of these batteries. This reviewer is a big proponent of this work, but it is a long-term project and should not be part of the ATD. This reviewer added that the work by Mike on cathodes is fine. The last reviewer stated that, of the lithium metal task, PHEVs need high energy, but they also need high power and acceptable safety. Li metal by itself is not a high power electrode, particularly at low temperature; any coating would most likely increase the impedance, making the situation worse. Before investing too many resources down this path, the researchers should first determine whether there is any possibility that Li metal can meet the power requirements for PHEVs, especially at low temperature. Furthermore, the safety is a high risk. Cycle life testing should include charge pulses of the magnitude to be expected during regeneration at low temperature, to determine whether the coating can prevent dendrites under those conditions. Regarding the new cathodes task: this task has identified the barriers and is likely to overcome them.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer noted the great performance promise, which is work well done. Another reviewer pointed to the fact that his or her comments refer to the Li anode only, adding that the cathode work is fine. Another person commented that the results are only preliminary, with limited progress due to the late start of the project. Another respondent wrote that the project has shown significant progress but it is not anywhere near to obtaining a practical high energy density product. Proof of concept at the material level is not adequate to overcome all the barriers existing to meet a goal of cyclability and greater than 200 mAh/g at the component level. Similarly, one reviewer remarked that both aspects of the research are at too early a stage to expect much progress. Cathode works looks exciting and novel. Anode works looks very difficult and also this reviewer thinks this might better be outsourced to someone like PolyPlus if possible. Alternatively, try to get coated lithium from PolyPlu's supplier, Ohara Glass. The physical dissolution of Li during deep discharge can be very challenging - the 150 mAh/g data shown is a very shallow DOD and not going to be enough for PHEV. This reviewer suggests they look at deeper DOD early in the program. The final reviewer stated that, unfortunately, the investigators have not made much progress toward developing a coating for lithium metal. Their literature survey apparently did not include a thorough review of the patent literature, where it has been shown by Steve Visco, for example, that it is possible to produce Li metal coatings for low rate cells. These investigators should attempt to reproduce the discovery made by Visco as part of their background work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses to this prompt were generally negative. The first reviewer stated that it is hard in this phase to estimate technology transfer. Another person added that the use of lithium metal anodes limits the safety of the lithium-ion cells. May need extensive testing to prove safety before marketing or technology transfer can occur. With respect to Dr. Thackeray's presentation, it is too early to think about technology transfer or marketing. One reviewer highlighted the 30 years that have already gone into funding this project, while another stated that it is unlikely that this project will be successful based on their reported work to date. One response noted there is high risk at this stage. One final reviewer commented on the low likelihood of success of these high risk approaches, adding that this

does not mean we should not fund them, but we need to ensure they have some early benchmarks and check back frequently for signs of progress or killer issues. This has to be viewed as seed money for longer-term blue sky projects. Also, protected lithium seems to be well done by PolyPlus and others – this reviewer is not sure how this group can expect to improve upon that. Maybe do a joint JV with Polyplus and /or Ohara Glass instead?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

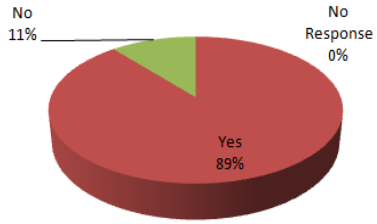
One reviewer commented that the work carried out is significant and the funding is adequate, while another person stated that this should be funded but under the BATT program. One other reviewer added that the funding should be funneled to the metal oxide program. Otherwise this reviewer suggests increasing the funding so that the metal oxide program gets done without funding limitations. In contrast, one person indicated that, although the quality level of the work in this project is adequate, this project should not be continued. Another reviewer remarked that the lack of information and the large funding planned make the evaluation hard. One respondent stated that, before substantial resources are devoted (yet again - as we know this happens about every decade) to lithium metal, serious thought should be given to questions of low-temperature power, manufacturability, and safety: the main hurdles for lithium metal. One final reviewer stated that funding for this work should be reduced unless a more thorough understanding of the existing technology in this area is established by this research group. This reviewer added that it is unfortunate that Mike Thackeray's work was lumped in with this report. It may be that Mike's work on $Li_{1.2}V_3O_8$ may lead to materials that would have value for PHEVs. His work should be and would have been scored differently from the scores given here for the lithium metal anode coating work.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

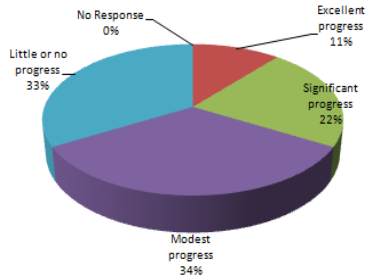
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Plug-in Hybrid Electric Vehicle R&D on High-Energy Materials

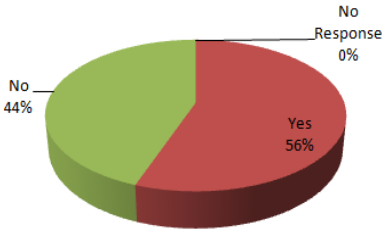
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



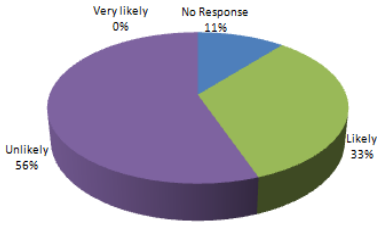
Question 3: Characterize the technical accomplishments and progress toward goals.



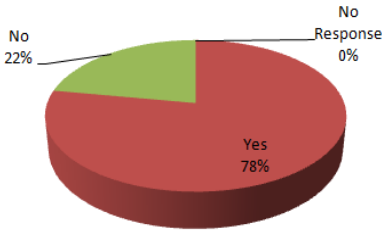
Question 2a: Are the goals of the project technically achievable?



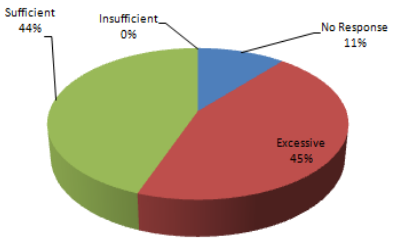
Question 4: How likely is the project team to move technologies into the marketplace?



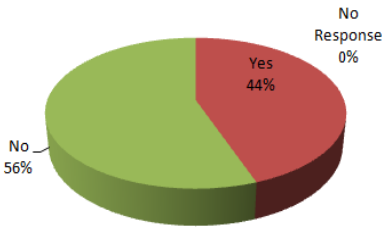
Question 2b: Have the technical barriers been identified and addressed?



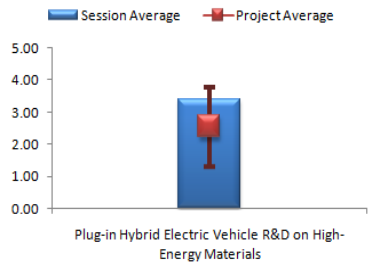
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



SEI Studies at ANL (D. Abraham, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer wrote that formation is a key step in manufacturing lithium ion cells, while another respondent stated that the project aims at the DOE objective of improving the calendar life of lithium batteries. One reviewer commented that the films are key to long life, low impedance, and maybe safety. One final reviewer indicated that this work will lead to the reduction of the use of oil because it will lead to better batteries for HEVs and PHEVs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent simply commented that the group has a good work plan. One reviewer indicated that the growth of the SEI layer on the negative electrode and the increase of deposits on the positive electrode are well known to have a negative impact on cell impedance during storage or cycling. The program is well designed to study these effects. One other person commented on the good results to date, and this reviewer likes the plan to do a Design of Experiments trial on formation. Another reviewer wrote that this project is focusing on understanding the protective layer that is formed on the anode during formation. Several National Labs are involved and the work is being coordinated. The results of this study may lead to an improved understanding of this process. One final reviewer stated the clear and well described approach is likely to give scientific explanation to SEI formation and electrode formation protocol, adding that the weak point is the limited number of chemistries analyzed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer indicated that the results are valuable and consistent with the planned activities, and that the extension to other components would be very important. Another respondent wrote that this project may lead to a better understanding of formation of cells and how that might be controlled better to extend the life of the cells. Similarly, one reviewer commented that this study contributes to the understanding of the cell performance and is quite useful. Another response stated that the ideas are quite good, but this reviewer would have loved to see more conclusive results. One respondent noted that it is difficult to show a direct relationship of the measured properties of the SEI and cathode deposits and the cell impedance, but the problems are too important to ignore. The progress is expected to be rather slow because of the difficulty of the studies. Another person wrote that this is a nice systematic XPS study – which is time consuming and difficult. A lot of very careful work has been done. This reviewer adds that binder-carbon free studies are very good as a fundamental study, especially as they seem to behave similar to real electrodes. Cycling tests seem to be a bit vague and need standardization – need to look at high voltages and high temperatures to study cycle life effects as another reviewer commented. There is some concern about the difficulty of distinguishing between simple electrolyte residues and actual surface films. The last reviewer felt that the scope of the project is too general, and work similar to much of this project has already been conducted elsewhere in the past. In particular, studies of binder/carbon-free electrodes are redundant to work conducted in the past. Inclusion of actual observations of the effects of formation parameters on SEI and/or on performance characteristics could be of value, but no information regarding this was presented.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first response commented that this seems to be key information, while another reviewer added that the industry seems to be a potential user of these results for improving lithium batteries. Another person wrote that this project is a comprehensive approach by several labs and should lead to new information about the formation process for lithium ion cells. However, this reviewer adds that it seems that the participants are not as familiar with prior work as they should be. One final reviewer commented that this work might lead to better general understanding. However, developers have their own processes in place, which are the results of many years of test data, and this reviewer doubts that there is any new data generated in these studies that would be of immediate interest to commercial producers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

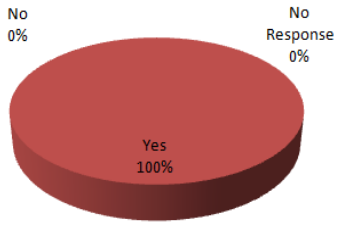
One reviewer stated that the funding for this project is sufficient, while another similarly stated that the resources roughly described seem adequate to the planned work. One person noted that the group has done a lot of work already, but adds that this is very difficult work. This reviewer suggests maybe leveraging outside resources more – i.e., people who have already been studying these films (e.g., Aurbach in Israel?).

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

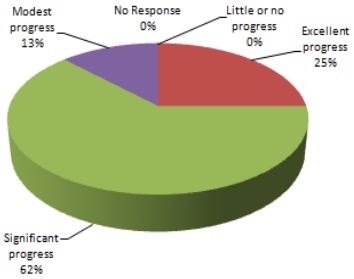
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: SEI Studies at ANL

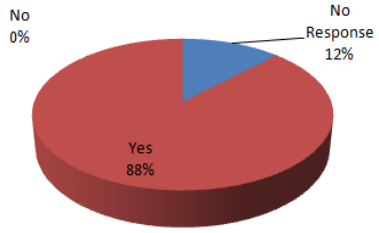
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



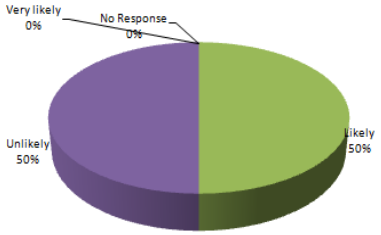
Question 3: Characterize the technical accomplishments and progress toward goals.



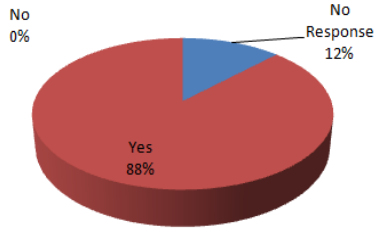
Question 2a: Are the goals of the project technically achievable?



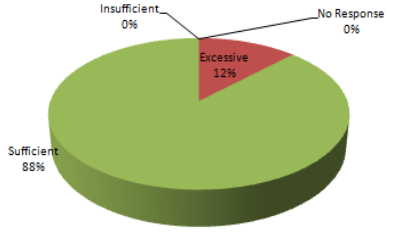
Question 4: How likely is the project team to move technologies into the marketplace?



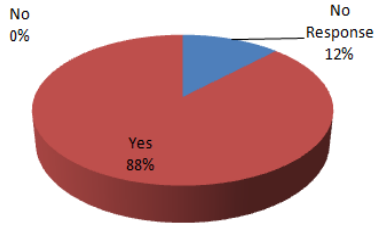
Question 2b: Have the technical barriers been identified and addressed?



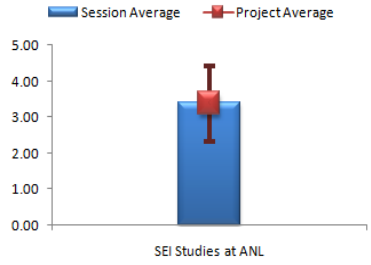
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Statistical DOE at INL (Kevin Gering, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer noted that the project is functional to the DOE objective to increase lithium-ion cycle-life. Another person commented that the project will provide useful results that will lead to more rapid development of batteries for HEVs and PHEVs thus reducing the use of oil. Many comments were focused on cell formation. One person simply pointed out that formation is a key step in manufacturing lithium-ion cells, while another person added that it is critical to making and testing real cells and estimate lifetimes reliably. Another person commented that the formation process is extremely important for long cycle-life, calendar-life, and can allow for capacity optimization (as shown). Another person remarked that SEI formation greatly affects the life of the cells and learning more about these and how they protect will help improve life by changing components that will enhance good protection that will last with extended cycling. They concluded by mentioning that statistical analysis provides insight into which parameters need to be pursued for father life studies. The last person commented that aside from the effects on performance and life, the formation process is a significant economic aspect of li-ion battery production, and detailed DOE studies such as in this study provide insight.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer simply acknowledged the good work plan. One person indicated that the researcher's work is of fundamental importance to obtaining a better understanding of the formation process. Another person observed that the barriers are well identified and the approach is likely to give indication to overcome barriers in an interesting fashion. One reviewer commented that statistical correlations show information already established in the lithium-ion database, namely, higher capacities obtained with higher end-of-charge voltages, higher capacities obtained with lower charge/discharge rates, etc. They added that the conclusion of higher temperatures being good for good battery performance can be misconstrued because the comparison was made between 40°C and 0°C, so they suggest that the researchers need to be more specific in this area. One person congratulated the researcher on employing a good strategy, but cautioned that the study is somewhat limited by using coin cells. They commented that this is a very nice first step in using statistical methods in a significant way and applauded DOE for selecting this particular project. Another person agreed, commenting that the researchers need to address other systems and cell sizes as described in more detail below. The final reviewer agreed, stating that it is unlikely that a full resolution of variables that are truly relevant to cylindrical lithium-ion or pouch cell lithium-ion can be determined from coin cell data. They highlighted the fact that the contact of the electrodes is quite different and gives rise to a different distribution of current on the electrodes. However, they felt that the studies can help to understand particular problems such as mass transport in electrolytes and solids in the coin cell experiments.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer simply commented that the researcher's systematic approach will lead to a better understanding of the formation process for Gen 3 cells. Another person commented that, although the study is limited to a very specific cell type, it provides useful information about some of the effects

of some key variables of the formation process. One person pointed out that the researcher has shown very important progress that can be used throughout the DOE program for optimized conditions. The researcher added that they would like to see a doubling or tripling of budget so that this type of methodology can be used also for electrode formulation, electrolyte composition, and formation studies. They concluded by suggesting that the scope be expanded into cyclability to look at trade off effects would also be helpful. Another reviewer indicated that overall the researchers have done outstanding work. They commented that is nice to see Design of Experiments work being done at a government lab. They acknowledged the project employs good experimental design, but having a somewhat nitpicking suggestion, they would have chosen a wider range for the number of formation cycles (such as N=2 and 5). The reviewer suggested that when doing a screening study the goal is to set the chosen levels to have a decent amount of discrimination to see if the variables are important. They concluded by noting that obviously, this cannot be taken too far, otherwise you just get into the good/bad region whereas you want to stay in the good/not-so-good range of performance. One person noted the good work plan, but they mentioned that they would have expected some concrete suggestions with respect to the "optimum" formation conditions. One person remarked that the study is nearly completed within its own barriers, but it needs to be related as far as possible to results from large lithium ion batteries. The reviewer also suggested that there needs to be an increased emphasis on standard deviations since the design is essentially statistical, rather than scientific. Another person acknowledged that the statistical analysis provides excellent data, although a lot of this information is already well-known. They added that the chosen factors should be incorporated into the studies and understood for the electrode materials and electrolyte compositions as these can vary depending on the compositions of the components. One person, however, commented that too many parameters to fit the experimental results, this fact reduces the effectiveness of this work. Another person mentioned that the large number of samples and the overall analysis of parameters affecting formation give results with a good coverage of possibilities; the weak point is due to the fact that the results are restricted to one chemistry. The last reviewer person remarked that the program is a brute-force approach to optimizing formation procedures and there does not appear to be much use of physical understanding to complement the brute-force statistical analysis. The reviewer commented that since the studies are being done with a single chemistry and electrode design, it is not clear how these results will be of general applicability to the battery industry.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reactions to this question were mixed. One person commented that the methods used for data analysis are very good as they correlate to what is already well known. Another person pointed out that the researcher collected a significant amount of data that has been used by him and his coworkers to make preliminary statements about the influence of various parameters in the formation process. However, they added that the analysis is limited to an empirical approach and the use of a geometric mean for the capacity is questionable. They concluded by indicating that data should be analyzed by using a physics-based model. One reviewer suggested that the project needs more resources to be useful. The reviewer added that work like this project needs to address other issues besides formation. Another reviewer argued that significant commercial producers of mass-produced li-ion cells already employ similar methods for studying formation parameter effects; however, it is possible that producers who may be entering the market at some future time would benefit from understanding this work and the general method. One person stated that only if they come out with a greatly improved formation process, the current data are not good enough for that purpose. Another person felt that until the translation of results to large cells is shown it is unlikely that the technology will be

marketable. Another reviewer remarked that the results do not seem to have their own specific market value, even if the developed methodology can be made available to other chemistry. The last reviewer highlighted that this work will increase speed to market and will assume that optimized conditions are used for the materials studied, which is critical for assessments, so that no false negatives are obtained.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

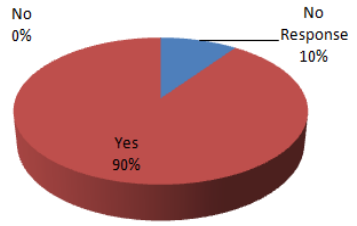
One reviewer simply stated that the funding for this project is sufficient. Another person agreed, stating that based on the quantity and quality of work, the resources seem adequate. One person mentioned that the number of cells and the test and analytical work seem consistent with the budget, even if uncertainties still remain about the overall resource use. One reviewer suggested that the inclusion of similar studies of cells produced using electrodes or materials produced by a significant mass-producer of li-ion cells would be very useful and would provide an important reference point, but would require cooperation with a significant mass-producer. One person suggested that the project funding should be increased and to have the researcher interact with all the experimentalists in a significant way with experimentalists providing the researcher with parameters they know affects performance the most and have the researcher find a cost effective way of studying those. The reviewer indicated that this is what the large manufacturers have spent a lot of time on in the past and will lead to guaranteed success. They added that some people would say that this type of research is for battery companies to perform, but the case is that if it is not done in conjunction with the materials development, the materials development will be hindered and not as effective as it could be. The last reviewer had detailed comments and highlighted that a lot more work needs to be done to address other chemistries and the additive influence and larger cells and cell types (e.g. pouch versus cylindrical). For example, gassing in pouch cells can be a real issue whereas cylindrical cells are less sensitive to this. The reviewer does not believe findings can be generalized from one system to another. They suggest that instead of running large full factorials on six variables, running a larger number of smaller experiments such as a half factorial. With six variables, the aliasing in the half factorial is pretty small and valid results can usually be obtained with far less data by leveraging the inherent replication in the Design of Experiments design. The reviewer asked whether the researchers repeated any runs to get an estimate of the replication error, or are they relying upon the replication built into the design; suggesting that it might be worth considering as a basic quality check of the data. They concluded by stating that overall, this work needs to be expanded and more resources applied.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

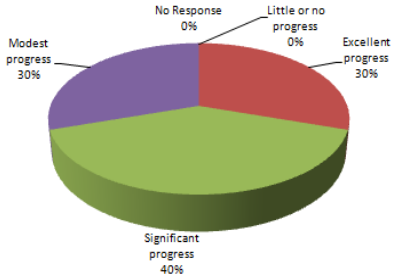
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Statistical DOE at INL

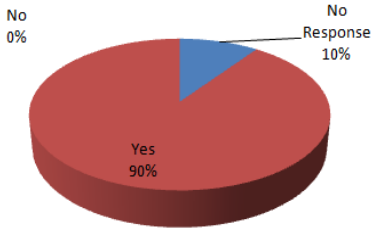
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



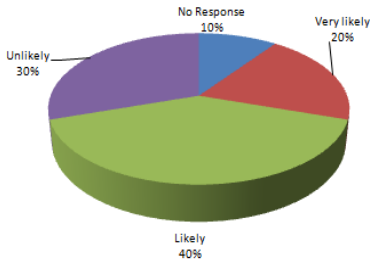
Question 3: Characterize the technical accomplishments and progress toward goals.



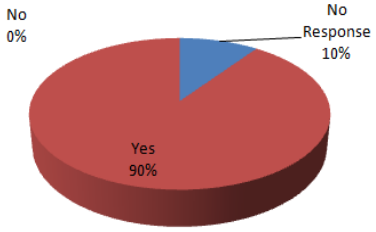
Question 2a: Are the goals of the project technically achievable?



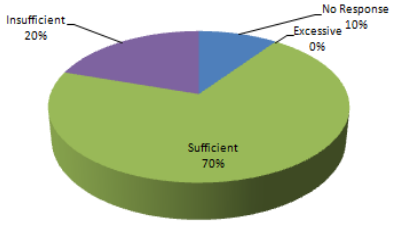
Question 4: How likely is the project team to move technologies into the marketplace?



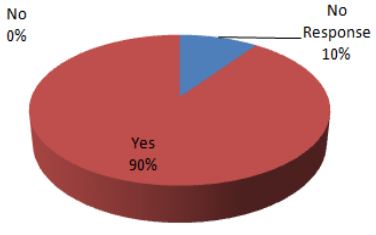
Question 2b: Have the technical barriers been identified and addressed?



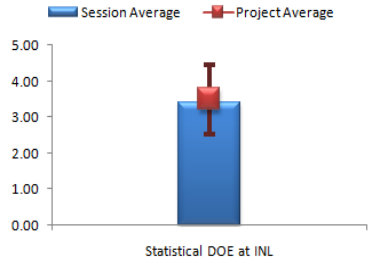
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



3. Battery Development, Testing, Simulation, Analysis

Introduction

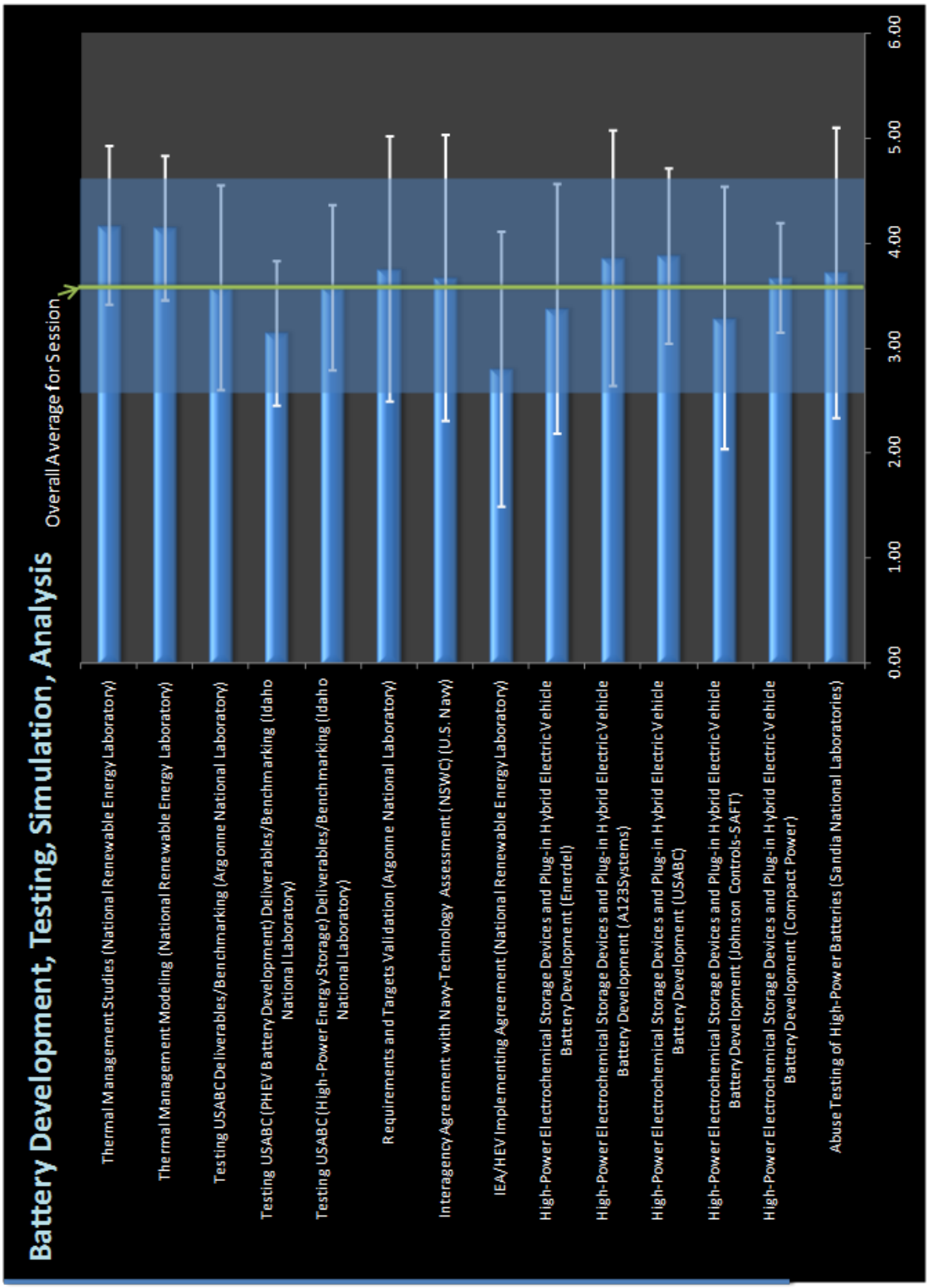
Battery systems research focuses on testing, evaluating, and developing energy storage technologies in close collaboration with developers and the automotive industry. This work is primarily accomplished through the United States Advanced Battery Consortium (USABC), a partnership among the U.S. Department of Energy (DOE) and DaimlerChrysler, Ford, and General Motors. Working with manufacturers and the DOE national laboratories, USABC pursues research and development (R&D) of advanced energy systems capable of providing future generations of electric vehicles with significantly increased range and performance. This work concentrates on three areas: full system development for electric and hybrid electric vehicle applications; assessment of laboratory-proven technologies and the technology developer's ability to develop and deliver a full-scale, fully packaged battery; and benchmark testing of emerging technologies.

This area maintains a balance between R&D projects that aim to directly aid the introduction of advanced energy storage technologies into the automotive marketplace. Work focuses on electrochemical energy storage systems, especially rechargeable batteries. Researchers maintain a balanced portfolio of R&D projects aimed at overcoming the barriers hindering the commercial viability of advanced energy storage systems in electric and hybrid electric vehicles.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
3-4	Abuse Testing of High-Power Batteries (Pete Roth, Sandia National Laboratories)	3.71	1.38
3-8	High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Ahsan Hababb, USABC)	3.88	0.83
3-11	High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Andy Chu, A123Systems)	3.86	1.21
3-15	High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Mohamed Alamgir, Compact Power)	3.67	0.52
3-18	High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Naoki Ota, Enerdel)	3.38	1.19
3-21	High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Mike Andrew, Johnson Controls-SAFT)	3.29	1.25

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
3-25	IEA/HEV Implementing Agreement (Ahmad Pesaran, National Renewable Energy Laboratory)	2.80	1.30
3-28	Interagency Agreement with Navy-Technology Assessment (NSWC) (Jim Barnes, U.S. Navy)	3.67	1.37
3-31	Requirements and Targets Validation (Dan Santini, Argonne National Laboratory)	3.75	1.26
3-34	Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking (Tim Murphy, Idaho National Laboratory)	3.57	0.79
3-38	Testing USABC (PHEV Battery Development) Deliverables/Benchmarking (Tim Murphy, Idaho National Laboratory)	3.14	0.69
3-41	Testing USABC Deliverables/Benchmarking (Ira Bloom, Argonne National Laboratory)	3.57	0.98
3-45	Thermal Management Modeling (Ahmad Pesaran, National Renewable Energy Laboratory)	4.14	0.69
3-49	Thermal Management Studies (Ahmad Pesaran, National Renewable Energy Laboratory)	4.17	0.75
	Overall Session Average and Standard Deviation	**3.62**	**1.03**


Battery Development, Testing, Simulation, Analysis
Overall Average for Session
Thermal Management Studies (National Renewable Energy Laboratory)
Thermal Management Modeling (National Renewable Energy Laboratory)
Testing USABC Deliverables/Benchmarking (Argonne National Laboratory)
Testing USABC (PHEV Battery Development) Deliverables/Benchmarking (Idaho National Laboratory)
Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking (Idaho National Laboratory)
Requirements and Targets Validation (Argonne National Laboratory)
Interagency Agreement with Navy-Technology Assessment (NSWC) (U.S. Navy)
IEA/HEV Implementing Agreement (National Renewable Energy Laboratory)
High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Enerdel)
High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (A123Systems)
High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (USABC)
High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Johnson Controls-SAFT)
High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Compact Power)
Abuse Testing of High-Power Batteries (Sandia National Laboratories)
0.00
1.00
2.00
3.00
4.00
5.00
6.00

Abuse Testing of High-Power Batteries (Pete Roth, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person noted that this activity provides critical support to the DOE objectives. Another person added that abuse testing is a key target of the DOE battery program, particularly for lithium batteries. Addressing safety was recognized as a critical element for DOE to cover. One person stressed that safety is the number one parameter that has to be met. They added that independent testing of safety is very critical to the success of the entire program. The reviewer finished, asking whether DOE has followers to Peter Roth that are being trained in the art. Another person agreed that safety is absolutely critical and Sandia's work is vital in doing independent tests on "real" batteries, not just ARC studies on small coin cells. The last reviewer commented that Roth and his coworkers at Sandia have established abuse tolerance tests that are capable of testing the safety of batteries for HEVs and PHEVs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person simply stated that the work is outstanding. Another person commented that the role and expected results from abuse testing are clearly described and motivated. One person highlighted that Roth has established several tests for single cells and is in the process of using these tests on high-power cells for use in HEVs and PHEVs. Another person commented that the project has repeatedly demonstrated flexibility and innovation in advancing capability and in achieving new technical understanding in lithium-ion abuse testing and phenomena, characterization, and interpretation. One reviewer pointed out that the safety investigations do not include other cell variables, such as void space, separator thickness and porosity, conductor levels, foil thickness, tab thicknesses and widths, etc. The reviewer felt that it would be useful to investigate some of the effects with the same system in cells made at Sandia to assess their safety impact. The last reviewer suggested that a use scenario study should be initiated because a lot more is known about HEVs now than what was the case a few years ago. They ask whether we have the appropriate methods for doing this or whether the tests be upgraded; this should at minimum be reevaluated.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Comments to this question were generally positive. One person commented that SNL's efforts in this area are recognized within the related global industry and are a significant critical asset to the advancement HEV battery development in the U.S. and internationally. Another person noted that SNL has a state-of-the-art laboratory with very good, highly capable, staff. They felt that it was obvious that the investigators are learning continuously, based on comments from previous years. The reviewer acknowledged that the art has matured, which is nice to see. They added that the challenge is to take this to the next step and invent abuse testing that can differentiate between the most significant tests on a gradual scale. They concluded by asking how systems with more than on/off on a meaningful to manufacturers scale can be graded. Another reviewer highlighted that abuse tests are absolutely necessary to evaluate the stability of the batteries developed under various programs. They also mentioned that the group developed the abuse test manuals, has very good abuse testing facilities, and carries out the necessary tests. Another reviewer pointed out that the researchers are developing

methods of testing HEV battery modules for safety. The reviewer concluded by highlighting that these tests are extremely important and will provide important data for battery developers. Another reviewer commented that Sandia is often able to explain the results and provide essential feedback to both cell developers and program directors; they do not just describe the pass/failure results, but present the results in terms of what's happening inside the cell. They point out that they are also, excellent at quantifying what is inherently difficult to measure. Their work that identified separator integrity and breakdown voltage as major issues is novel and wildly recognized. This has in part led to an industry-wide search for more robust separator materials, some of which are already making it into commercial production in consumer applications. The reviewer acknowledged that most of this is from other talks given by the PI - this format does not enable presenters to give details. Other reviewers, however, were more critical. One person suggested that a broader investigation of variables would make the investigations even more useful. The final reviewer commented that the progress shown seems limited because it is not clear why only two USABC technologies have completed abuse testing.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments to this question were positive. One person mentioned that results from observations conducted at SNL have influence on the direction of HEV battery development. Another person noted that this project is a fundamental activity to assist battery development and carmaker selection of safe technologies. Another person mentioned that technology has to be safe to be launched, so this will show if it is or not. The outcome is very binary, either you pass the test or not. The testing on systems with a removed "safety component" may fool people, so the researchers need more disclosure on this as the removal might not always be a "real life" scenario, it was not clear to this reviewer if this is the case or not. Another person commented that this work is critical for marketplace entry and Sandia is recognized as an important gatekeeper with methodology being widely respected and copied. The reviewer noted that the researchers seem to have for the first time developed specific safety guidelines for acceptable safety of these cells. The reviewer concluded by stating that really this should come from the auto makers, but in the absence of such leadership it is great to see Sandia pushing this forward. The last reviewer commented that the safety tests being developed at Sandia for high-power cells and battery packs will provide valuable data to battery developers. They mentioned that this data will reduce the development time for HEV and PHEV battery packs. The reviewer concluded by stating that Roth and his co-workers should work with others to analyze their data in light of a models of the tests that they carry out.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One person suggested that expansion of resources and activity in this area would be of critical utility to the advancement of the HEV battery industry. Another person mentioned that no comment was made on too little equipment to accomplish testing. The reviewer suggested training the "next generation" and that it is also good to have training programs to spread this knowledge throughout DOE, which is critical for future programs in any area of activity. They concluded by stating that the researchers have significant knowledge that many people within DOE can draw upon (and outside DOE). The last reviewer commented that the researchers have built up some very impressive test methods and equipment, however, this work is incredibly labor intensive and it is difficult to run large sample sizes. The reviewer also noted that variability among supposedly equivalent cells is very common in the battery industry. The reviewer suggested that the team needs a much higher degree of replication to be sure of the validity of the results. They concluded by stating that the researchers probably cannot outsource this work due to the hazards involved (and maybe the needs for absolute

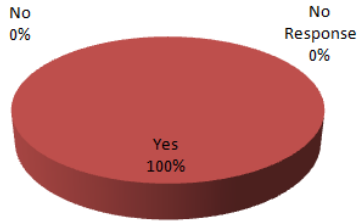
confidentiality since bad safety performance is a very touchy issue). One person simply stated that hard evaluation of not described resources and unclear planning. The last person thought that the funding is excessive for the level of testing and analysis carried out.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

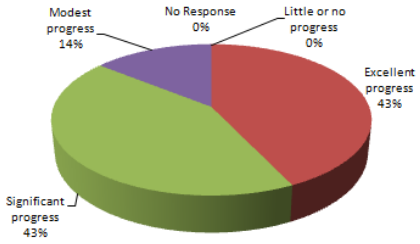
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Abuse Testing of High-Power Batteries

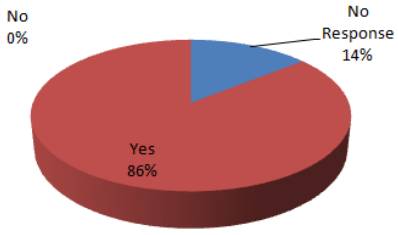
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



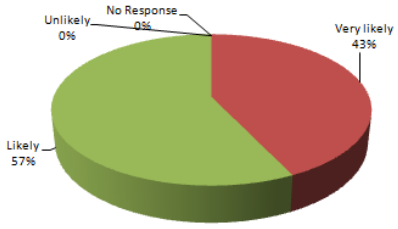
Question 3: Characterize the technical accomplishments and progress toward goals.



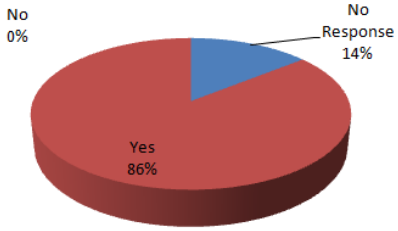
Question 2a: Are the goals of the project technically achievable?



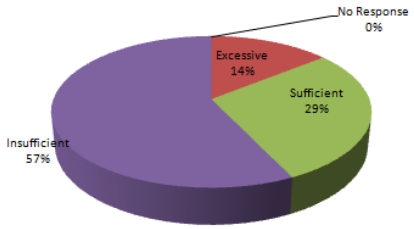
Question 4: How likely is the project team to move technologies into the marketplace?



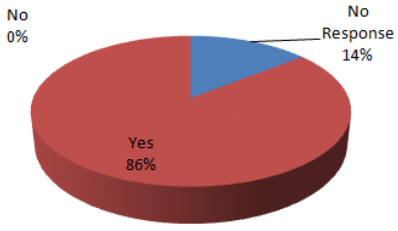
Question 2b: Have the technical barriers been identified and addressed?



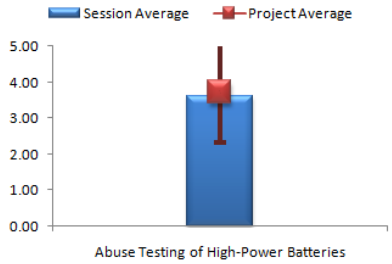
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Ahsan Habab, of USABC)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Reviews to this question were generally positive. One person noted that USABC members work together to develop advanced batteries for HEVs and PHEVs. Another reviewer acknowledged that the USABC clearly addresses key enabling transport technologies to significantly support DOE objectives in the sector. Another person noted the importance of HEV and PHEV in the process to move to an oil-free era, but that energy storage is currently the key barrier. They pointed out that li-ion batteries and ultracapacitors are among the choices to develop by USABC with focuses on li-ion battery because of the current energy density advantages. The concluded by noting that the USABC has set goals for the research in batteries. One reviewer commented that USABC is actively involved in developing the energy storage systems (batteries and ultracapacitors) in close collaboration with developers. They added that the work covers the most known areas or aspects of li-ion battery technology and ultracapacitor technology. It was then noted that most of the characteristics of energy storage systems have been significantly improved and the technologies are ready for application in hybrid-electric vehicles. They concluded by stating that this effort certainly support the overall DOE objectives of petroleum displacement. The final reviewer suggested that the researchers focus on spider chart, noting that it was only on screen for a short time so they were not able to review it completely. They felt that the chart was OK, but noted that cost, low temperature and calendar life were shown, and they believe that safety is a huge "gap".

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person simply stated that this project is a coordination project. Another felt that the program has identified key technical and economical barriers and defined acceptable steps to overcome them, but the activities on ultracapacitors need better specifications and efforts. One reviewer suggested that the researchers should consider involving more companies and universities, to diversify the research portfolio including investigating ultracapacitors and other chemistries in addition to li-ion batteries. Two reviewers had comments safety related comments. One reviewer commented that safety was not clearly addressed and that it was difficult for a reviewer to technically evaluate this aspect of the work. They added that only Johnson Controls' effort appears to have significant program management necessary for large-scale production in place. The last reviewer stressed that safety is critical and needs to have much more emphasis in the program. The concluded by stating that they did not believe that the DOE or USABC even has metrics for what the goals are at the cell and pack level.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One of the reviewers pointed out that no technical data was available, but then said that the technical data shows the "easy to get" targets. Another person simply stated that they were not able to comment much from an overview talk like that which was given. One reviewer noted that this project consists of coordination and goal setting, on which they felt the researchers have done a fairly good job. Another person commented that the progress has been very good with well organized actions to overcome technical barriers. Another person had similar comments, acknowledging that significant

progress has been made in the li-ion battery, including energy density and other aspects, however they felt that more aggressive targets may be possible.

The last reviewer had detailed comments stating that except for in the areas of cost, some abuse tolerance, cold temperature performance, and calendar life, most of the performance characteristics of energy storage systems have met the requirements established by the USABC. They pointed out that several automobile manufacturers have started using the batteries developed under the USABC contracts in their hybrid vehicles on the road today. They concluded by noting that all the USABC programs are concentrating their activities in those areas that still need improvements.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer commented that the technology transfer may be limited by proprietary considerations. Another acknowledged that the support mostly goes to companies who has reasonable infrastructure which will ensure the long-term manufacturing of such batteries. One person highlighted the fact that the lithium-ion battery supplied by Johnson Controls, a company working with USABC, will be used by Mercedes in their S-Class hybrid-electric vehicles in October 2008. The last reviewer commented that the researchers are working with the right partners in most cases, although they questioned the choice of Celgard, since most of the advanced safer separators seem to be coming from other suppliers including LG.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

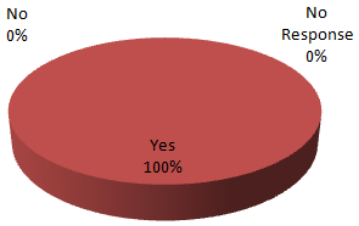
One reviewer commented that they were not able to answer the question without studying this in much more detail. Another person felt that the resources are important and adequate for the work already planned. One reviewer commented that the current funding is sufficient for the research, particularly with 1:1 match by the undertaking companies. They added that they would like to see the funding increase in the coming years in particular when universities and other non-profit organizations are involved in fundamental research. Another person agreed with the point that additional funding would be beneficial, stating that more funding would lead to domestic battery suppliers. The last reviewer commented that it was difficult to assess whether safety has been sufficiently addressed in these systems. They felt that it was not clear why the developing companies would have good PHEV systems.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

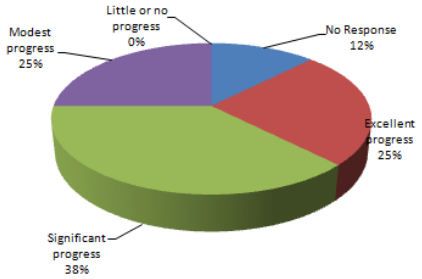
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development

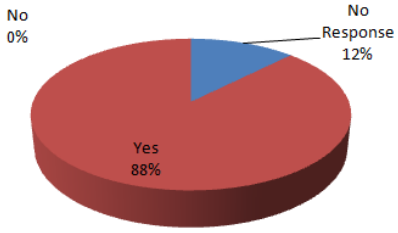
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



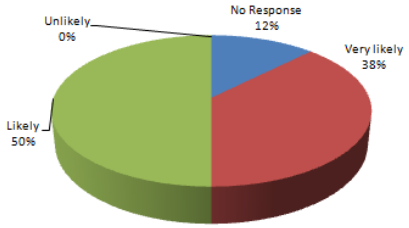
Question 3: Characterize the technical accomplishments and progress toward goals.



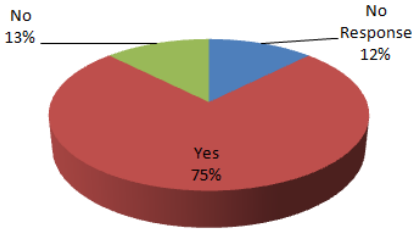
Question 2a: Are the goals of the project technically achievable?



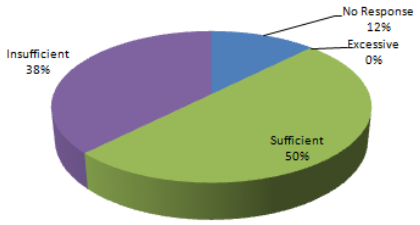
Question 4: How likely is the project team to move technologies into the marketplace?



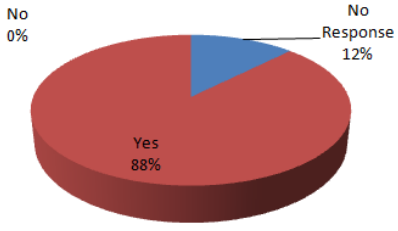
Question 2b: Have the technical barriers been identified and addressed?



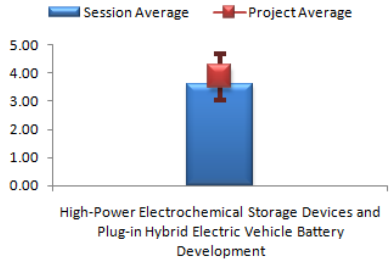
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Andy Chu, of A123Systems)

Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

One reviewer acknowledged that the project looks at specific objectives of the DOE program, addressing key targets of the battery sub-program and that li-ion battery is the key technology presently targeted. Another person noted the importance of HEV and PHEV in the process to move to an oil-free era, but that energy storage is currently the key barrier. They pointed out that li-ion battery and ultracaps are among the choices to develop by USABC with focuses on li-ion battery because of the current energy density advantages. Another person agreed, adding that li-ion technology critical to HEV and PHEV structure. One reviewer pointed out that the focus of the work is high rate, low-temperature and safety, which are all keys for a practical HEV battery; however, they felt that the energy penalty with $LiFePO_4$ may be more of a stretch for application in PHEVs. The last reviewer acknowledged that A123 is making $LiFePO_4$ cells that are currently being used by DeWalt for their portable tools, which is an indication of their success in developing high-power cells needed for HEVs and PHEVs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The strategy is reasonable even if only limitedly described. The technical barriers are well analyzed, but concerns remain about the cost target. One person pointed out that A123 is currently manufacturing batteries for power tools and that the company is making good progress in the USABC program. The reviewer felt that there is a good probability for A123 technology to be deployed for automotive applications. One person noted that A123 is addressing the goals of reducing the cost and improving the power of their cells; however, another person felt that the 20kW target for HEV applications is too low. Another reviewer also had a comment related to the power of the cells, stating that the approach was fine overall, but that a high-power cell may be less helpful in reducing pack size and cost for PHEV applications where energy needs are higher. They pointed out that the cells are a very good fit for PHEV, but they still would like to see more emphasis on safety of full packs. The last reviewer had detailed comments, pointing out that the program manager talks about electrode and materials development, but with a frozen design, which is not consistent. They felt that this inconsistency shows that the battery design is likely far from frozen which raises doubt regarding the cost-effectiveness of its implementation. They suggested that yields may be low in the factory or that materials supply has been difficult. They highlighted the fact that no data was presented for used cells and that the data that was shown was for non-critical scenarios. They felt that it was hard to comment on other factors, such as power performance, as this was not presented, adding that the presentation would have benefitted from some more insights on what is being developed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Comments to this question were mixed, but were generally negative. One reviewer commented that A123 has produced an outstanding battery in a very short period of time while continuing to produce better cells and have reduced the cost of their battery packs by approximately 40%. Another person stated that the presentation declares, and partially shows, the real progress on specific power and cost. They point out, however, that the abuse testing was carried out on a cell design different from the

HEV type. They suggest that some more quantitative results on life testing should not be of a confidential nature. One reviewer acknowledged that even though the batteries have been used in power tools, they are still in the pilot phase of HEV testing and that the cost (on a $/kW basis) is still high. They point out that the 20kW power target is not sufficient to drive a PHEV in electric-only mode and that a full hybrid will require about 30kW to 50kW; so a PHEV may require up to 100kW. They add that research has verified the life and abuse tolerance to be good. They concluded by stating that the testing results by National Labs is consistent, but more work is needed on increasing battery capacity and power rating. One person simply stated that the presenter did not provide any significant data, which leads to a negative impression of the work. The final reviewer had detailed comments, noting that the product is almost there already from the viewpoint of low-temp performance and cost, and that the safety is better in small cells. However, they were not sure that safety is good enough in large packs, pointing out that some of Sandia's testing looks pretty ugly on actual abuse tests. They caution that ARC and others are fine tools to study materials and even some designs, but that the final product safety is not the sum of the safety attributes of the components; the system design and thermal mass issues are key. The reviewer agrees that the lack of hot spots in the thermal imaging is nice, but that thermal management in large packs is going to be critical. They highlight the need to investigate what happens with a defective cell since they will be present in real-world large scale applications. The reviewer concluded by noting that the modeling work shown by a later presenter showed that the thermal imaging cannot in fact detect hot spots inside the cell, which undermines the whole thermal imaging work in my view.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments to this question were all positive. One person acknowledged that A123 has truly outstanding employees who are working together to improve their cells and cell packs. Another person pointed out that the company has already shown capacity in developing and commercially producing li-ion cells for power tools in a very short time and demonstrated significant interest in HEV applications. Another reviewer highlighted the fact that the company has gone from a lab to a real product in such a short time as to be absolutely amazing. The reviewer was very impressed with A123's abilities and the ability to leverage funding to get to a real product so quickly. They pointed out that the company is using product sales in other existing markets help drive this work (e.g. power tool and electric bicycles) forward to implementation, which enables a step-wise lower risk implementation path. Another reviewer also noted that the company has already produced lithium batteries for other applications. They felt that the cost reduction projections of 40%, if reached, will be significant progress. One person simply added that the work on $LiFePO_4$ is important as this is a material with great promise. The final reviewer commented that the technology involved with this project may have a reasonable chance of movement into or toward the marketplace, based on the relative benefits and risks as a cell chemistry alternative to more mainstream cell chemistries.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Comments to this question ranged from some reviewers believing that the funding level is too high to others that felt that the company is adequately funded. One person commented that in comparison with development projects of comparable scope, this project should be able to demonstrate potential viability with a significantly lower resource level. Another person, however, commented that the resources are used efficiently and are adequate. One reviewer felt that the company is doing well with the funding they have. The reviewer felt that A123 had shown good commitment and suggested that their cells and chemistry be given priority in safety testing at Sandia. This reviewer would like to see what happens with a defective cell, since with the large number of cells per car that even one bad cell

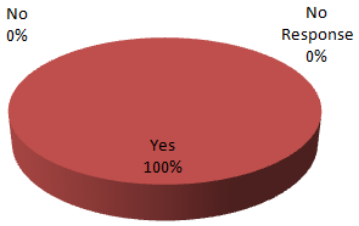
in 100,000 (0.001% failure rate) could lead to field problems. Another person; however, felt that the company should be given additional funding to assist them in their optimization program and to continue to improve the safety of their cells. The last reviewer stated that it is hard to evaluate this given the lack of results shown in the presentation, but they acknowledged that no insufficiency was mentioned.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

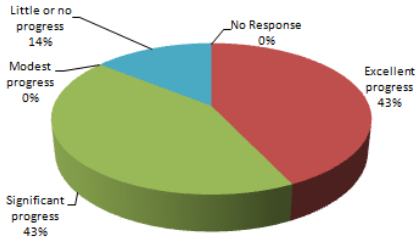
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development

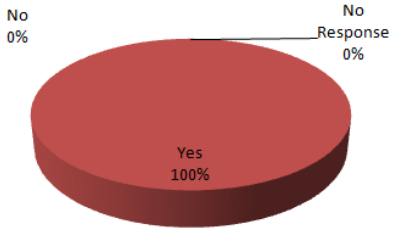
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



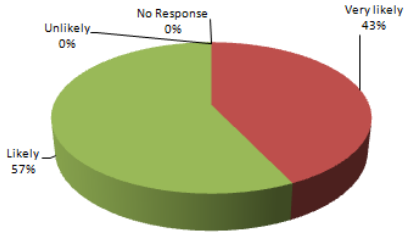
Question 3: Characterize the technical accomplishments and progress toward goals.



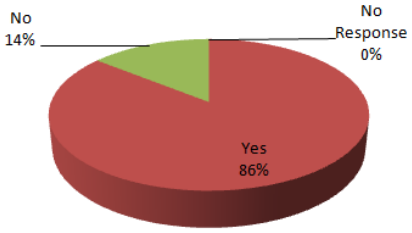
Question 2a: Are the goals of the project technically achievable?



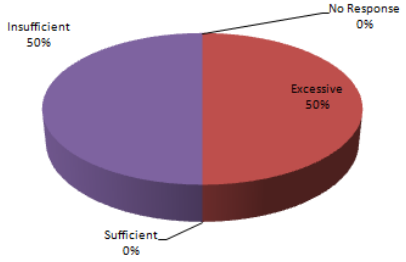
Question 4: How likely is the project team to move technologies into the marketplace?



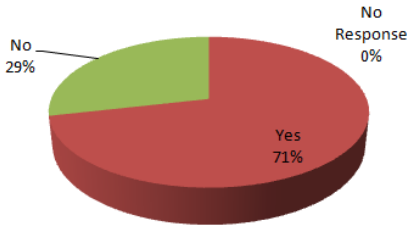
Question 2b: Have the technical barriers been identified and addressed?



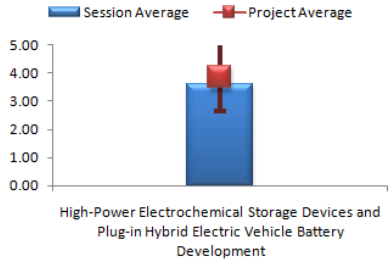
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Mohamed Alamgir, of Compact Power)

Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

Comments to this question were generally positive. One reviewer noted that the project focuses on spinel cathode for very high-power lithium batteries, which is well in line with the DOE core battery technology for HEV and PHEV with a significant industrial financial commitment (65%). Another person noted the importance of HEV and PHEV in the process to move to an oil-free era, but that energy storage is currently the key barrier. They pointed out that li-ion battery and ultracaps are among the choices to develop by USABC with focuses on li-ion battery because of the current energy density advantages. One reviewer commented that Compact Power is working on a cell that may be able to deliver the required power for HEVs and PHEVs as well as developing a safe, low-cost cathode that will deliver high-power. The reviewer pointed out that Dr. Patil (Compact Power CEO) has significant experience in the auto industry and LG Chem is a world class company. The final reviewer noted the goals included making a low-cost cathode material practical, as long as it can meet the other criteria. The reviewer questioned whether the researchers will ever be able to meet the cost target, and if not, they asked why this work was even being performed. The reviewer concluded by commenting that the researchers should be able to do an end-of-the-line cost estimate with what they know now.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

Comments to this question were varied. One person felt that the approach is reasonable and well structured with clear identification of key barriers. Another person acknowledged the fact that Compact Power/LG has been able to extend the calendar life of their cells as well as meeting the cold-cranking requirement. Another person, however, was more critical, stating that the presentation does not contain any details of the work the company is doing; and even did not say what type of battery they are developing. Therefore it is not possible for the reviewer to understand whether the company's goals are achievable; what barriers they have, etc. The last reviewer commented that the presenter stated that cost is unknown and at this stage, which should not be the case. They also pointed out that the safety in large packs was not addressed by the presentation. They concluded by saying that the separator approach is very nice, and that maybe it should be paired with A123 systems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One person commented that again the spinel-based chemistry that they are using as the cathode in their cells is enabling them to improve the performance of their cells and packs. Another person acknowledged that the company was able to meet the cold cranking requirement, and that the $500 per pack cost target has not yet been met, but work in addressing this is underway. They felt that the presentation gave a poor description of the cell chemistry. The PHEV results shown seemed to be well in line with the project targets, but some info about HEV battery cycle life and performances would have been appreciated. Another person reiterated the project goals of achieving a $500 per pack cost target; 5 kW cold cranking ability (-30°C). The reviewer commented that the presentation did not mention what type of battery and technologies are being used and what barriers will need to be overcome, so more details should have been provided. The last reviewer noted that the presenter claimed to have overcome Mn dissolution issues, but added that they believe that lots of people have

done this, which made them unsure whether the researchers have done anything special in this regard. They point out that no data was shown to support the lifetime claims; this reviewer was not able to accept the claim of a 15-year lifetime on a new cell design. They added that there was no time for the presenter to show the basis of his claims. They concluded by simply stating that the separator work is interesting.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer highlighted CPI's previous history as LG Chem in successfully developing and producing Li batteries. Another person commented that Compact Power/LG has demonstrated that they are using the latest technology to address such issues as following the state-of-charge of their cells using a state space Kalman filter approach. The reviewer felt that this advanced approach will enable them to be successful. Another person stated that LG has the muscle and dedicated internal buyers for these products to supply small cells as well as having a big interest in electric bicycles and HEVs. The reviewer felt the company had a good path to commercialization. They felt that the company's access to the less litigious Asian market may encourage more risk taking. The reviewer acknowledged the company's good long-term commitment in terms of internal funding. The reviewer expects this technology to go head to head with $LiFePO_4$ in the marketplace, much as is currently the case with portable power tools. The last reviewer simply pointed out that the company has delivered four PHEV packs for GM Volt, which provides a good indication of the company's progress.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

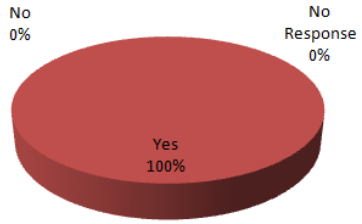
One person stated that the resources seem adequate. Another reviewer noted that the company has received additional funding recently and should have sufficient funding at this time to continue to demonstrate success. The last person commented that it seems to be a lot of people for what seems to be a cost savings/pack design process going forward (assumes the company has really solved the lifetime issue).

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

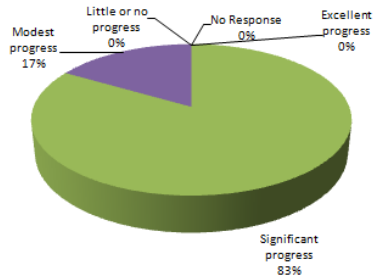
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development

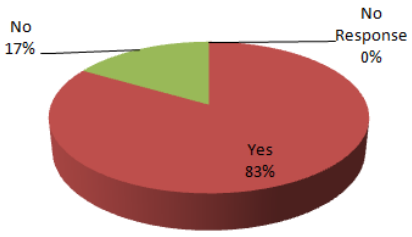
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



Question 3: Characterize the technical accomplishments and progress toward goals.



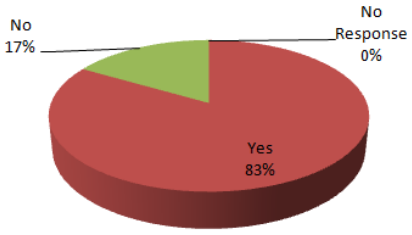
Question 2a: Are the goals of the project technically achievable?



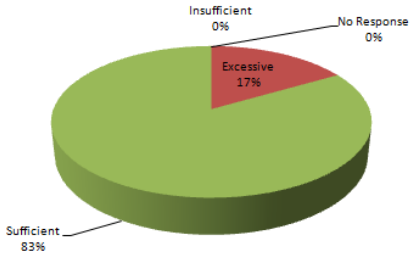
Question 4: How likely is the project team to move technologies into the marketplace?



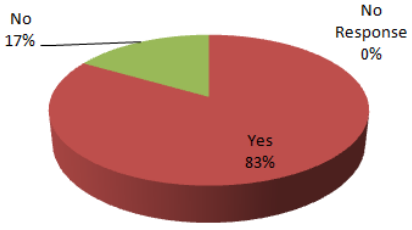
Question 2b: Have the technical barriers been identified and addressed?



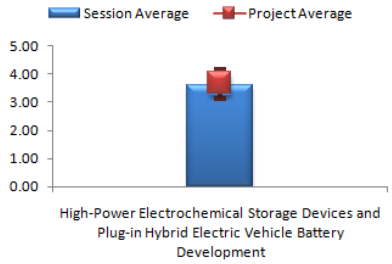
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Naoki Ota, of Enerdel)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that li-ion technology will be superior for HEV and PHEV applications, as soon as cost targets can be met. Another person stated that the project aims at lithium batteries for various transport applications, which is a key technology for the DOE objectives. Another person agreed, simply stating that the goals of this project activity would theoretically support the overall DOE objectives. Another person noted the importance of HEV and PHEV in the process to move to oil-free era, but that energy storage is currently the key barrier. They pointed out that li-ion batteries and ultracapacitors are among the choices to develop by USABC with focuses on li-ion battery because of the current energy density advantages. One reviewer felt that EnerDel/Japan has the experience and capability to develop battery packs for HEVs and PHEVs and that the safety of their cells is expected to help them be successful in the market place. The last reviewer commented that the work seems promising for HEV especially where long life is required (e.g. trucks, fleet and stationary applications). They commented that the higher anode potential leads to lower energy, which led them to believe that the system will not meet the PHEV energy goals. The acknowledge that the anode safety is good, which could be a fall-back position if the other systems cannot meet safety goals, so consequently, they thought that the work is important and should continue.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that EnerDel has established the capability of producing their cells in large numbers using cell production technology from their Japan partners. Another person noted that the company has identified barriers and procedures to overcome them and that they have detailed information on the technology progress. The reviewer pointed out that the company has delivered packs for HEV applications, but that they need to further develop their PHEV pack (e.g., more power and more capacity). Another person felt that the presentation did not clearly address the project technical barriers, even if the description of the work and the experimental activities are well presented. One reviewer highlighted that the project has had difficulty in verifying sufficient progress in the basic performance and reproducibility of the raw materials and processing methods at the lab-scale or small-cell-scale. Another pointed out that nothing was mentioned about the production readiness of the raw materials; if these change due to cost constraints, then new development must take place, which will be time consuming. The last reviewer commented that the results seem promising for HEV, but they do not believe the system will have the energy to meet many PHEV goals. They added that the anode safety is good and small cell safety is claimed to be good, but that the testing needs to be expanded to include some large cell testing.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Reactions to this question were mixed. One reviewer noted that EnerDel has licensed the titante anode technology that will provide high-power cells that are safe, from Argonne National Laboratory. Another person commented that the range for ASI and power capability is impressive. One person commented that the HEV project has reached significant progress with well justified results based on

cell research. They noted that the extension to full HEV battery systems is under investigation with characterization, including safety testing, and in-vehicle testing being done at ANL. Another reviewer pointed out that the company has made progress and have detailed strategies on the technology. They add that the company has delivered packs for HEV applications, but that additional work needs to be done on the PHEV pack, to increase the power and capacity. Other reviewers had more critical comments. One person highlighted that the life capability of EnerDel cells involved with this project has repeatedly been demonstrated as unexpectedly poor. They felt that there should be no inherent reason for this poor life capability due to the fundamental materials technology, and so there have apparently been repeated significant shortcomings in either cell manufacturing or raw materials. The last reviewer was critical stating that they did not like the nail penetration video, pointing out the smoking seen and some high temperatures from what is a small cell. They felt that there needs to be much more work to demonstrate their safety advantage, which they thought was mostly related to overcharging, and not to physical abuse.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reactions to this question were mixed. One person pointed out that the company has ambitious industrial mission and targets with significant financial commitment. Another reviewer noted that the company has good facilities and personnel, and that it seems, according to information provided by all the presenters, that the company may be the first ones to go into mass production. One person commented that EnerDel has selected their cell chemistry to develop into cells and packs that is safe and has high-power that will replace the NiMH cells in the near-term. Another person cautioned that mass production must be demonstrated and a pathway for cost shown, especially for a new material. Another person noted that the project performance does not currently provide strong confidence for ability to competitively progress toward the marketplace. The last reviewer cautioned that if other anodes can be made to work safely, then this anode is not needed since other cells would be smaller and cheaper. They added that being smaller gives additional benefits such as lower costs, smaller cooling system etc. The reviewer would still like to see this work continue as a back-up option. They concluded by suggest that DOE monitors how the company does in the power tool market versus A123 and carbon-spinel batteries.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

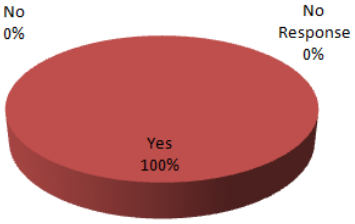
In general reactions to this question were positive. Two reviewers stated that the funding is sufficient for the current program. Another person agreed saying that considering the scope of the project in relation to the scope of other current similar projects, the project resources are sufficient. Another person felt that the question was hard to evaluate based on the presentation, but resource constraints were not mentioned. One person had a differing opinion, stating that the company deserves the same magnitude of support as A123 and others since their work is about the same; and their progress on the technology as well as technology and manufacturing progress are comparable. The last reviewer commented that the project needs more help in the area of safety testing and linkage to "real" car makers in the USABC. It was not apparent to the reviewer whether the company has the expertise and staff to move to pack design, so suggest that they either need a pack builder partner or to add staff to handle pack and systems integration.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

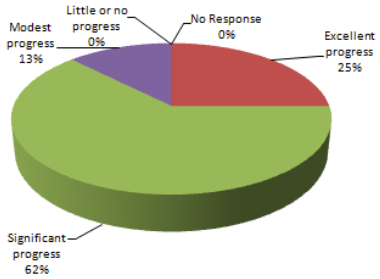
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development

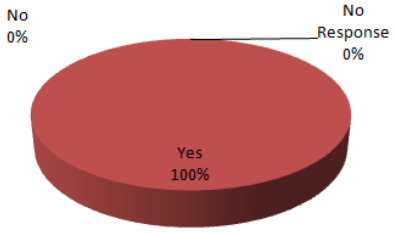
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



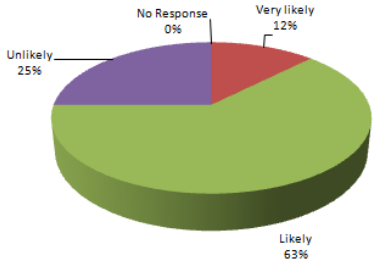
Question 3: Characterize the technical accomplishments and progress toward goals.



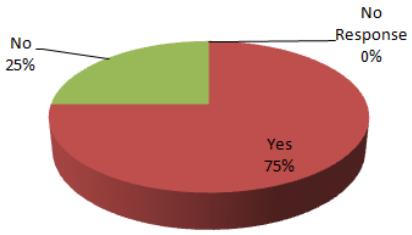
Question 2a: Are the goals of the project technically achievable?



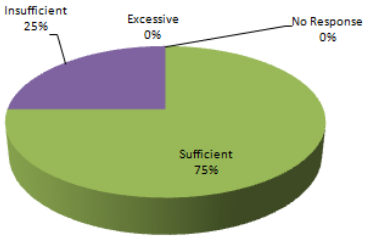
Question 4: How likely is the project team to move technologies into the marketplace?



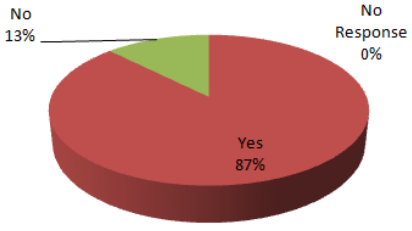
Question 2b: Have the technical barriers been identified and addressed?



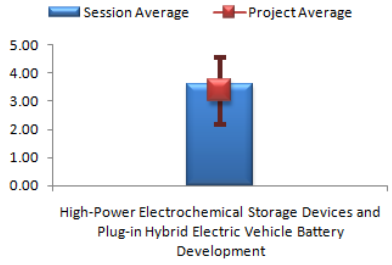
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development (Mike Andrew, of Johnson Controls-SAFT)

Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

One reviewer mentioned that the targets of the projects are clearly in line with DOE objectives in term of li-ion battery advancement in USABC technical and cost performances, adding that the presentation addressed HEV applications. Another person commented that the project has demonstrated useful life performance for an NCA cathode cell chemistry and has developed detailed cost model information. One person stated the presentation mentioned that the company has detailed information on the technology progress and that they have delivered packs for HEV applications. The reviewer suggests that the company needs to work on the PHEV pack application to improve the power and capacity. Another person commented that Johnson Controls-Saft is a joint venture of two outstanding companies that are well known for their success in batteries and are capable of producing high quality cells and packs to meet the needs of HEVs and PHEVs. The last reviewer mentioned that the cost goals for the program seem to be unrealistic for a Co-based cathode, particularly if this ever gets implemented and the demand drives the cobalt cost even higher.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer commented that the key technical challenges are analyzed and described; adding that they felt that the project is well-organized, complementing Johnson Controls and Saft expertise. The reviewer noted the concentration on low-temperature performance and mass production costs shows confidence in the selected chemistry (which was not described in the presentation). The reviewer concluded by stating that providing the reviewers with some more details on the chemistry would allow for better evaluation and reviewing. Another person commented that Johnson Controls/Saft has demonstrated that they can meet the low-temperature requirement. They further acknowledged that the companies are working on the important systems and electronics development for the efficient performance of their battery packs, and that the companies are currently on track to meet the cost requirement. One reviewer indicated that the presenter did not provide technical details; but felt that overall the approach is achievable. Another person simply stated that they do not believe NCA can meet safety requirements for HEV or PHEV. The final reviewer had detailed comments, stating that they think this project entails excellent technical work, but does not really target the PHEV/HEV business since, like the previous comment, they do not believe the NCA costs will ever meet the goals. The reviewer remarked that they may be useful for specialty applications that are less cost sensitive, which they felt may explain Saft's interest. The reviewer is not convinced that this program is in the interest of DOE. They felt that eventual U.S. production seems very unlikely, and that even if Johnson Controls produces the cells, they will likely go offshore for this unless they are mandated by the government to produce them in the U.S., which is presumably not an option for a commercial business. In the end, the reviewer did not buy into the "made in USA" scenario. They concluded by mentioning that the plant that Saft is building in France has a very small production capability and does not represent a big investment.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer indicated that they believe Johnson Controls /Saft has met many of their goals and have outstanding plans to meet the cost goal. Another person commented that technically, the program is fine, although they pointed out that all the presentations are so short that there is no "meat" to really critique, no science is presented, just conclusions. They concluded by commenting that based on other presentations, Saft seem to have done a very nice job at improving the low-temperature performance of their system. One person highlighted that the progress has been shown only in relation to the key issues of low-temperature behavior. They add that no results or considerations about safety aspects as a consequence of the changed electrolyte were presented. The last reviewer felt that progress is a little behind milestones. They suggested that the 40kW power target and price target of $1,200 for a 40kW pack is moderate and could be more aggressive.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The joint venture between Johnson Control and Saft has the clear goal to reach the market faster with more competitive and performance lithium batteries. Another reviewer shared a good opinion of the companies, observing that Johnson Controls /Saft have track records of producing and selling batteries for many applications, so they will be successful with their packs for HEVs and PHEVs. Another reviewer noted that both NiMH and li-ion are under investigation for HEV and PHEV; and that the joint venture comes with experience of Johnson Controls and Saft to leverage the battery development. Another person remarked that although the lack of significant li-ion consumer cell mass-production manufacturing background is a drawback to this project, the project has demonstrated a reasonable chance of moving the technology toward or into the marketplace. The final reviewer had detailed comments, stating that they think this project entails excellent technical work, but does not really target the PHEV/HEV business since they do not believe the costs will ever meet the DOE goals. The reviewer remarked that they may be useful for specialty applications that are less cost sensitive, which they felt may explain Saft's interest. The reviewer is not convinced that this program is in the interest of DOE. They felt that eventual U.S. production seems very unlikely. They also mentioned that the plant that Saft is building in France has a very small production capability and does not represent a big investment. They commented that raw materials costs are likely to be an insurmountable barrier to implementation that is not amenable to more R&D efforts. They concluded by arguing that even though this technology is actually likely to make it into the marketplace, it will only be in niche markets, not the markets that DOE is cares about.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers felt that Johnson Controls/Saft have received sufficient funding at this time. Two other reviewers, however, felt that the project was over-funded. One person commented that according to the invoices, the work completion and the results, the initial budget seems to be overestimated; however, the reviewer admits that the description given in the presentation hardly assists reviewers in properly analyze resource allocation and uses. Another person cautioned that the scope of the project is sufficient or (if anything) excessive relevant to some other similar projects. The final reviewer praised the fact that Saft has excellent people and Johnson Controls has good business linkages, however this reviewer's main issue is that they are working on the wrong materials. The reviewer remarked that the project is basically funding a French company's business plan. The reviewer stressed that they do not believe that this is a good use of taxpayer funding unless the work can be redirected to only work on lower cost cathodes. They added that raw materials costs are likely to be an insurmountable barrier to implementation that is not amenable to more R&D efforts. They

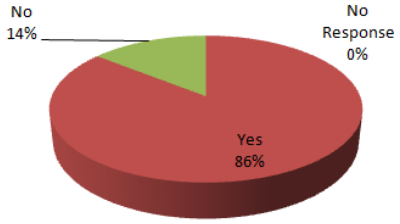
concluded by suggesting that another approach might be to fund this at the DOD who they believe are most likely going to be the beneficiaries of this work.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

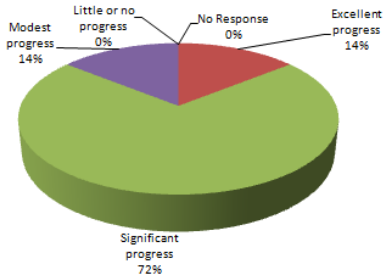
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development

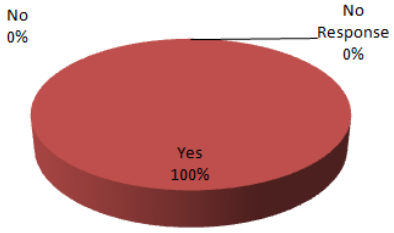
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



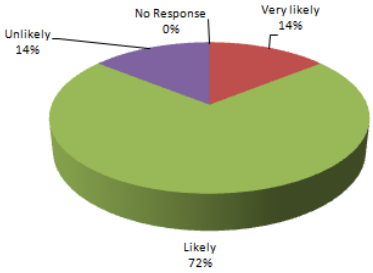
Question 3: Characterize the technical accomplishments and progress toward goals.



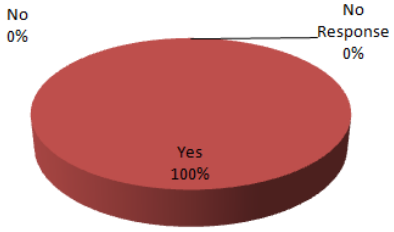
Question 2a: Are the goals of the project technically achievable?



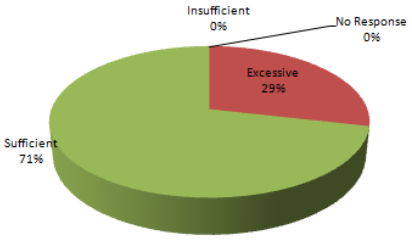
Question 4: How likely is the project team to move technologies into the marketplace?



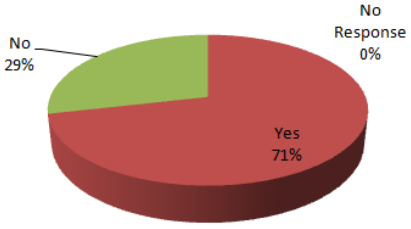
Question 2b: Have the technical barriers been identified and addressed?



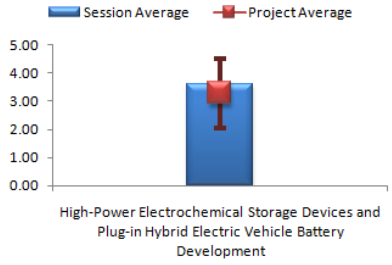
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



IEA/HEV Implementing Agreement (Ahmad Pesaran, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
All comments to this question were positive. One reviewer highlighted the fact that the U.S. alone does not do the majority of HEV/EV activity in the world, ergo, most is done elsewhere, and this program could be a valuable resource for tapping in to that base so we can learn from others and collaborate where it makes sense. Another person agreed that international collaboration is instrumental to achieve DOE targets in the battery sector. Another remarked that NREL supports the IEA/HEV implementation agreement in energy storage; international collaboration is a critical aspect for mankind. The last person commented that the IEA/HEV agreement will help all participants reduce oil consumption by sharing critical information about battery pack development for HEVs and PHEVs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer simply commented that the presenter did not provide many details about the project. Another person felt that the project addressed a limited number of barriers. Another person acknowledged that the agreement will help achieve the goals of the DOE through cooperation across international borders. The last reviewer commented that the project seems to be greatly undervalued as a resource to learn something. The reviewer noted that they never heard of an example of anything they have gained from this exchange; this reviewer was very concerned that the program suffers from a U.S.-centric/ "not-invented-here" mentality. The reviewer highlighted that we really need to learn from others and not try and do everything ourselves. They concluded by stating that this project should be viewed as a major effort, not just a something to do to be nice to the rest of the world activity.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person simply noted that the presenter did not provide many details of this project. Another person agreed, stating that a useful assessment of the project's accomplishments cannot be determined from the presentation. One person commented that a limited effort is required to pursue this international collaboration. Another person noted that the agreement is new and is expected to bear fruit in the future. The last reviewer remarked that they had never heard of one example of anything the researchers have gained from this exchange. They concluded by asking whether this is an exchange, or if they are just reporting what DOE is doing.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person commented that the question does not apply since NREL is helping, not producing technology, under this project. Another person pointed out that the project seems to be undervalued and ignored. One person felt that the project allows for international exchange of information. The last person commented that the European members of the agreement are probably closer to placing HEVs and PHEVs in the marketplace.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

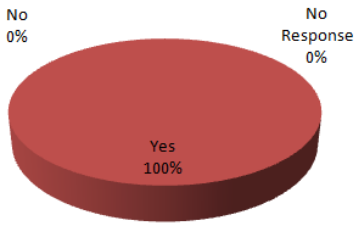
The reactions to this question were generally positive, but reviewers offered suggestions to improve the program. One person commented that a useful assessment of the sufficiency of resources cannot be determined from the presentation or otherwise. Another person simply stated that the role and involvement is adequate. Another person agreed, mentioning that the funding for this agreement is sufficient. One person asked whether the projects needs more resources, or just more commitment from leadership. The last person remarked that they would like to rate this very high in a summary rating, but this seems to be given such a low importance that it actually has low value as currently implemented.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

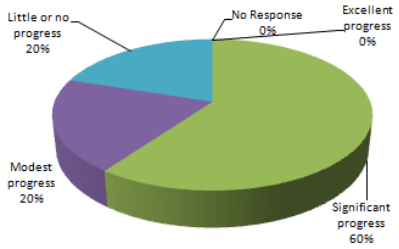
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: IEA/HEV Implementing Agreement

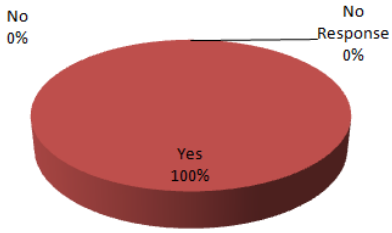
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



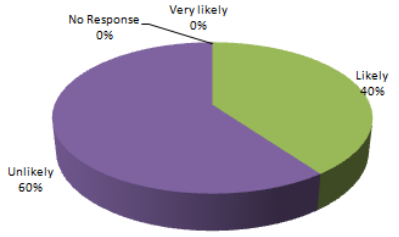
Question 3: Characterize the technical accomplishments and progress toward goals.



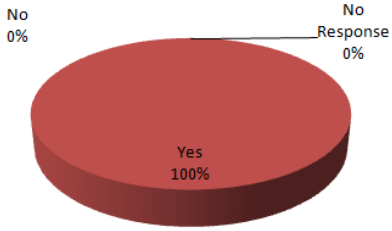
Question 2a: Are the goals of the project technically achievable?



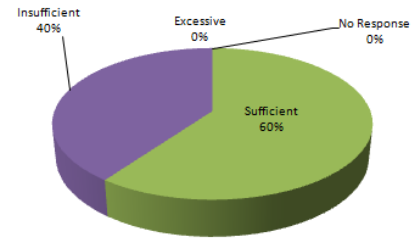
Question 4: How likely is the project team to move technologies into the marketplace?



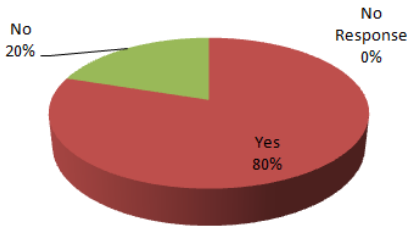
Question 2b: Have the technical barriers been identified and addressed?



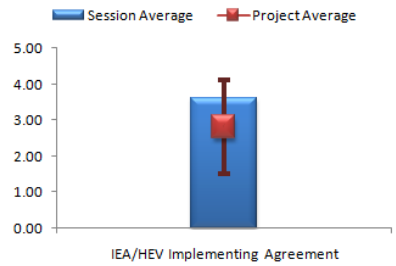
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Interagency Agreement with Navy-Technology Assessment (NSWC) (Jim Barnes, of U.S. Navy)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person mentioned that the project is part of the DOE activities to support program objectives and improve use of available resources. Another person mentioned that this agreement will help small companies contribute to the goal of reducing oil dependency. One person noted that the project involves soliciting ideas from outside the DOE, rather than being driven by DOE's vested interests. They felt that the project is blue sky work and insurance against missing opportunities. The last person commented that collaboration and coordination between different government agencies are critical to ensure the technology and developed in collective effort. The reviewer pointed out that battery, power electronics and other related technologies are applicable to DOE, DOT, Navy, and military applications. They concluded by indicating that the new focus on cutting edge technology is good.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the project has clear targets and process steps to overcome basic high risk barriers by soliciting different types of research approach (SBIR). Another person mentioned the project's focus is on cost, performance, abuse, tolerance, etc., which are appropriate for SBIR/STTR research. Another reviewer highlighted the fact that the SBIR and STTR programs have already been shown to be successful as illustrated by A123 and TJ Technologies, for example. The last reviewer commented that the program is high risk, but if focused correctly can be a very powerful risk mitigator and very good at leveraging outside resources in identifying new opportunities, at a relatively low cost.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer simply noted that the project involves a high risk to reward ratio. One person commented that the approach is challenging and offers possibilities to search for real scientific and technological breakthroughs. They pointed out that the Interagency Initiative optimizes the governmental efforts. Another reviewer mentioned the project has resulted in several successes in the past, especially in light of expected low likelihood of success of the portfolio. They caution that success in future may not be high, but the potential impact is large. The reviewer felt that a good selection process was used and that they are open to off-beat ideas but they do not waste money on bad science, of which there is a lot being pedaled. One person provided examples, stating that A123 Systems products, TJS technologies, and EEI move to production were the result of Phase 1 SBIR. Another person felt that this interagency cooperation has lead to outstanding success and the development of small companies into major potential suppliers of batteries for HEVs and PHEVs. The last person reiterated that A123 Systems received Phase 1 and Phase 2 SBIR grants, and as a result have developed to be a significant player/manufacturer of li-ion batteries, which is a good accomplishment.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer mentioned that the program involves a high risk to reward ratio. Another person indicated that a small portion of SBIR/STTR were successful but is sufficient to break through. Another person observed that the Phase 2 of the project is likely to start up more industrial initiatives after an exploratory phase. Another commented that the SBIR/STTR program has already demonstrated success by A123 Systems in their development of cells for power tools. The reviewer felt that it is highly likely that their success will be duplicated by their developing battery packs for HEVs and PHEVs. The final person commented that getting small companies through to the implementation stage can be very difficult, but maybe the invention just gets picked up by larger companies if it is promising enough.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

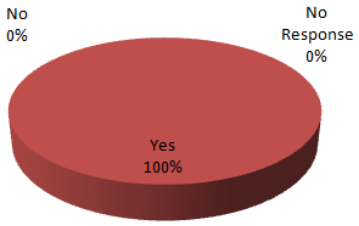
One person commented that the scientific and technological challenges of lithium technologies require an exploratory phase (bottom up approach) complementing the already existing sub-program of BATT. One person commented that the program has funded six Phase 1 and four Phase 2 projects for energy storage, which seems to be reasonable. They highlight that if one of them successful, it will make a huge difference. Another person felt that a reasonable number of projects have been funded and that the project is a good use of public funds. The reviewer stated, definitely do not reduce this work, even though the near-term focus is on implementation, we still need to cover our bases with these kinds of projects. The last reviewer commented that funding level for STTR in this program is too small and should be increased by a factor of 10 to be on par with the SBIR program.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

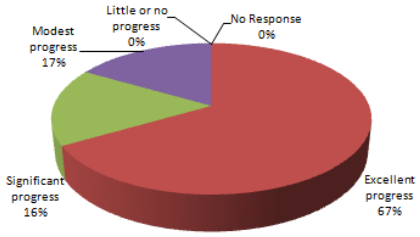
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Interagency Agreement with Navy-Technology Assessment (NSWC)

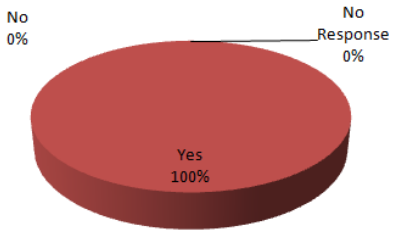
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



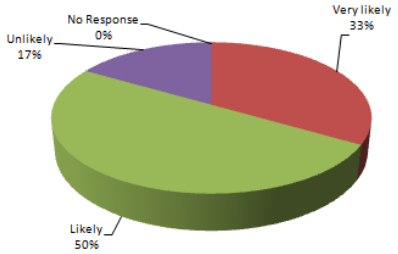
Question 3: Characterize the technical accomplishments and progress toward goals.



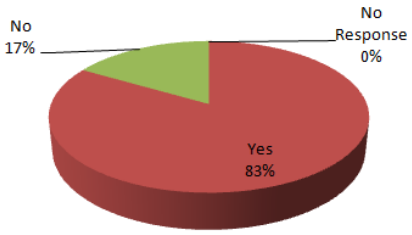
Question 2a: Are the goals of the project technically achievable?



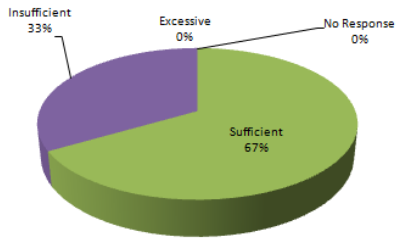
Question 4: How likely is the project team to move technologies into the marketplace?



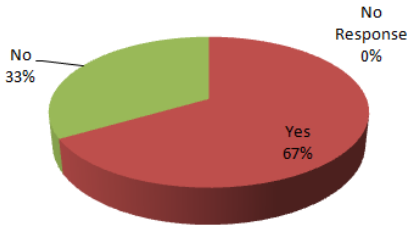
Question 2b: Have the technical barriers been identified and addressed?



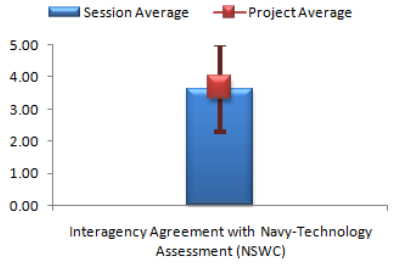
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Requirements and Targets Validation (Dan Santini, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person simply noted that the researcher seems to be looking at the big picture. Another person commented that the project supports the use of PHEVs with evaluations for various scenarios and the battery choice and design specifications. The reviewer added that the project also evaluates consumer advantages and proposes possible incentive schemes. The last person commented that the project will lead to reduction of oil consumption by validating the utility of PHEVs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person commented that the question is not really relevant to this presentation; it should be used as a basis for making decisions. Another person, however, felt that key barriers and conditions are well described and studied with specific analytical models. The last person commented that the project is a comprehensive study of PHEVs with EPRI will probably lead to a definite study that presents clearly to citizens and politicians the value of PHEVs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer mentioned that the project compares simulation results and different studies to properly evaluate the best way to introduce PHEV. The reviewer suggested to further complicate the analysis by introducing other impact factors related to the use of conventional vehicles (external costs related to accidents, air quality impact in urban areas and health effects of pollutants). Another person noted that the project seems to have looked at a bunch of concepts, but that it was hard to follow everything in such a short talk and that they were not sure what the bottom line was. The reviewer asked whether the researchers had overall recommendations, and if so, what were they and are they politically acceptable? The reviewer added that the PI seems to be very clued in to what others are doing and that it is nice to see them using others' studies, not just doing another one of their own. The last reviewer commented that the study will clarify the value of PHEVs to the public at various levels of market entry and will have a tremendous impact on the future of PHEVs. The reviewer felt that it is likely that the study will show the true value of PHEVs as the cost of battery packs is reduced.

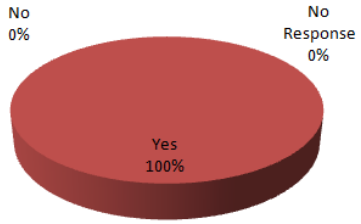
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented that it sounds as though the researchers are being open and trying to get at the reality behind some of these scenarios and models. Another reviewer indicated that the study will clarify the goals for HEVs and PHEVs for near-term and long-term value of these vehicles. One person felt that the results may support policy, governmental measures and also assist industrial commitment in the sector. The last person commented that the study provides useful consideration, but is based on theoretical scenarios, which in some cases are themselves based on the outcome of other theoretical scenarios or estimations. The reviewer added that it is possible that the study could have some influence on market direction and may be useful for consideration of future scenarios, but the scope of considerations included in the study may be too great given the current status of actual development in the real world.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One person simply commented that the funding is sufficient for this project. Another agreed, stating that the effort seems to be adequate in respect to the available budget. The last person commented that the researchers are good at learning from outside resources and that they seem to do a lot with what they have.

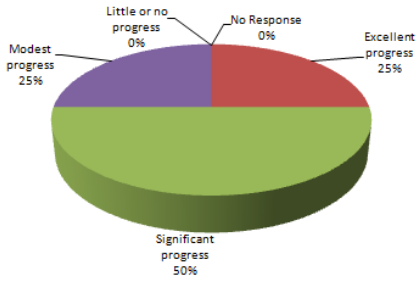
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Requirements and Targets Validation

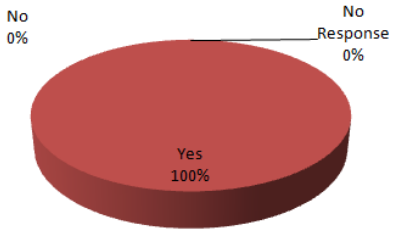
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



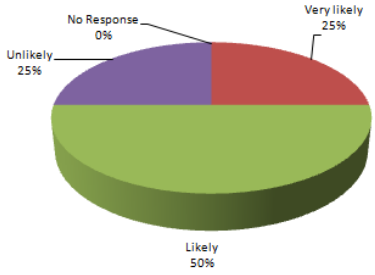
Question 3: Characterize the technical accomplishments and progress toward goals.



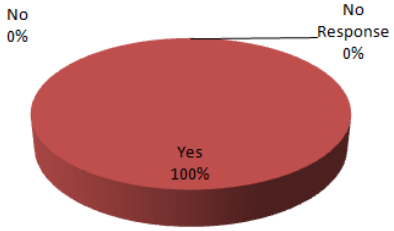
Question 2a: Are the goals of the project technically achievable?



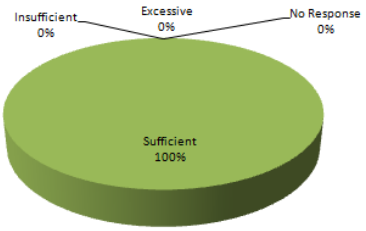
Question 4: How likely is the project team to move technologies into the marketplace?



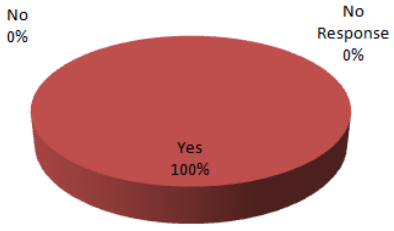
Question 2b: Have the technical barriers been identified and addressed?



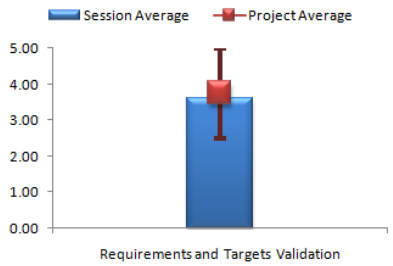
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking (Tim Murphy, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments to this question were all positive. One person acknowledged that the project is functional in assisting and verifying DOE targets and program results. Another person indicated that INL provides useful and timely verification of and/or alternative measurements to developer characterization and life observations. One reviewer observed that the independent testing and validation of the deliverables is a critical activity that can help detect issues with systems developed that also standardizes the performance between the systems, which are all critical for evaluating the technologies. Another person commented that it is crucial to know where you are and to generate independent testing using agreed-upon test criteria. They added that linking the results to the physical and other testing is extremely important. The last reviewer noted that INL is developing and carrying out testing of cells that may be used in HEVs and PHEVs. The reviewer acknowledged that the lab is maintaining a close working relationship between their activities and those at Argonne.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses to this question were generally positive. One reviewer pointed out that the technical and economical barriers are well identified and include specific performances, cost, and abuse behavior. They felt that the project approach is reasonable and well structured to assist the comprehension of the program progress on batteries and ultracapacitor technologies. Another reviewer remarked that the testing of developed batteries is an essential part of all the battery development programs and thus it is very important part of deployment strategy. Another person noted that the researchers seem to have things well in hand, but that they would have to do an audit to actually test the testers so to speak. One person noted that INL is developing standardized tests and test equipment that will be used to test cells that have been developed for HEVs and PHEVs. They concluded by highlighting that the testing protocols include analysis to help develop predictive models. One reviewer suggested that the number of testing stations should be increased, because as multiple companies move into the area of HEV technology, the need for independent evaluation is becoming important so having the facilities to accommodate this will be necessary. They add that the longer term studies for the more promising technologies will tie up stations. They concluded by cautioning that the 15-year validation is in risk unless that continues on an independent basis. The final reviewer had a differing opinion, arguing that most of the barriers identified by this project are outside the scope of the project's responsibility.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that the presentation claims to have good cross-checks in place. Another person commented that test procedures have been issued in timely and validated manner and that the delivered batteries have been tested according to the established planning. They add that the test results were not presented, but the test campaign was described. They cautioned that there is a discrepancy between the cell type under development by Johnson Controls VL6P and that tested at INL VL7P. Another reviewer commented that the testing appears to be standardized and that it will

be hard to show significant "rapid" progress for this group, hence their rating. However, they added that it appears that group has detected "non-standard" behaviors, which is critical, and that is significant progress. Another person mentioned that standardized ongoing testing has been well-supported and well-documented by INL. They highlighted that support for the development of life prediction models has apparently been insufficient to achieve significant progress. The final commented mentioned that INL produced PHEV battery test procedures that can be used by battery developers and battery users. They have also completed long-term calendar life testing and combined calendar life/cycling tests.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One commenter observed that INL is developing tools that will enable battery suppliers to improve their cells to meet the DOE goals and that these tools (testing and analysis) will assist battery developers reduce the time needed to develop new PHEV batteries. Another person agreed, stating that the experimental work supports the product development and the industry validating in an independent and objective manner batteries and ultracapacitors for various applications. One reviewer felt that the validation and standardization process will enable selection of the critical technologies for funding, all which contributes to implementation into market place. Another person simply stated that the industry needs these methodologies to make unbiased decisions. Another reviewer, however, pointed out that it is more likely that methods will be adopted by industry than new technologies will move toward marketplace. The final reviewer indicated that it is possible that the project will be able to influence accepted life prediction methodologies towards improved methods, but that it is of equal or greater likelihood that efforts within industry have, or will, supersede or more expeditiously achieve progress than those of this project.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reactions to this question were mixed. One reviewer commented that INL's funding is sufficient for the projects they have underway. Another stated that the resources were not described in the presentation, so hardly can be analyzed. One person remarked that while there appear to be sufficient personnel available for useful support of standardized verification testing and related interaction with developers, there apparently are insufficient resources dedicated to, or available for, life prediction methodology development and support.

One reviewer had detailed comments, suggesting that the researchers probably need additional testing stations (based on number of cells tested). They agree that benchmarking, and the statistical significance of it, is important. They encourage looking at alternate low-cost suppliers for this, where data can be generated to less cost, suggesting that multiple Chinese vendors exist for instance. The reviewer was not clear if statistical methods are used for validation of the performance attributes. They suggest working with Johnson Controls and augment their own results with testing made at their factories to achieve statistical significance, in cases where too few test stations are available. They concluded by suggesting that the researchers develop and publish accelerated testing methods, which is useful for the whole industry.

The final reviewer also had detailed comments. They commented that the interpretation of the data is very high-added-value and that some of the testing has safety issues that require in-house testing. However, they urged that, in view of the high overhead costs associated with the government labs, much of the routine testing could be outsourced. They provided the example that consumer companies do this all the time for advertising substantiation and for getting data to support and defend law suits. They add that confidentiality should not be an issue as you should get the cells back once

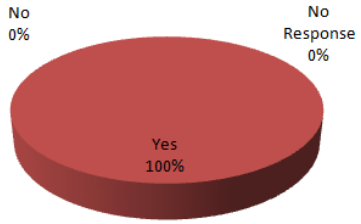
testing is completed. They highlighted that the labs still need to be heavily involved in analyzing the data, since their strengths lie in their brains and not in their equipment. They concluded by indicating that maintaining test equipment running correctly is actually a very demanding, full-time job that is often underfunded; so suggested leaving it to those who already do this for a living.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

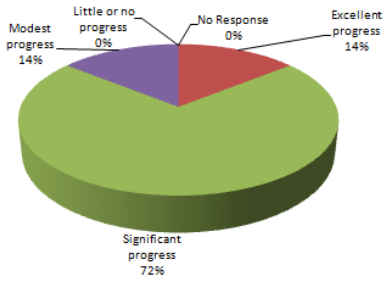
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking

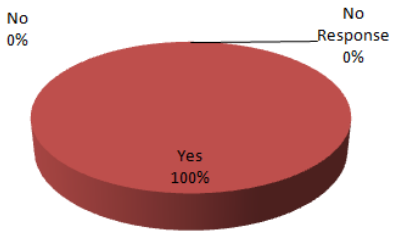
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



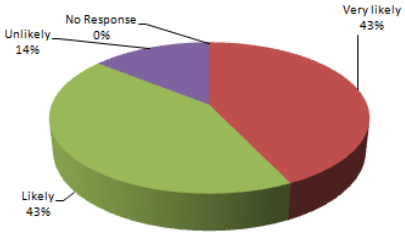
Question 3: Characterize the technical accomplishments and progress toward goals.



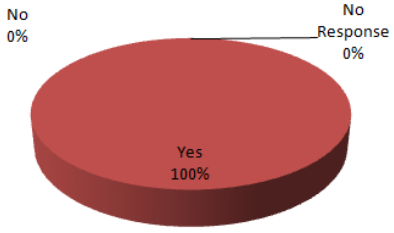
Question 2a: Are the goals of the project technically achievable?



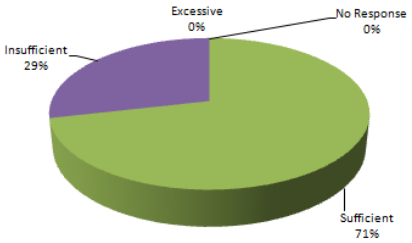
Question 4: How likely is the project team to move technologies into the marketplace?



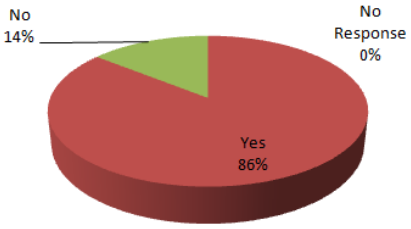
Question 2b: Have the technical barriers been identified and addressed?



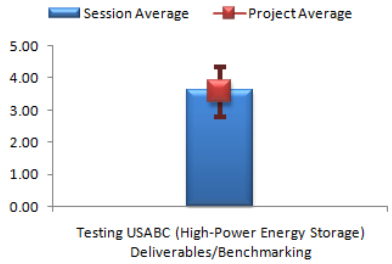
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Testing USABC (PHEV Battery Development) Deliverables/Benchmarking (Tim Murphy, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer simply stated that this work is important for the new PHEV products evaluation. Another person agreed that INL provides useful and timely verification of and/or alternative measurements to developer characterization and life observations. One person acknowledged that INL is developing and carrying out testing of cells that may be used in HEVs and PHEVs and are maintaining a close working relationship between their activities and those at Argonne. One person pointed out how crucial it is to know where you are and to generate independent testing using agreed-upon test criteria. They added that the linking of the results to the physical and other testing is extremely important. The last reviewer commented that the independent testing and validation of the deliverables is a critical activity that can help detect issues with systems developed. It also standardizes the performance between the systems, all critical for evaluating the technologies. They asked whether there is a need to upgrade for PHEV conditions, for instance, to verify calendar life for various driving scenarios, which affects the state-of-charge used during "storage".

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person noted that INL is developing standardized tests and test equipment that will be used to test cells that have been developed for HEVs and PHEVs. They add that the testing protocols include analysis to help develop predictive models. Another person commented that the researchers seem to have things well in hand, but would have to do an audit to actually test the testers so to speak. Another person, however, commented that the project is not yet described but seems to be similar to that for HEV battery. The final reviewer pointed out that most of the barriers identified by this project are outside the scope of this project's responsibility.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Reactions to the question were mixed. One person observed that INL has produced PHEV battery test procedures that can be used by battery developers and battery users and have completed long-term calendar life testing and combined calendar life/cycling tests. One person noted that the researchers claim to have good cross-checks in place. Another reviewer mentioned that standardized ongoing testing has been well-supported and well-documented by INL. They indicated that support for the development of life prediction models has apparently been insufficient to achieve significant progress. Another person noted that the testing of developed batteries is an essential part of all the battery development programs and thus it is very important part of deployment strategy. The final reviewer, however, felt that the activities do not seem yet started.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person stated that INL is developing tools that will enable battery suppliers to improve their cells to meet the DOE goals, adding that these tools (testing and analysis) will assist battery developers reduce the time needed to develop new PHEV batteries. Another person simply noted that the project

is functional to new PHEV battery development. Another person acknowledged that the industry needs these methodologies to make unbiased decisions. The last reviewer suggested that it is possible that the project will be able to influence accepted life prediction methodologies towards improved methods, but it is of equal or greater likelihood that efforts within industry have, or will, supersede, or more expeditiously achieve, progress than those of this project.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

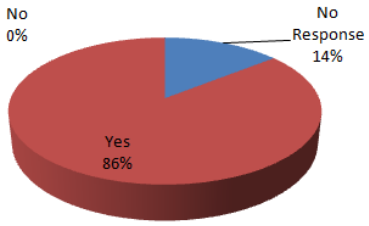
One reviewer felt that the information available is not sufficient for an adequate evaluation. Another person felt that INL's funding is sufficient for the projects they have underway. One person cautioned that while there appear to be sufficient personnel available for useful support of standardized verification testing and related interaction with developers, there apparently are insufficient resources dedicated to, or available for, life prediction methodology development and support. The last reviewer reiterated similar comments to a previous question, stating that the interpretation of the data is very high-added-value and some of the testing has safety issues that require in-house testing. However, they suggest that in view of the high overhead costs associated with the government labs, that much of the routine testing be outsourced. They point out that consumer companies do this all the time for advertising substantiation and for getting data to support and defend law suits. They pointed out that confidentiality should not be an issue since the cells will be returned once testing is completed. They remarked that the labs still need to be heavily involved in analyzing the data, since their strengths lie in their brains not their equipment. They concluded by mentioning that maintaining test equipment running correctly is actually a very demanding, full-time job that is often underfunded; so why not leave it to those who already do this for a living.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

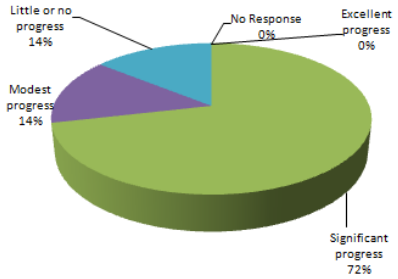
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Testing USABC (PHEV Battery Development) Deliverables/Benchmarking

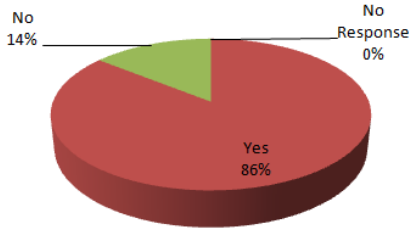
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



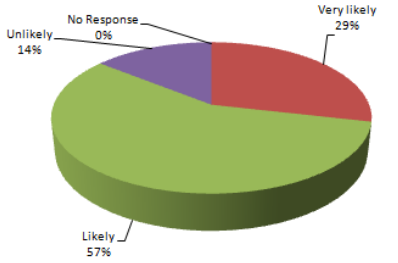
Question 3: Characterize the technical accomplishments and progress toward goals.



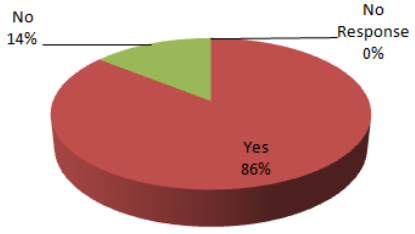
Question 2a: Are the goals of the project technically achievable?



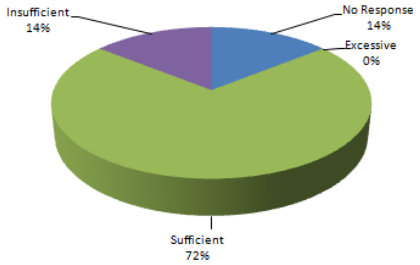
Question 4: How likely is the project team to move technologies into the marketplace?



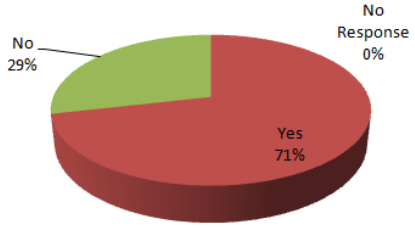
Question 2b: Have the technical barriers been identified and addressed?



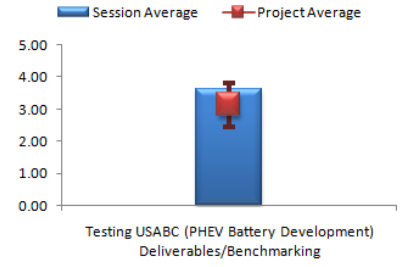
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Testing USABC Deliverables/Benchmarking (Ira Bloom, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer pointed out that the project assists the verification of DOE objectives in the battery area. Another person acknowledged that it is critical to get good reliable data and to link the data to fundamentals so you can understand them. Another person noted that the independent testing and validation of the deliverables is a critical activity that can help detect issues with systems developed. They added that this also standardizes the performance between the systems, which are all critical for evaluating the technologies. The last reviewer indicated that the researchers' work at ANL is leading to the capability of characterizing cells produced by potential suppliers. The tests and the analysis procedures that they are using have been established and are well-known, so they are using this experience now to develop similar tools for the batteries intended for PHEVs. They concluded by acknowledging that the researchers are performing calendar life and cycling tests that

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person remarked that the work on protocols and testing is fundamental in assuring comparable results and feedbacks to USABC and developers and that the benchmarking and program deliverable testing is extremely important to trace the progress of the technology. Another reviewer commented that with benchmarking the challenge is to find accelerated protocols that differentiate earlier would be a significant achievement for this group. They suggested that the group should look for cheaper testing methods and deploy this for increased capability. One person commented that in general, the project has been able to overcome the barriers which have been identified by the project, with the exception of significant progress in the technology life validation method and related manual development. The last reviewer pointed out that the researchers are working together to use empirical modeling to analyze the data they are collecting. The reviewer felt that they are publishing this information in a timely manner, which enables others to use their results or extend their results to meet their needs. The reviewer concluded by mentioning that the researchers are developing new testing protocols to reveal important features of cells that have been stressed at high charge and discharge rates, as needed for PHEVs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer simply stated the straightforward battery testing in support of program. One reviewer noted that the benchmark testing, especially, is an integral art to identify the advanced battery technology. Another person indicated that the progress has been clearly shown and justified against planned milestones and deliverables, but suggested that accelerated tests may give significant information reducing costly tests for rapid technology application. One person noted that standardized ongoing testing has been well-supported and well-documented by ANL. They added that the level, or sufficiency, of support for benchmark testing is unclear from the presentation or otherwise, and that support for the development of life prediction models has apparently been insufficient to achieve significant progress. One reviewer noted that the unbiased nature of testing and the disclosure of the methods used are very important and well thought out. They added that the ability to separate out causes of problems is very important in guiding developers and understanding how good the systems will likely be under real world situations. Another person felt that it was hard

to show rapid progress for this group, as test is somewhat standardized. They applauded the work on the test manuals, but they asked whether a review of these was needed. The reviewer asked whether the tests are the best tests, given what we know today. They suggested that significant progress for this group would be to discover alternate tests that even further enhance the testing and interact with car companies for review of user models, which may have changed with fuel prices and environmental awareness. They concluded by asking whether we need to change the test of the batteries as the electrical engines are improved, or as the battery system chemistries are developed. The last reviewer pointed out that work has focused primarily on empirical or semi-empirical data analysis, but that they should include analysis of data using models such as those developed by Newman et al.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments were generally positive. One person indicated that this project provides valuable support to USABC and developers to improve the technology and set plans for commercial availability. Another mentioned that the work is helping battery manufactures by providing test results and curve fitting of those results. One reviewer highlighted the fact that without understanding, progress will be hit and miss, so the project results are increasing our knowledge, not just accumulating data; very nice work. Another person commented that the differentiation brings a selection of the best technologies and additional funding will come that stimulates market deployment, which is very important. The last reviewer suggested that it is possible that the project will be able to influence accepted life prediction methodologies towards improved methods, but it is of equal, or greater, likelihood that efforts within industry have, or will, supersede or more expeditiously achieve progress than those of this project.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the information seems to be adequate because the planned milestones seem to be reached in timely manner. Another person noted that while there appear to be sufficient personnel available for useful support of standardized verification testing and related interaction with developers, there apparently are insufficient resources dedicated to, or available for life prediction methodology development and support. They concluded stating that the sufficiency of resources relative to benchmark testing is unclear from the presentation or otherwise. One reviewer suggested that likely more testing stations are needed (the reviewer stated that they always have to make this comment since it is critical). They felt that the funds were well spent, as long as manpower follows, also suggesting that the group should be challenged with coming up with additional acceleration and maybe a protocol for tests that removes a cell from testing to give a place for other technologies that are more promising if it fails a certain sequence. The reviewer felt that this would essentially result in leveraging the most testing for the best technology. They acknowledged that the presenter shows critical thinking and discovery of degradation factors, which is healthy feedback for the developers - well done. The reviewer concluded by stating that the researchers have made good choices for next year's activities. Another reviewer noted that the researchers are doing well, but I believed that they should not be burdened with so much testing that can really be outsourced. Instead, they would like to see them having more time to utilize their considerable expertise in interpreting results and guiding the developers. The reviewer stressed that It is not just the cost - having these people do routine testing is a waste of their brainpower; they do not have time to do more value-added activities. In this area, the reviewer thought that more of their effort should be spent on diagnostics, not testing. The reviewer added that when the researchers see changes in behavior during testing, they need to have time and resources to understand and explain this - unless the developers are going to do this on their

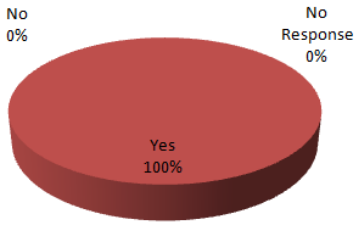
own. (Some may be capable of doing this, but the smaller ones are not). The final reviewer felt that the funding is excessive for the results produced.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

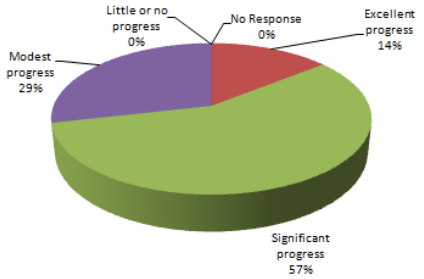
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Testing USABC Deliverables/Benchmarking

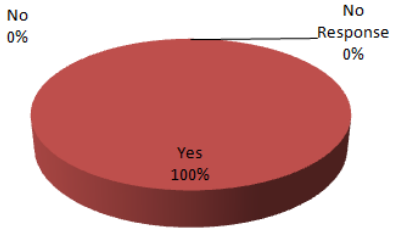
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



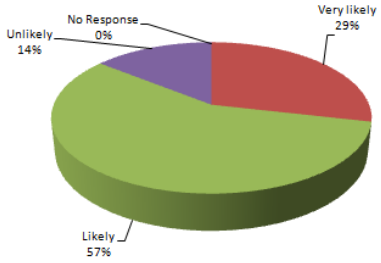
Question 3: Characterize the technical accomplishments and progress toward goals.



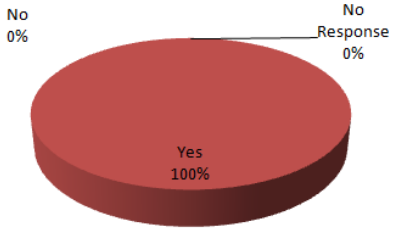
Question 2a: Are the goals of the project technically achievable?



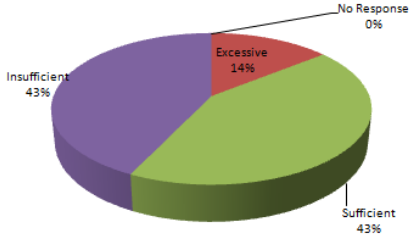
Question 4: How likely is the project team to move technologies into the marketplace?



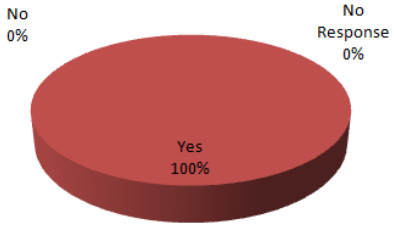
Question 2b: Have the technical barriers been identified and addressed?



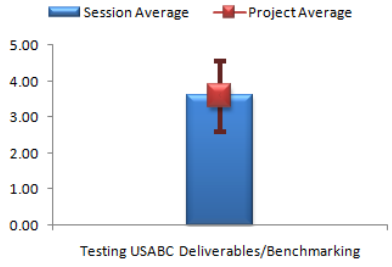
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermal Management Modeling (Ahmad Pesaran, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments were positive. One person simply stated that the project supports battery development targets. Another reviewer commented that large pack safety and performance is critical and thermal management seems to be key. One person acknowledged that thermal modeling is important for batteries in HEV and PHEV applications. Another person agreed, adding that thermal management is absolutely necessary for the energy storage systems to be safely implemented before the DOE objective of petroleum displacement can be met. Another added that thermal systems design is important for safety and performance, and that the capability of this laboratory can in a major way support those designs, since they have necessary instrumentation that would not be easily available at a company. Therefore, this activity will shorten the time to market. One reviewer commented that the program has provided useful thermal abuse modeling characterization to HEV battery system development, and that NREL's activities in this area to date appear promising. Another person agreed, stating that NREL's thermal management modeling will be very helpful to auto and battery companies to reduce the development time for safe battery packs for HEVs and PHEVs. The final reviewer remarked that the modeling of the different sizes was a good idea and will support cheaper batteries, as the size could potentially be reduced, which could potentially achieve an easier cost target for developers.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person simply stated that the project is well thought out and well organized. One reviewer commented that the researchers had a good strategy, highlighting that the idea on modeling differently sized system is good. Another person agreed that the researchers have shown a good approach, and added that the modeling supports to the experiments are very important for a full understanding, which can help define the systems that control the thermal properties of the pack and its geometry. Another person commented that there is a clear identification of barriers related to thermal behavior of lithium batteries. The indicated that the thermal model is well developed to analyze different module configurations and gives feedback to improve design and thermal management needs. The last person commented that NREL's strategy of combining physics-based models with thermal data for cells will lead to better understanding of the performance of the battery packs and the required thermal management systems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person noted that the results clearly show the progress and the potential advantages. Another person felt that researchers have shown great test set-up and very good implementation of the modeling, which can be immediately validated through the good test station set-up. They added that this is very hard to do for a battery company and would take a few years to set up and learn, so it is critical for launch of new technology and will shorten time to market. One person commented that the project has repeatedly demonstrated flexibility and innovation in advancing capability and in achieving new technical understanding of the thermal behavior of HEV batteries. They concluded by mentioning that the more recent work with thermal behavior modeling appears to be promising and useful and should be expanded. Another reviewer pointed out that NREL's combined approach

developing battery pack, thermal management, and vehicle simulation programs will reduce the development time for battery pack developers. The reviewer added that NREL has used their modeling approach to demonstrate the time lag between a thermal run away event occurring in a cell and being seen by temperature sensors mounted on a cell's surface. They have also developed similar tools for shorted cells. Another person observed that the project implemented li-ion reaction chemistry into a finite volume three-dimensional cell model addressing various design elements and simulated oven test and internal short-circuit events, examined impact of cell design parameters. The reviewer also mentioned that propagation of abuse reaction through a module was also simulated taking into account of the balance between heat transfer network and dispersed chemical sources. They pointed out that this work showed that the balance is affected by module design parameters such as cell size, configuration and size of cell-cell connectors, and cell-cell heat transfer medium.

The last reviewer had detailed comments, commenting that the project is off to a good start and that the thermal imaging is nice, but the reviewer questioned whether the imaging system can really identify hot spots inside the jellyroll since the metal case could well mask them. They asked whether the researchers have done validation studies to show that if a hot spot were present they could see it; in fact, the modeling work the researchers showed later seemed to explicitly show that the outside case temperatures does not in fact show a thermal hot spot. This, in the reviewer's view, undermines the studies done using heat cameras. They added that they appreciated the acknowledgement of cell to cell variability. They concluded by stating that the work base on the assumption that one cell will actually go into thermal runaway and look at the propagation of that event should lead to the kind of robust design needed for successful implementation.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer noted that this is more an assessment study, so the question does not apply to this project. Another person felt that the results are very interesting and give direction to improve cell design and battery systems. One person commented that the modeling can help provide direction for a developer, which enhances speed to market. Another person agreed with this, stating that the project will shorten time to market with a facility that is not available at the "typical" battery manufacturer. One person highlighted that viable systems will not be possible without thermal management; adding that thermal management systems need to be part of the entire system design and cost estimates. The last person commented that NREL's efforts coupled with battery and auto companies' use of their results will reduce the time to market for HEVs and PHEVs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One person simply pointed out that the amount of work shows good and timely results. Another commented that the funding is sufficient for this effort. One person noted that the presenter made no comments on this, so they are probably sufficient. The reviewer argued that DOE should continue funding this effort and build staff knowledge beyond the principal investigators. Another person commented that nothing was mentioned regarding insufficient resources, but they felt that it was unlikely that less funding would give the same good results. The reviewer commented that as the field is growing, DOE will need to train more staff in the skill set of the PI and this should probably start now. The reviewer felt that providing the program with more funding would help achieve this, but maybe use next year to hire staff and fund one year later after initial training would be appropriate. One person remarked that the funding level seems to be OK, but may need more people as developers get closer to making a final battery pack as opposed to single cells. The reviewer suggested that DOE revisit the needs for this program more frequently as likely to need a rapid increase at some point in

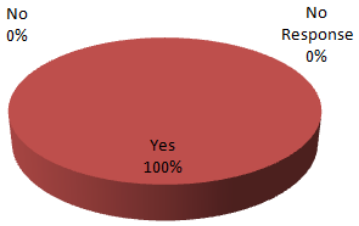
time. The last reviewer commented that NREL's analysis of HEV & PHEV requirements and work in the area of battery life modeling is useful. They cautioned however, that battery life modeling in particular may be better accomplished by battery developers and OEM's working together and may be most relevant to the competitive commercial activity between battery developers and OEM's. Additionally, they felt that NREL may not have sufficient resources to sustainably include HEV & PHEV requirements analysis and battery life modeling within the scope of its total activities and that NREL's focus of activity may be most useful if re-directed and more closely targeted on thermal characterization and thermal abuse reaction modeling.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

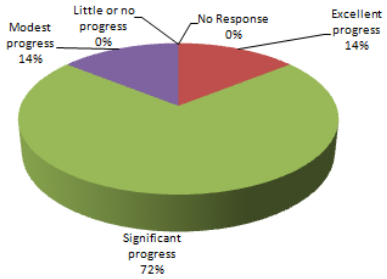
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermal Management Modeling

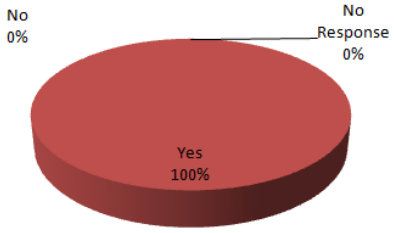
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



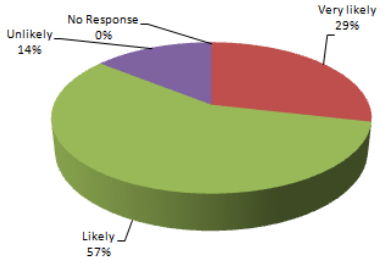
Question 3: Characterize the technical accomplishments and progress toward goals.



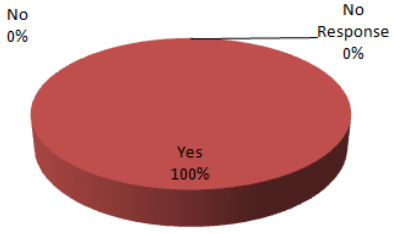
Question 2a: Are the goals of the project technically achievable?



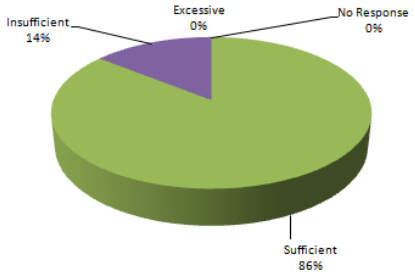
Question 4: How likely is the project team to move technologies into the marketplace?



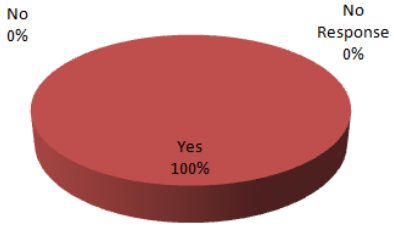
Question 2b: Have the technical barriers been identified and addressed?



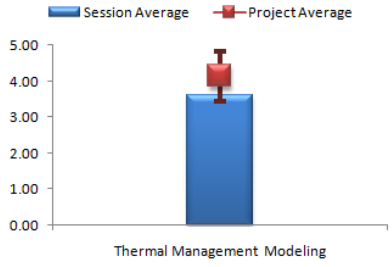
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermal Management Studies (Ahmad Pesaran, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments to this question were generally positive. One person commented that the project clearly addresses key DOE battery program objectives. Another stated that large pack safety and performance is critical and thermal management seems to be key. Another person indicated that battery thermal is an important aspect to widely promote HEV and PHEV. One person noted that NREL's work on thermal testing of battery packs will lead to better understanding of the thermal management requirements for battery packs for HEVs and PHEVs. One reviewer highlighted that useful thermal characterization is a critical aspect of HEV battery system development and is a shortcoming in capability within most automotive OEM's and battery developers; NREL's activities significantly address this shortcoming. The last reviewer commented that the design of thermal systems is important for safety and performance and that the capability of this laboratory can in a major way support those designs, instrumentation that would not be easily available at a company, but necessary; therefore this activity will shorten time to market.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person felt that the research is well organized with all objectives laid out and that problems are identified and approaches are identified to solve them. Another person mentioned that thermal management is a key barrier in lithium battery use and the approach is very appropriate to assist the solution of the technical and practical problem. One reviewer felt that the researchers have used a good approach with modeling that provides support to the experiments are very important for a full understanding, which can help define the systems that controls the thermal properties of the pack and its geometry. The last person commented that the work to combine data gathering and data analysis for battery packs will lead to battery packs that will be safe.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer simply noted that the objectives are well addressed. Another person commented that NREL's battery pack testing will aid battery suppliers and auto companies with valuable data for thermal management design. One person felt that the results are well described and support the development of lithium technologies. They added that the thermal analysis and modeling are well progressed in order to adequately support battery technology development and application in various electrically-driven vehicles. Another reviewer commented that the project has repeatedly demonstrated flexibility and innovation in advancing capability and in achieving new technical understanding of the thermal behavior of HEV batteries. Another person had favorable comments, stating that the researchers have shown great test set-up and very good implementation of the modeling, which can be immediately validated through the good test station set-up. They highlighted that this is very hard to do for a battery company and would take a few years to set up and learn, so it is critical for launch of new technology and will shorten time to market. The last reviewer had detailed comments, commenting that the project is off to a good start and that the thermal imaging is nice, but the reviewer questioned whether the imaging system can really identify hot spots inside the jellyroll since the metal case could well mask them. They asked whether the researchers have done validation studies to show that if a hot spot were present they could see it; in fact, the modeling work

the researchers showed later seemed to explicitly show that the outside case temperatures does not in fact show a thermal hot spot. This, in the reviewer's view, undermines the studies done using heat cameras. They added that they appreciated the acknowledgement of cell to cell variability. They concluded by stating that the work base on the assumption that one cell will actually go into thermal runaway and look at the propagation of that event should lead to the kind of robust design needed for successful implementation.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reactions to this question were mixed. One person simply stated that this project is more of an assessment study, so the question does not apply to this item. Another person commented that NREL's studies will help battery and auto companies develop thermal management systems for battery packs for HEVs and PHEVs. Another person noted the project's goal is to shorten the time required to reach the market and that the lab's facility is not available at the "typical" battery manufacturer. Another person mentioned that most of the results have a manifold impact on the final commercial products in terms of cell design and material selection, working conditions, control needs and module and system engineering. The last reviewer commented that the system will not be viable without thermal management; thermal management systems need to be part of the entire system design and cost estimates.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

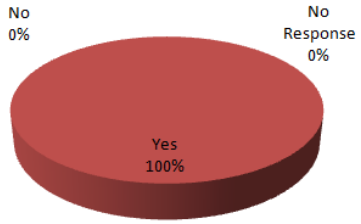
One reviewer felt that the amount of results and supporting studies well justifies the used budget ($1.2 million). Another agreed, adding that the resource seems to be reasonable in this effort. Another person agreed, stating that NREL's results are consistent with their funding level. One person indicated that the presenter made no comments on this subject, so probably sufficient. Please continue fund this effort and build staff knowledge beyond the principal investigators. Another commenter observed that the funding level seems OK, but may need more people as developers get closer to making a final battery pack as opposed to single cells. They suggested that DOE should revisit the needs for this program more frequently as likely to need a rapid increase at some point in time. The final reviewer commented that NREL's analysis of HEV & PHEV requirements and work in the area of battery life modeling is useful; however, battery life modeling in particular may be better accomplished by battery developers and OEM's working together and may be most relevant to the competitive commercial activity between battery developers and OEM's. Additionally, NREL may not have sufficient resources to sustainably include HEV & PHEV requirements analysis and battery life modeling within the scope of its total activities. They concluded by indicating that NREL's focus of activity may be most useful if redirected, and more closely targeted on, thermal characterization and thermal abuse reaction modeling.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

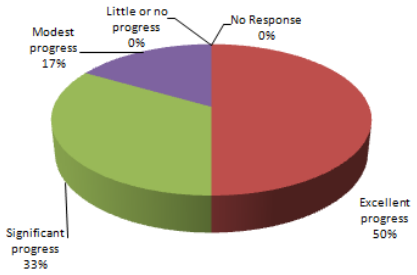
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermal Management Studies

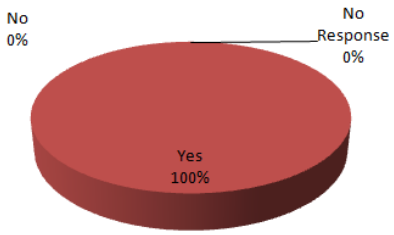
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



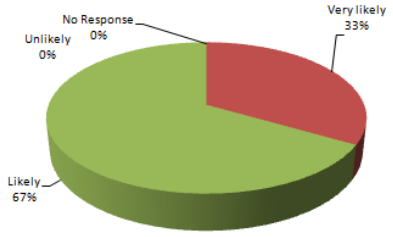
Question 3: Characterize the technical accomplishments and progress toward goals.



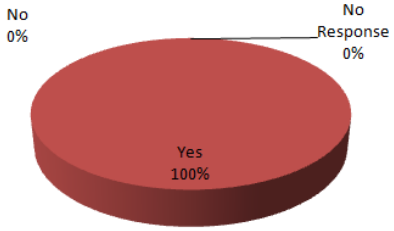
Question 2a: Are the goals of the project technically achievable?



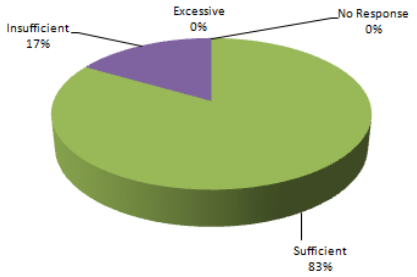
Question 4: How likely is the project team to move technologies into the marketplace?



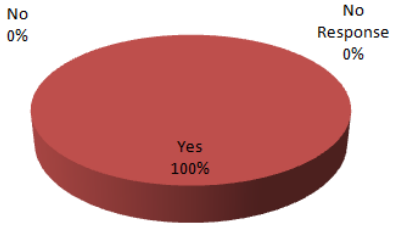
Question 2b: Have the technical barriers been identified and addressed?



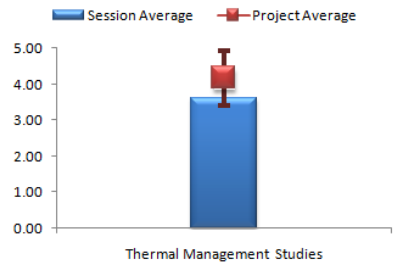
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



4. Exploratory Battery Research

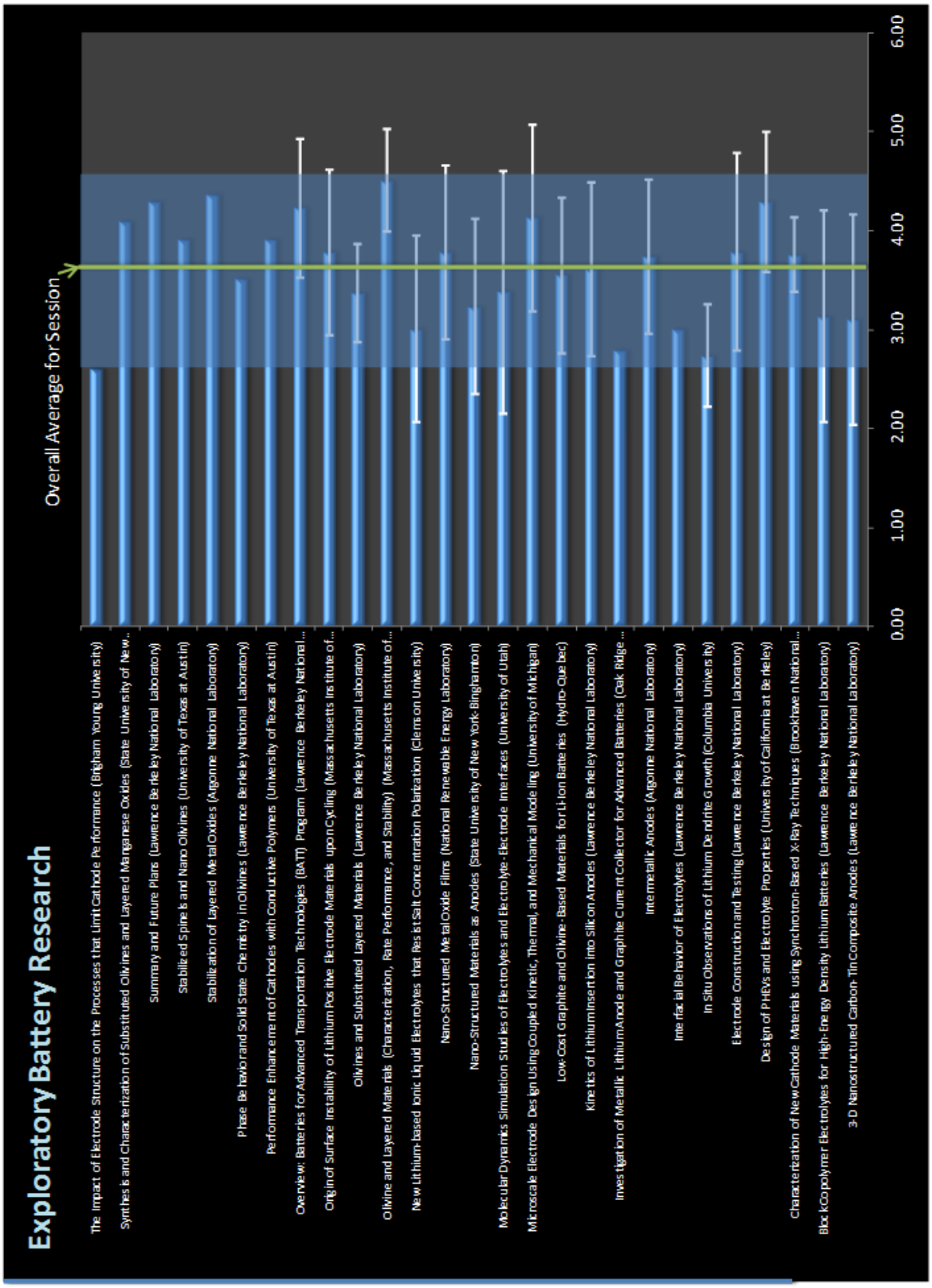
Introduction

Long-term research addresses the chemical instabilities that impede the development of advanced batteries. Researchers focus on synthesizing components into battery cells and determining failure modes, while maintaining strengths in materials synthesis and evaluation, advanced diagnostics, and improved electrochemical model development. Goals include developing a better understanding of why systems fail, creating models that predict system failure and permit system optimization, and investigating new and promising materials. The work concentrates on six research areas: advanced cell chemistry, non-carbonaceous anodes, new electrolytes, novel cathode materials, advanced diagnostics and analytical methods, and phenomenological modeling.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
4-4	3-D Nanostructured Carbon-Tin Composite Anodes (R. Kostecki, Lawrence Berkeley National Laboratory)	3.09	0.70
4-8	Block Copolymer Electrolytes for High-Energy Density Lithium Batteries (N. Balsara, Lawrence Berkeley National Laboratory)	3.13	1.55
4-11	Characterization of New Cathode Materials using Synchrotron-Based X-Ray Techniques (X.Q. Yang, Brookhaven National Laboratory)	3.75	0.71
4-14	Design of PHEVs and Electrolyte Properties (J. Newman, University of California at Berkeley)	4.29	0.76
4-17	Electrode Construction and Testing (V. Battaglia, Lawrence Berkeley National Laboratory)	3.78	0.67
4-21	In Situ Observations of Lithium Dendrite Growth (A. West, Columbia University)	2.73	0.90
4-25	Interfacial Behavior of Electrolytes (J. Kerr, Lawrence Berkeley National Laboratory)	3.00	0.93
4-28	Intermetallic Anodes (M. Thackeray, Argonne National Laboratory)	3.73	1.01
4-32	Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries (N. Dudney, Oak Ridge National Laboratory)	2.78	1.09
4-36	Kinetics of Lithium Insertion into Silicon Anodes (V. Srinivasan, Lawrence Berkeley National Laboratory)	3.60	1.07
4-40	Low-Cost Graphite and Olivine-Based Materials for Li-Ion Batteries (K. Zaghib, Hydro-Quebec)	3.55	0.93

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
4-44	Microscale Electrode Design Using Coupled Kinetic, Thermal, and Mechanical Modeling (A.M. Sastry, University of Michigan)	4.13	0.83
4-48	Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces (G. Smith, University of Utah)	3.38	1.41
4-51	Nano-Structured Materials as Anodes (S. Whittingham, State University of New York-Binghamton)	3.22	1.30
4-54	Nano-Structured Metal Oxide Films (A. Dillon, National Renewable Energy Laboratory)	3.78	1.09
4-58	New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization (D. DesMarteau, Clemson University)	3.00	1.07
4-62	Olivine and Layered Materials (Characterization, Rate Performance, and Stability) (G. Ceder, Massachusetts Institute of Technology)	4.50	0.71
4-66	Olivines and Substituted Layered Materials (M. Doeff, Lawrence Berkeley National Laboratory)	3.36	0.50
4-70	Origin of Surface Instability of Lithium Positive Electrode Materials upon Cycling (Y. Shao-Horn, Massachusetts Institute of Technology)	3.78	1.20
4-74	Overview: Batteries for Advanced Transportation Technologies (BATT) Program (V. Srinivasan, Lawrence Berkeley National Laboratory)	4.22	0.83
4-77	Performance Enhancement of Cathodes with Conductive Polymers (J. Goodenough, University of Texas at Austin)	3.91	0.70
4-81	Phase Behavior and Solid State Chemistry in Olivines (T. Richardson, Lawrence Berkeley National Laboratory)	3.50	0.71
4-85	Stabilization of Layered Metal Oxides (M. Thackeray, Argonne National Laboratory)	4.36	0.81
4-89	Stabilized Spinels and Nano Olivines (A. Manthiram, University of Texas at Austin)	3.91	1.04
4-93	Summary and Future Plans (V. Srinivasan, Lawrence Berkeley National Laboratory)	4.29	0.76
4-96	Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides (S. Whittingham, State University of New York-Binghamton)	4.09	0.83
4-100	The Impact of Electrode Structure on the Processes that Limit Cathode Performance (D. Wheeler, Brigham Young University)	2.60	1.07
	Overall Session Average and Standard Deviation	**3.60**	**1.04**


Exploratory Battery Research
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
The Impact of Electrode Structure on the Processes that Limit Cathode Performance (Brigham Young University)
Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides (State University of New...
Summary and Future Plans (Lawrence Berkeley National Laboratory)
Stabilized Spinels and Nano Olivines (University of Texas at Austin)
Stabilization of Layered Metal Oxides (Argonne National Laboratory)
Phase Behavior and Solid State Chemistry in Olivines (Lawrence Berkeley National Laboratory)
Performance Enhancement of Cathodes with Conductive Polymers (University of Texas at Austin)
Overview: Batteries for Advanced Transportation Technologies (BATT) Program (Lawrence Berkeley National...
Origin of Surface Instability of Lithium Positive Electrode Materials upon Cycling (Massachusetts Institute of...
Olivines and Substituted Layered Materials (Lawrence Berkeley National Laboratory)
Olivine and Layered Materials (Characterization, Rate Performance, and Stability) (Massachusetts Institute of...
New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization (Clemson University)
Nano-Structured Metal Oxide Films (National Renewable Energy Laboratory)
Nano-Structured Materials as Anodes (State University of New York-Binghamton)
Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces (University of Utah)
Microscale Electrode Design Using Coupled Kinetic, Thermal, and Mechanical Modeling (University of Michigan)
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Characterization of New Cathode Materials using Synchrotron-Based X-Ray Techniques (Brookhaven National...
Block Copolymer Electrolytes for High-Energy Density Lithium Batteries (Lawrence Berkeley National Laboratory)
3-D Nanostructured Carbon-Tin Composite Anodes (Lawrence Berkeley National Laboratory)

3-D Nanostructured Carbon-Tin Composite Anodes (R. Kostecki, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The work was felt to support DOE petroleum displacement objectives. Electrode studies are very relevant to the DOE battery objectives. Issues addressed are low energy, low power, poor cycle and calendar life, which are in line with the goals of the program. The work aims at increasing the capacity of anodes for Li-Ion batteries and hence is relevant. Kostecki's work will lead to a reduction in the use of oil because his work will lead to better, cheaper batteries for HEVs and PHEVs. A reviewer commented that metal anodes hold promise for high volumetric capacity PHEV batteries. Another felt this work could be an enabler for Sn or other anodes. A dissenter said that the current activity in this project supports the overall DOE objectives only in a very minor way and only with a very long term possible potential.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
To one commenter, this was a new project with potential. Another said that the original and creative approach has already been successful in previous years. The project goals are then feasible and well connected to the identified barriers. One said the experimental work so far is executed very well. Kostecki's approach of using chemical vapor deposition (CVD) to produce a new anode material for lithium ion cells may reduce the cost and improve the performance of these cells.

A reviewer noted that use of new methods to synthesize intermetallic compounds for anodes and characterization of the anodes using diagnostic techniques such as Raman spectroscopy is a part of the project plan. Deposition techniques to obtain thin films of C/Sn have also been explored in conjunction with obtaining better performing anodes for li-ion cells.

A reviewer said this was a high-risk project, but the approach of using a carbon matrix is a good one. The PI focuses on different degrees of carbonization/graphitization, which is good. Exploration of various organic precursors (Conoco knows all about this) and catalyst will vary the size of the graphene flakes formed. Pure graphite will be hard to obtain at temperatures selected. Emphasis on decreasing surface area will likely be necessary and should be an objective for study, which is challenge given the small particles, but the carbon might take care it.

A final reviewer specifically noted that irreversible capacity loss is high and may need graphite to fix that, but graphite needs too high of a ba temperature to work with the low melting point of tin.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Several specific technology comments were provided here, along with more general comments. In general, a reviewer thought this could be a good first result but the authors should move away from this exotic methodology of making materials which have very few commercial applications. A significant result is the creation of composites that has some capacity. Kostecki's C/Sn anode, obtained by using CVD, shows promise as a material for lithium ion cells.

A reviewer stated the results are of a high level showing substantial progress towards goals. The loss of 40% of anode capacity in 500 cycles does not seem to be a very good result. The preparation process requires some cost evaluation and comparison with carbon costs. The behavior at low temperature should be investigated.

A reviewer highlighted the conclusion that C/Sn binderless thin-films can be manufactured in a fast, inexpensive, single-step process and the films C/Sn anodes display significantly improved electrochemical behavior. These films retained good electronic contact between the active material and the current collector. The significant improvement in cycleability is attributed to the high porosity and fine dispersion of Sn in 3-D carbon matrix.

A reviewer stated that a good method has been obtained to synthesize nano-composite anodes and binderless thin film on any substrate. Testing has shown that there are no detrimental dimension changes and the electronic conductivity has been maintained. The materials show high reversible capacities and the degradation mechanisms have been well understood and attributed mostly to the irreversible losses due to carbon. The program could benefit from some safety tests on completely assembled cells or half cells and by understanding the thermal properties of the new materials.

Another felt that the micro wave plasma technique looks promising and should be extended to silicon based materials (without forming SiC). The materials characterization results are convincing and the work should be supported further. The fact that they could cycle for 500 times is encouraging.

A reviewer said that although the project provides some positive findings for possible usage in the areas of li-ion consumer cells in the longer term, the likelihood of application in the area of HEV battery systems seems only to have some possible potential in the very long term. With the exception of the further CVD-related work, the other future work intended by this project would be of much greater value than the current project focus and the other future work should be supported.

A reviewer commented that there has been so much published literature on Sn embedded in carbon. This reviewer asked how this work is novel compared the work by Yoshio and others. 500 cycles to 60% fade (at what mAh/g?) has been reported by others before with similar materials. This reviewer saw nothing novel in this work with respect to what was reported by others in the past five years. The PI does not appear to have been keeping up on state of the art in the literature. Kostecki's diagnostic techniques are such a valuable tool within the BATT program: this reviewer hoped this task is not diverting his time away from his Raman and AFM work. It would be much more valuable for Kostecki to try to form ties to industry to use his diagnostic techniques for the benefit of industry - he could learn from Clare Grey and from Yoon and Yang at Brookhaven in that respect.

Finally, a reviewer praised the nice methods and good technical work. However, this reviewer still questioned scalability. Mass production methods using CVD and the like are definitely out there but are still cost prohibitive for many applications, especially when you have to lay down significant amounts of materials.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments on this prompt were mixed. One said that these materials might have a niche application. The improved material with low synthesis costs has a high chance of undergoing technology transfer and marketing. Another said that IPR results and publications show a clear attention to the technology transfer in various ways. A reviewer saw technology moving in a two-fold manner through

publication, and by the Sn/C material being robust enough for technology transfer. A reviewer thought this was a high-risk project right now.

The processing methods involved with the current work might have application to some consumer or industrial battery systems in the long term, but it is unlikely that these would be suitable for application to HEV battery systems. Kostecki's approach may be adopted by cell manufacturers if they can become comfortable with the new to them processing methods associated with the CVD process.

A reviewer still questioned scalability. Mass production methods using CVD and the like are definitely out there but are still cost prohibitive for many applications, especially when you have to lay down significant amounts of materials. The method remains useful as a development tool for Whittingham and Thackeray's work.

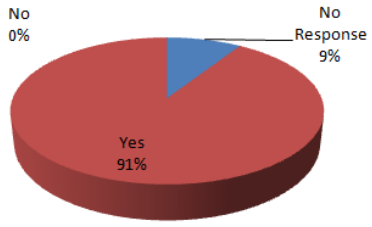
It was suggested that Kostecki's diagnostic techniques are highly valuable. He should focus more on that and try to reach out more to industry to provide diagnostic support to battery companies and materials developers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The resources seem adequate, and funding for this project is sufficient. A reviewer said that there had been good work for the funding obtained. Another could not comment on resource sufficiency. The final reviewer said that with the exception of the further CVD-related work, the other future work intended by this project would be of much greater value than the current project focus and the other future work should be supported by the available resources.

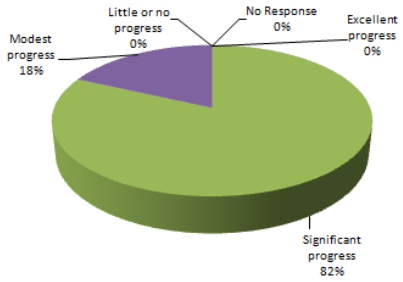
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: 3-D Nanostructured Carbon-Tin Composite Anodes

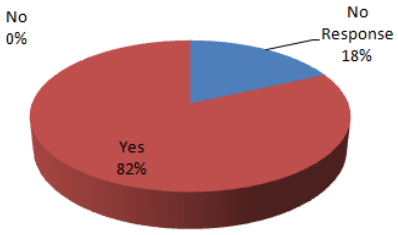
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



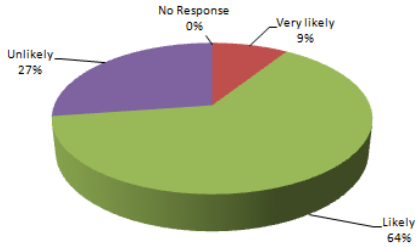
Question 3: Characterize the technical accomplishments and progress toward goals.



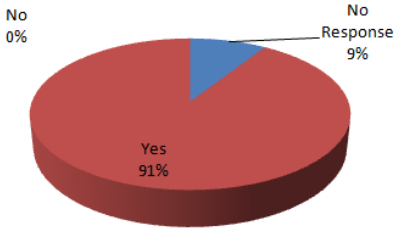
Question 2a: Are the goals of the project technically achievable?



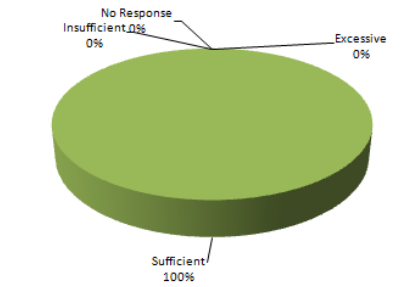
Question 4: How likely is the project team to move technologies into the marketplace?



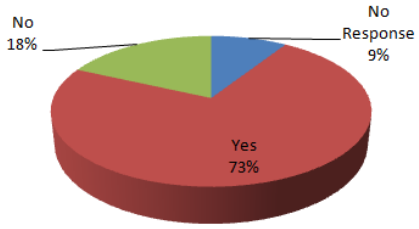
Question 2b: Have the technical barriers been identified and addressed?



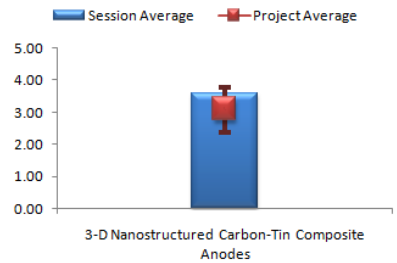
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Block Copolymer Electrolytes for High-Energy Density Lithium Batteries (N. Balsara, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The work is related to the development of polymer electrolytes for high energy li-ion batteries. If the work can lead to the development of the desired polymers, they would be very useful in PHEV applications. The project is relevant to DOE objectives in looking at novel electrolyte for Li batteries, according to a commenter. To another, the work addresses high-energy for EV, long-range PHEV, as well as low flammability electrolytes. Balsara's work may lead to better batteries for HEVs and PHEVs which will result in less oil being consumed.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Positively stated, a reviewer noted the project is on plan and progress is made. The approach focuses on one of the key issues of the Li metal batteries. The development of a better electrolyte coupled with the elimination of dendrite growth may revitalize high power and energy Li metal polymer systems. Balsara's work to develop a coating for the lithium metal anode may lead to higher energy density batteries.

The project needs to address concerns for high impedance over the range of vehicle operating temperatures. Low temperature seems to be a real challenge without a major change in polymer materials. Concept work is acceptable but this reviewer was not sure there is a path to a real product. While -30°C for a polymer electrolyte is probably never going to be realistic, this reviewer would have thought the material would have to at least run at ambient.

This should be a long-term project for the BATT program. We should look for immediate return on this type of electrolyte work.

One person commented that questions 2a and 2c are difficult to answer, and they are being optimistic that it will work out and we have a completely new type of electrolyte.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Balsara's approaches are very novel and this reviewer was amazed by the improved conductivity values from a polymer electrolyte having such mechanical strength. Work on nanostructured electrolytes is encouraging and shows promise in the area of solid polymeric electrolytes. The polymer shows good mechanical modulus and conductivity and hence they could decouple the electronic and mechanical properties.

The results are very interesting but not yet complete. An analysis of the effective impact of the new electrolyte requires a comparison with a more conventional Li metal cell with specific performance considerations and above all impact in cycle life. A reviewer was not able to find any specific accomplishments, but the plans are all good.

A reviewer highlighted the good technical work and pictures that show good polymer structure of combining a soft but conductive medium inside a hard framework. Full cell work could benefit from using soft polymer only in cathode. Concept work is acceptable but the reviewer was not sure there is a path to a real product with a reasonable temperature performance, unless a design involving extensive heaters were acceptable. This reviewer believed having heaters to handle sub-zero temperatures may be reasonable but having to heat the cells all the time would seem to be expensive and far too wasteful of battery energy. Error bars on Li thickness/EO thickness are pretty large relative to difference in the means – the reviewer was not sure the explanation is correct for the conductivity.

Balsara's work has lead to an interesting coating, but the rate is much too low for use in batteries for HEVs or PHEVs. It is unlikely that he will be able to achieve high rates because of the low conductivity of his coating.

A reviewer asked that the team provide resistance measurements (AC impedance or HPPC at a ten second time scale) in terms of Ohm-cm^2 at different temperatures including 0°C, the high impedance of PEO and of Li metal at this temperature are of concern for PHEVs (which actually usually have operating requirements at -30°C) and a large barrier for use of Li metal-polymer batteries. John Kerr has done a good job of raising these concerns with Li metal - Balsara needs to address the problems identified by Kerr.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Among the positive aspects here are that they will have immediate application in low-rate devices, and that a start-up company and publications are already in place. Another noted that the PI has already formed a start-up company with an ambitious marketing plan. Similarly, a reviewer said that the PI has interest in a start-up company, and that the PI has done important fundamental work on electrolytes. The technology has been licensed to a small start-up, but the reviewer was not sure if this will actually make it to implementation for EV/HEV applications, but maybe more relevant to other applications where low temperature performance is not a requirement. Balsara's coating does not provide a rate that would be useful by battery developers. Finally, the activity of this project could have some impact on consumer batteries, but any impact on HEV/EV batteries would be considerably longer term and questionable.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

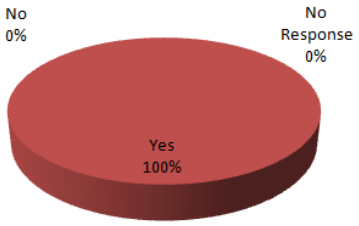
The resources are reasonable, said one reviewer. Another said that in general, Li-metal-related activity should be terminated. However, if any Li-metal-related projects are to be continued, this may be the most worthwhile current project. A reviewer recommended that the team only continue if they have an approach to get at ambient temperature performance. Otherwise this reviewer could not support funding this work any further under a vehicle program. The final comment was that the results from this project do not support continued funding for this project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

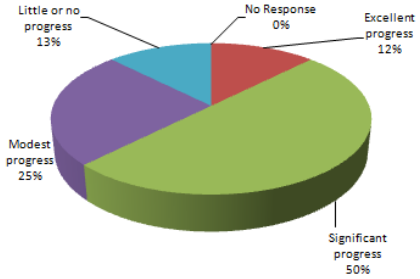
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Block Copolymer Electrolytes for High-Energy Density Lithium Batteries

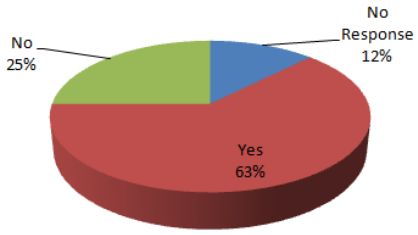
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



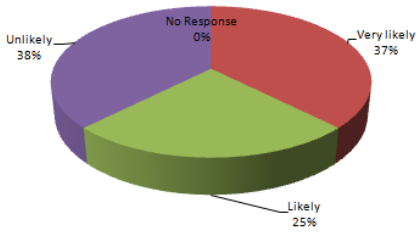
Question 3: Characterize the technical accomplishments and progress toward goals.



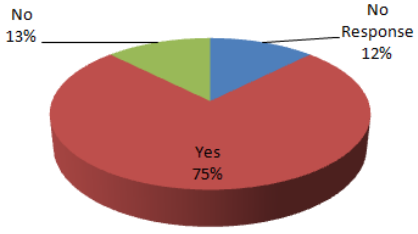
Question 2a: Are the goals of the project technically achievable?



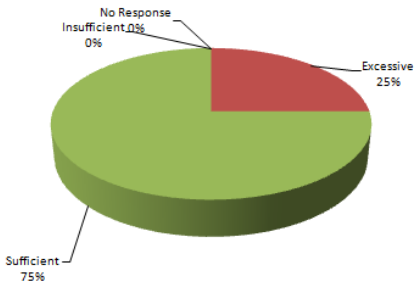
Question 4: How likely is the project team to move technologies into the marketplace?



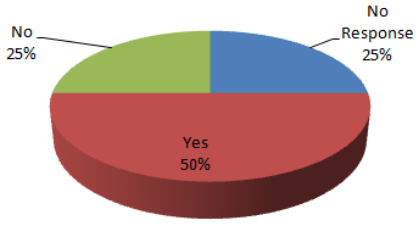
Question 2b: Have the technical barriers been identified and addressed?



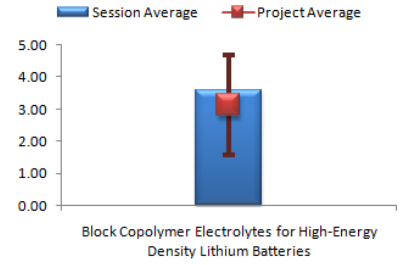
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Characterization of New Cathode Materials using Synchrotron-Based X-Ray Techniques (X.Q. Yang, of Brookhaven National Laboratory)

Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

A reviewer stated this work was a key characterization tool for advancing battery technology. Another said that cathode characterization is functional to DOE program. Basic research is a continuous source of new ideas and stimulus for new solutions. Furthermore, efforts are being made to improve materials using coatings and using diagnostic tools such as synchrotron X-rays to characterize the materials to meet program goals. It correlates structural changes to performance improvements. A reviewer noted that this work relates to the in-situ synchrotron study of cathode materials and has relevance to Li-Ion batteries. Another felt this work addresses stability and reaction mechanisms. Finally, a reviewer said that Yang's work may lead to better understanding of the formation of the SEI layer, for example, using X-Ray techniques. His results may lead to better batteries for HEVs and PHEVs that will lead to reduction of oil use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

To one reviewer, the approach is mostly related to a well-justified integration of measuring techniques to analyze structural changes and support development of new materials (cathodes and electrolytes). Another said that this unique integration of diagnostic tools must continue to be used by all the program participants to achieve continuous support in the research and development work. Good strategy with lots of different new materials studied, said another reviewer. A reviewer characterized the goal of their study as being clear and they have the techniques for studying the local electronic structure of cathode materials. Much of the work in this project involves critical support and knowledge provided to fundamental materials work being done in other projects. A reviewer highlighted the excellent use of multiple techniques and coordination with other PIs. Yang's experimental techniques yield dynamic data from in-situ studies, stated the final reviewer. His X-ray absorption work may lead to a better understanding of the phenomena that occur in cathodes due to the ability to follow the change in the oxidation state of Mn during discharge, for example.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Brookhaven is doing excellent work in supporting the development of new energy materials, stated the first reviewer. The second said that the project is efficiently supporting the achievement of the key DOE goals with interesting experimental results able to improve various material developed by other participants. A third thought that good progress has been made in characterizing the new materials synthesized and suggested that the work continue. To another, these studies help deeper understandings of the electrode processes. A reviewer thought it would be interesting to extend the same approach to anode and complete cells analysis.

A reviewer stated that in situ X-ray diffraction and absorption studies on coated and uncoated $LiFe_{1-x}M_xPO_4$(M=Mn, Co, and Ni) type of olivine structured cathode materials showed the important effects of doping and surface coating on the structural changes and performance of the lithium-ion cells: XANES data supported by EXAFS showed that the oxidation state of Mn does not change with lithium content. On the other hand, Ni ions are oxidized by incorporating lithium ions in the

transition metal layers. The oxidation state of Ni is close to that of NiO(Ni^{2+}) and $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$($Ni^{3+}$) for x=0 and 0.20, respectively. Similarly, another reviewer noted that using synchrotron XANES technique the authors have determined the local oxidation state of Ni. The result could shed light on the cycle life and stability of these kinds of cathode materials. A reviewer said the work provides good understanding of the chemistry using in situ experiments. This is key information to support modeling, fundamental understanding, and identifying problems with real electrodes.

Finally, Yang's work shows how the components in the cathodes change oxidation states with differing amounts of Li. His X-ray method shows clearly what actually happens during the cycling of cathodes.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The technology transfer is a continuous process underway, related to the strict collaboration in place in the project, noted the first reviewer. Second, the project team's results are very crucial for dissemination of the knowledge to industry and academia about the electronic stability and structure of these cathode materials. To another reviewer, this project has consistently provided key information to other materials development projects. The materials obtained in some of these projects will undoubtedly be transferred to or influence the marketplace in some way. Lastly, Yang's work shows how doping changes the mechanism for charge storage in doped olivines. His work shows that at what state of charge the components change oxidation state.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

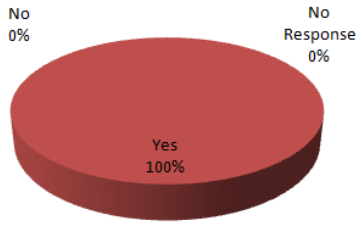
To several reviewers, the resources seem consistent with the work and funding is sufficient, with good work for the funding obtained. A reviewer stated that a possible extension to anode material and cells may require an increase of the resources. Resources devoted to electrolyte development work without well-defined and specific goals for this activity may be better re-directed towards X-ray related activities, stated a reviewer. In particular, re-direction of resources from electrolyte development work towards the planned in-situ XAS studies of thermal stability would be beneficial. The final reviewer could not comment on the resource level.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

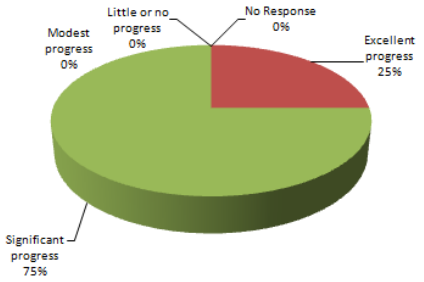
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Characterization of New Cathode Materials using Synchrotron-Based X-Ray Techniques

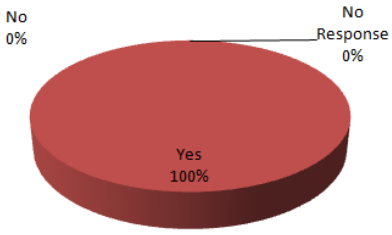
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



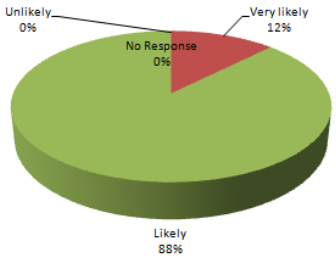
Question 3: Characterize the technical accomplishments and progress toward goals.



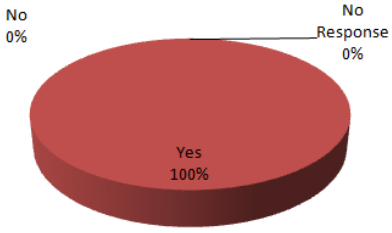
Question 2a: Are the goals of the project technically achievable?



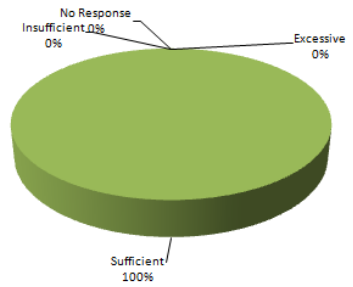
Question 4: How likely is the project team to move technologies into the marketplace?



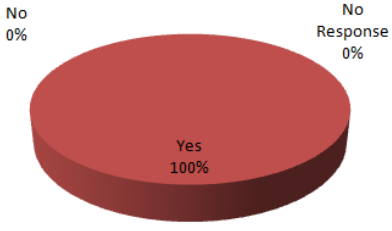
Question 2b: Have the technical barriers been identified and addressed?



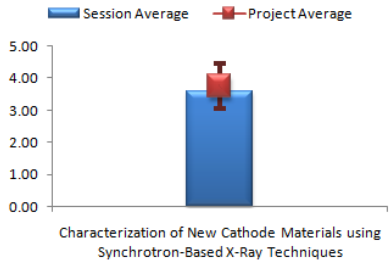
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Design of PHEVs and Electrolyte Properties (J. Newman, of University of California at Berkeley)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer indicated that the work is important for the development of PHEV and HEV vehicles, while another commented that Newman's contributions to improving batteries are well-known and will lead to improved cells for HEVs and PHEVs, thereby reducing oil consumption. One other person stated that modeling is a cross-cutting technology very relevant to achieving DOE objectives on battery development. One final reviewer wrote that understanding transport and thermodynamic properties may help improve electrolyte materials and help with the goals of the program.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response indicated that the modeling information provides a benchmark for energy and power requirements for PHEVs and eventually EVs. One reviewer wrote that the group is developing improved experimental methods to study the transport and thermodynamic properties of the electrolytes, with the goal of achieving better electrolytes to meet program goals. Another respondent stated that the limited and well-focused goals were relevant to the DOE program. The approach is reasonable and able to achieve goals in a timely manner.

One final reviewer wrote that Newman's contribution in this project is useful to help battery producers focus on the limitations associated with current cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Responses to this prompt were generally positive. One reviewer commented that the progress is good with a capacity to complete the work in a timely manner. Another person added that Newman has contributed useful results to battery developers. One respondent added that the work is very relevant for the current development of PHEV vehicles. It allows the OEM researchers and product development people to know the theoretical limit of the power-to-energy ratio for a given set of material parameters. Similarly, one individual remarked that the development of new methods for the determination of electrolyte properties provides useful alternatives for arriving at relevant information for other modeling or optimization purposes, and the development of new models for battery and vehicle design will be of current and significant value to vehicle OEMs and battery developers.

Another reviewer wrote that it was nice to see that Newman and his group developed a simplified model to provide insights on the design of HEVs and PHEVs. A combined battery and vehicle model has also been used to provide accurate and comprehensive prediction of behavior in HEVs and PHEVs, for design. Measurements of the transport and thermodynamic properties of LiPF6 in several solvents support these models.

One final reviewer noted that transport and thermodynamic properties of the electrolyte has been studied. A simplified model to characterize the performance of HEVs and PHEVs has been developed. The model indicates that the state of discharge is an important factor in the power performance of the battery which is well-known. The separator thickness has been taken into

consideration. That is only one factor. Another is the total internal resistance of the cell which translates to material properties, thickness of electrodes, conductivity of electrolyte and resistive losses are other factors that limit the power capability. It may help to use more or all of these factors in the design. The change of these properties with temperature is also an important aspect.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer wrote that these results have direct relevance to real-life applications. Another response commented that Newman has produced in this project relatively simple design rules that will help battery developers. One other reviewer stated that publications are adequate tools for transferring the project results, while one final person stated that the modeling concept is well known and well understood.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

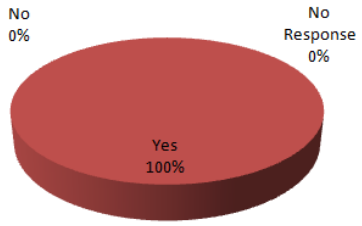
Two reviewers indicated that there are adequate resources for this project, while another felt that more work can be performed for the funding received. One other reviewer commented that, if the modeling of spurious lithium deposition is carried out as future work, efforts to produce and observe actual conditions resulting in lithium deposition in Li-ion systems should be included.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

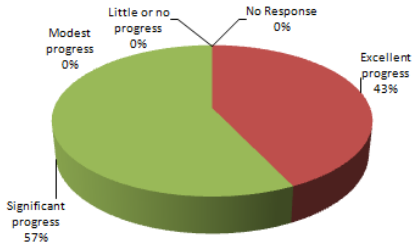
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Design of PHEVs and Electrolyte Properties

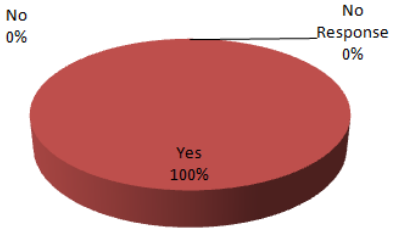
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



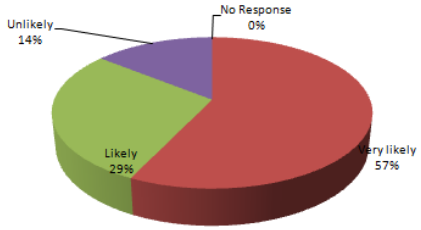
Question 3: Characterize the technical accomplishments and progress toward goals.



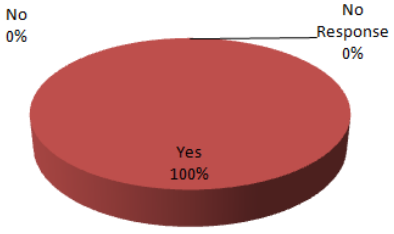
Question 2a: Are the goals of the project technically achievable?



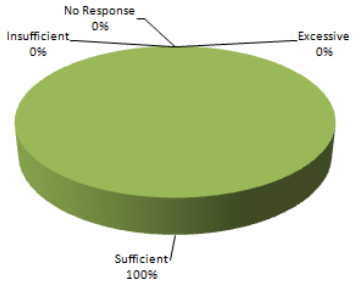
Question 4: How likely is the project team to move technologies into the marketplace?



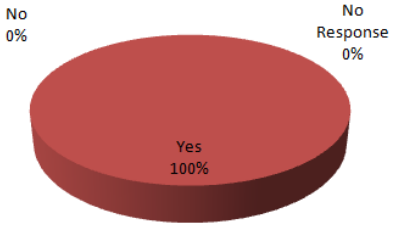
Question 2b: Have the technical barriers been identified and addressed?



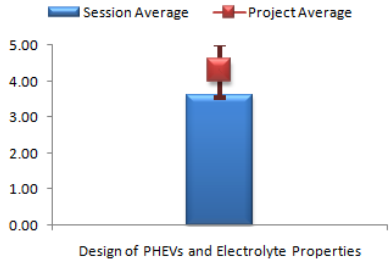
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Electrode Construction and Testing (V. Battaglia, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
This work addresses a very critical aspect of cell technology, stated the first reviewer. The second felt that technology optimization and experimental verification is relevant to confirm the achievement of the DOE objectives in battery development. The work is related to fabrication and design of electrode material for li-ion batteries. Electrode construction, analysis and understanding the limitations of this component of the cell support the program goal. Electrode design issues are critical to moving the project forward. Battaglia's work will probably lead to better batteries for HEVs and PHEVs thus reducing oil consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer simply noted the very well-designed experiments. A reviewer said that the PI and team have addressed all the technical challenges extraordinarily well. The practical design of electrode and their optimization has been demonstrated very well. Study of electrode materials, characterization of the electrodes, collaboration with modelers, fabrication of half and full cells and testing are the project's strategy in meeting the program goals. To a reviewer, the focus on electrode design is very nice to see. The PI is also leveraging other program PI's and the work seems very well coordinated and focused.

A statement was made that the project has useful goals for the purposes of direct application within the BATT and ATD environment and maintains productive interaction within the BATT/ATD environment. Another similarly stated that the project is central to all BATT programs. The project has the key role to overcome the technical barriers of design, realization and testing of components and cells in order to get optimal performance. There is no focus on cost considerations in selecting materials and cell design, which may be a side result of the optimization work.

Battaglia's work is very useful to battery developers because his team can investigate possibilities that may be too expensive for developers to investigate. His work also yields explanations for his results that may help cell developers understand their results or help them decide not to investigate certain regions of possible recipes for electrodes. His work will help developers find optimum or near optimum recipes for electrodes for the desired operation (high-power or high-energy).

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The results are very interesting, according to one reviewer, and are very important for coming up with electrodes especially for PHEV batteries. Battaglia's work is producing results that can be used immediately by cell developers. His work is also useful to academic investigators (Sastry, e.g.) who can use his experimental data to support their modeling work to help find optimum electrode fabrication procedures.

The progress is significant and really functional in accelerating the use of the BATT results. The extension to other materials is strongly recommended. An upgrading analysis from cell performances

to equivalent battery system performances for various applications should be highly effective for progress evaluation.

A reviewer felt this was very good work that has the right mix of experiments guided by modeling; the control experiments for optimization and the correlation between structure-morphology of the electrode materials with cycling and rate capability has been demonstrated very well. The reviewer suggested that the researchers continue such work on newer materials that have passed Gen-3 chemistry and beyond so that we are on target for electrode optimization with PHEV application, although they believed that the researchers have already begun working on this.

Within the scope of the BATT and ATD environment, the project has made numerous useful findings which are of direct benefit towards BATT and ATD activities. However, the general activity of this program is already conducted on a much more rigorous and ongoing basis by all significant mass-producers of li-ion consumer cells in the global marketplace. The project would benefit greatly from interaction, collaboration, and formal cooperation with significant mass-producers of li-ion consumer cells in the global marketplace, and this would also be of great value to the rest of the BATT and ATD community.

The authors concluded that carbon/binder/active material interactions suggest different ratios for different applications and found that Mn-spinel evaluation indicated that BATT material is as good as, or better than, commercial material. The authors also stated that the optimized cathode design suggested cells of 500 Wh/l are possible. These studies were done in the lab with small electrodes and cells and by no means can be certain that these conclusions will hold for bigger cells. Also the conclusion that OMAC 15 from Osaka Gas may be a suitable replacement for MCMB-10 is not supported by names of any manufacturer who may use or is using it.

The critical ratio of carbon to binder when mixed with cathode active material was studied and found that the ratio affects the power performance of the material. Similar work was carried out with anode materials to determine a new graphite to replace the MCMB. Limitations of the new graphite have been well understood. If the method of pulsing is not adequate and the limitations of pulsing against a Lithium metal anode are well known, methods to improve this should be pursued. As this may lead to ambiguous results unless past experience has shown that a relative comparison would still be valid. The team will need to carry out some studies on materials used by battery manufacturers especially the carbons or graphites being used by them to replace the MCMB.

A reviewer appreciated that LBNL needs to improve its electrode- and cell-making capabilities, which are not yet state-of-the-art in terms of producing electrodes with low impedance. However, the formulation work is not a good use of national lab resources. The work is naive and well below the state-of-the-art in the industry - it is not telling industry anything not already known. Many of the results appear to be artifacts of poor mixing, coating, and calendaring procedures. Relative to finding a replacement for MCMB, the reviewer wondered why the PIs are not talking with Jansen at ANL, who has been screening commercially-available anode materials. This reviewer thought one part of this task was to make electrodes from the new materials being developed by others in the BATT program - why is there no mention of that?

A reviewer said the team showed good understanding and identifying the true “killer issues.” However, the path going forward seems less clear. This reviewer said the PI is doing really good work. Can/is this being fed into the Dees model? The reviewer thought there was just not enough time to present all this work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Positive comments included that these findings are key knowledge and could be easily transferred to the developers. Key activities and tech transfer are likely (recognizing that transfer is to others in program and only indirectly to industry). Battaglia's screening work can be used immediately by cell developers and will reduce the time to market for cells for particular applications associated with batteries for HEVs and PHEVs. A reviewer said that the tech transfer is part of the approach with continuous contacts with developers and end users. A reviewer summarily said that the tech transfer would occur if significant work can be accomplished to find an anode that works.

The project's success and findings are directly transferable to the rest of the BATT and ATD activity as a whole. The project should be continued, but because the project's activity is redundant with and necessarily must be much less extensive than that of significant mass-producer's of li-ion consumer cells in the global marketplace, documentation of the project's general approach to electrode formulation optimization for the purposes of potential use by new battery developers who may enter the market in the future could be a valuable new goal for the project to consider and this might result in greater long-term technology transfer and market transformation promise for this project. With this focus, the project might also be able to dedicate more activity to interaction and learning with significant global li-ion manufacturers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

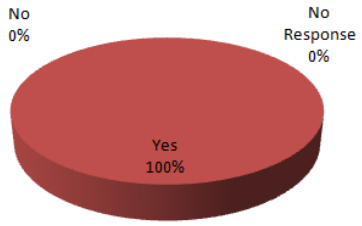
Funding for Battaglia's work is sufficient, according to one reviewer: to another, there was good work for the funding provided. A reviewer disagreed by saying that the resources should be increased. A reviewer added that the project would benefit from additional resources and from a tempered change in focus from internal optimization of BATT and ATD-related electrode optimization to more of a focus on interaction with and learning from significant global manufacturers of li-ion consumer cells, while at the same time documenting internal and external learning regarding the general process of electrode formulation optimization. Resources should also be increased to allow for the valuable planned activity involving quantification of carbon/binder and binder/active material interactions from DSC. The final commenter keyed on the good level of resources and the observation that they are leveraging and working with the other PI's extremely well.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

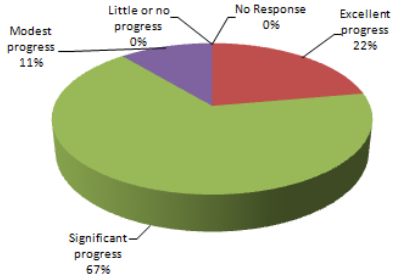
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Electrode Construction and Testing

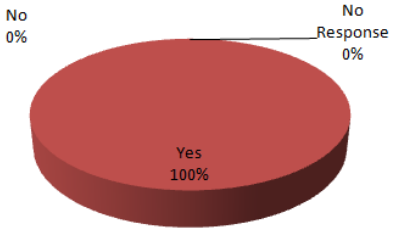
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



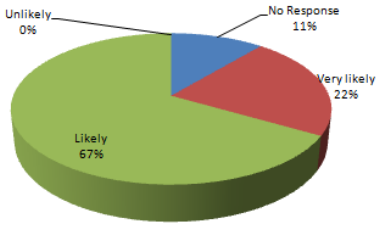
Question 3: Characterize the technical accomplishments and progress toward goals.



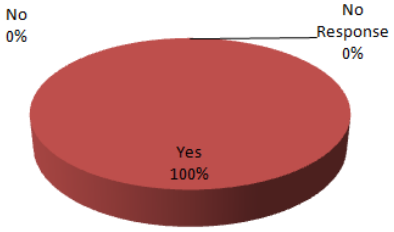
Question 2a: Are the goals of the project technically achievable?



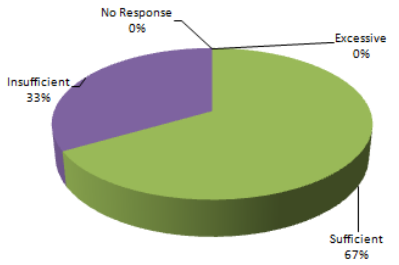
Question 4: How likely is the project team to move technologies into the marketplace?



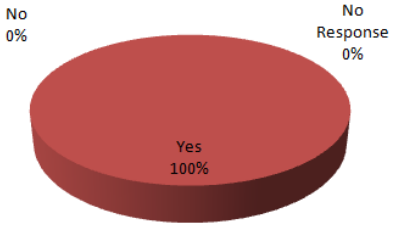
Question 2b: Have the technical barriers been identified and addressed?



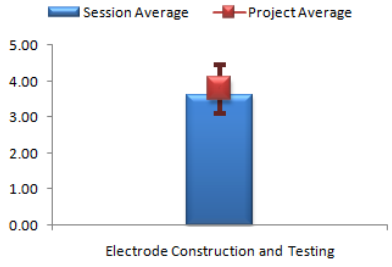
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



In Situ Observations of Lithium Dendrite Growth (A. West, of Columbia University)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Lithium does remain the holy-grail in anode technologies, according to one reviewer. It seems that only Li metal can address long-term EV demands, and these could be an enabler for lower cost cathodes for PHEV, but unlikely to be worth the risk in this reviewer's view. Another said that lithium metal electrodes would support DOE goals, but must be made safe. Their work addresses possible safety issues in developing Li-Metal electrodes. There are also some Li plating issues at low temperature on electrodes and their study could be relevant for li-ion battery research.

The analysis of Li dendrite formation is functional to basic knowledge of DOE program. West's work will lead to a better understanding of the formation of lithium dendrites which may lead to use of lithium metal in batteries for HEVs and PHEVs, which will lead to a reduction in oil use for cars. Limitations to long life and high cycle life are being studied by studying lithium dendrite formation and this in support of the PHEV and HEV goals and objectives.

The techniques developed for the measurements can be used for other systems that incorporate Li metal. That would be useful for optimizing electrolyte and additives, something that would be extremely useful for the program.

The final review comment was that although there is new work accomplished in this project, and the work is of high quality, the basic subject of this study does not warrant this type of activity and has already been extensively investigated over many past years.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
On the positive side, a reviewer said that if the objective is to watch dendrites, then the approach is very novel. Another said that the project is studying one of the major causes for reduced life in lithium-ion cells. This has been correlated to electrolyte properties which is a new approach. A reviewer also said that there is no deployment strategy in this kind of project, but their experimental plan and the tools to achieve them look feasible. The final comment was that West has developed an experimental technique that will provide useful data for the development of the so-called SEI layer on anodes in lithium ion cells. He has shown experimentally the effect of the VC additive.

On the other hand, reviewers said the team needs to do a better job of identifying electrolytes that can cycle lithium with a high figure of merit. Work on lithium metal will be rejected by most battery manufacturers, a reviewer stated, as it requires too much moisture control and risk of fires etc. in materials supply is high. This reviewer did not see how that would be successful. However, understanding the dendrite formation for other anodes than Li metal is a good idea. For another commenter, it appears that the project outcome could result in methods to impact dendrite growth or dendrite growth rate in a positive way. However, in terms of battery systems for HEVs or PHEVs, there is no clear route for deployment based on much past work over many years on li-metal systems. A reviewer said that the project mainly focuses on dendrite formation study and the technical barriers have been identified in the way to measure and analyze the dendrite growth. Li metal does not have great space in BATT. More analysis on the Li metal system may better clarify the situation and support decisions. The final comment was simply that the project had a low likelihood of success.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Some of the specific goals of this project have been addressed, but these cannot be translated into progress towards DOE goals as related to HEV or PHEV battery systems, stated one reviewer. One person noted the good experimental set-up and the new technique for the study of dendrite formations. West's work shows that Li dendrites grow from the base electrode to a greater extent than from the tip of the dendrite. Consequently, he should be able to measure the rate of formation of dendrites. Several aspects of dendrite formation have been studied from nucleation to the velocity of growth to the effect of current density on this growth. The use of VS additive and its effect on the growth of dendrites has been studied well. The preferential nucleation of lithium dendrite on the base was not explained well. Is there a surface morphology difference between the base/ the tip and the sides of the copper rod? It may be beneficial to study the dendrite growth in systems that have a carbon anode for practical purposes. The study on copper is somewhat relevant as it could be extended to studies on cells that have undergone high cycle life where defragmentation of carbon has occurred exposing the surface of the copper. But it would still help if the anode were carbon.

The experimental analysis is outstanding in improving comprehension of the process but no answer is found yet for solving dendrite growth formation. The project seems quite slow. Experimentally the authors have clearly demonstrated the Li dendrite formation and their origin. The dependence of the role of solvent and additives in dendrite growth and formation is interesting.

The authors have shown that mass transport does not seem to play a role in dendrite initiation. Deposition quickly becomes mass transfer controlled after dendrite formation. High interfacial resistance inhibits dendrite formation, but it also hurts battery performance due to slowed Li transport through the SEI.

A reviewer said that the approach to view Li dendrite is novel but if they are trying to eliminate Li dendrites then these are not the approaches this reviewer would use. People have done these for many years without any permanent solution to the problems.

A reviewer stated the team was basically doing method development and just now starting to get data. This is good fundamental work in a difficult area. Interesting, looking at ether-based electrolytes will give better dendrite formation as another reviewer mentioned. One caveat is that these electrolytes will not withstand high voltage cathodes. Still, they are good for some V and Mn systems that do have good energy if paired with lithium, even with their low cathode potential.

The main problem with progress is in using electrolytes which do not cycle lithium metal very well. Thus, while the dendrites can easily be identified and studied, they are not characteristic of systems which can attain a high figure of merit which have minimal dendrite growth and which may have a different character, e.g. more mossy and less dendritic.

While this work is scientifically interesting, and this reviewer recognized that the project is still in its infancy, it is not clear how it has any relevance to practical issues with lithium batteries. Nearly 50 years of past work on Li metal have shown that it will not be practical to use lithium metal with liquid, gel, or even polymer electrolytes. Small increases in onset time are not practically significant - the onset time needs to be increased to years, not minutes, over the course of thousands of cycles in order to meet requirements for safety and life in automotive applications. Power would also be a problem with lithium metal, especially at low temperature, even for large batteries in PHEVs. The PI is talented but the choice of research focus is not the best. This reviewer asked that the team try to focus

on issues of more relevance. The analysis is thorough and well done. But why is it a surprise that lower exchange-current density gives a lower rate of dendrite growth? That is basic to the theory of secondary current distributions.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

West's work may need to lead to a deeper understanding of the dendrite formation process based on the composition of the electrolyte. He has shown quantitatively how the time to produce Li dendrites depends on the PC concentration in the electrolyte. A reviewer said the development of a diagnostic tool will be a good focus. Excellent work performed that has great marketability was how one reviewer characterized the activity. Their work is important for understanding a fundamental process that could lead to new insights how lithium plates on surfaces. Success is likely if the work is refocused to non Li-metal electrodes.

On the less positive side, a reviewer did not see any revolutionary idea to resolve this mother of all problems (e.g. dendrite formation) within this scope of this program. Another said that it is too premature and limited information has been presented. This old problem does not yet have interesting answers. A suggestion was made that safety is a major problem with all lithium metal batteries to date, so the team will need to develop a strategy to deal with this.

Lastly, a reviewer said success was a very long shot, but may be worthy of funding on a small scale only. Frankly, the manufacturer's risk associated with coming out with a lithium metal cell would seem too prohibitive (witness the demise of Moli Canada and Avestor). No matter how much testing you do, it is going to be hard to be sure that lithium dendrite formation will not occur under real life conditions.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The increase of the use of the in situ device may require more resources, depending on the recommended extension to other materials. Another said that there had been excellent work for the funding obtained. A reviewer stated that funding for this project is sufficient.

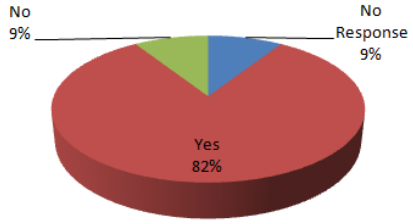
On the opposing viewpoint, funding for this activity should be terminated, stated a reviewer. Another said DOE should continue to fund, but at no more than the current level as this is a long shot, blue-sky program. DOE should give them another year to show whether this approach is useful or a dead end. They should have frequent oversight to ensure it still makes sense to continue.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

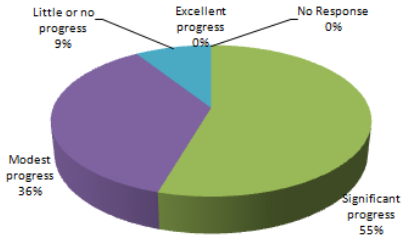
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: In Situ Observations of Lithium Dendrite Growth

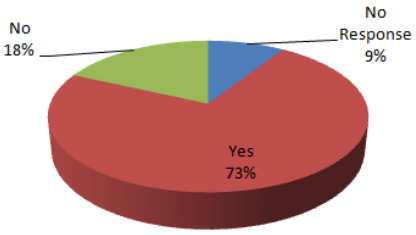
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



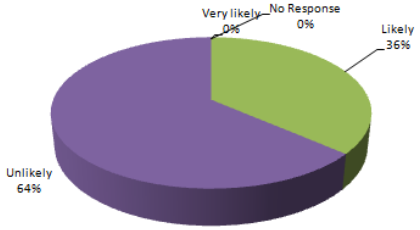
Question 3: Characterize the technical accomplishments and progress toward goals.



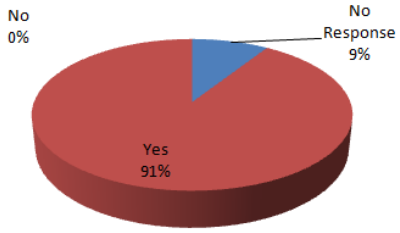
Question 2a: Are the goals of the project technically achievable?



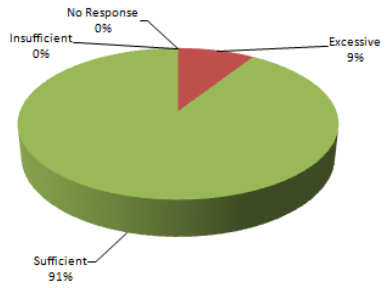
Question 4: How likely is the project team to move technologies into the marketplace?



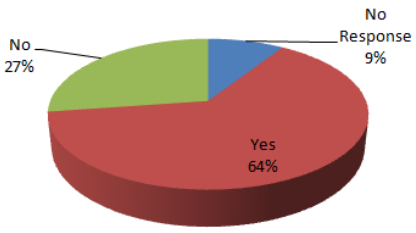
Question 2b: Have the technical barriers been identified and addressed?



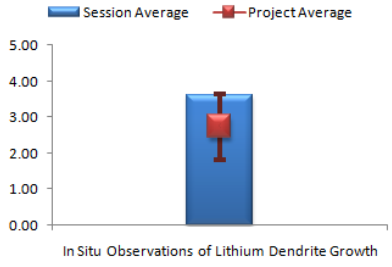
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Interfacial Behavior of Electrolytes (J. Kerr, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Understanding of the interfaces is a key to improving battery characteristics, to one reviewer's mind. Another said that basic understanding of electrolyte behaviors is relevant in developing Li batteries for DOE program. A reviewer said that improved electrolytes provide better performance which leads to higher capacity and pulse power performance and longer life and they are all in line with the goals of the program. A reviewer noted that the work relates to electrolytes for li-ion batteries. The last comment was that Kerr's work on ionic liquids may lead to better batteries which would lead to more use of HEVs and PHEVs thereby reducing consumption of oil.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the reviewer does very good work on analysis, but the reviewer saw a lot of issues being explored within his group and felt that it is rather confusing (NASA or ATD request etc.), so suggested that the program needs better focus. Another stated that the approach is adequate for an increased focus on novel electrolytes. The studied electrolytes (mainly ionic liquids) should be further analyzed to verify their compatibility with new electrodes. The author has a good plan and addressing the technical barriers, stated another reviewer. Among the notes made by a reviewer were that the Interfacial properties of ionic liquids with respect to different anodes have been studied and the carbonate based electrolytes and anode interfaces have also been studied. Finally, Kerr's work has not lead to useful results, which address the needs of battery developers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
To one reviewer, the achievements are interesting and worth continuation and completion of the analysis according to the plan. Another offered that this is tedious work to pursue and this reviewer would understand the slow progress. Another comment was that the authors have studied effects of conductivity of ionic liquids with co-solvents and have made progress on the interfacial impedance study of graphite half cells with ionic liquid with co-solvents. The PIs need to carry out studies on completed cells. A reviewer looked forward to similar work on Gen-3 anodes as well (formation experiments with $LiPF_6$ electrolyte).

A reviewer felt there had been good analysis on the interfacial resistance study with ionic liquids. But the conclusion that they are not good for lithium-ion batteries may not be true. More studies should be carried out in this area as polymer li-ion cells will benefit from this type of electrolyte. With respect to the carbonates and the interfacial resistance, the use of LiTFSI additive in the electrolyte to improve performance at higher temperatures is good. Limitations of the materials have been understood but more work is required to make improvements.

The findings of this work which indicate that ionic liquids may not be suitable for higher rate applications such as hybrid vehicles are of value. It may make sense to generally end work with ionic liquids on this project, after providing slightly more support and documentation for this general conclusion, which should be more formalized. The portion of work focused on exploring formation

phenomena, electrolyte degradation, and electrolyte kinetics with $LiPF_6$ versus LiTFSI, etc. should be continued and expanded.

A reviewer was very glad to see the measurements of interfacial impedance expressed in Ohm-cm^2. These measurements raise a red flag for other projects in the BATT and ATD programs that are looking at Li metal. Relative to the AC impedance of unformed cells, the hypotheses presented are somewhat "wild" to this reviewer: there are a lot of other factors that could be contributing to the high impedance of the unformed cell - and it is not clear that this line of work will be of any use. This reviewer thought pursuing the impedance of unformed cells is a distraction from the main issue, which is the impedance of the formed cell. The work presented is unfocused and it is not clear what was learned. The plans for next year look more focused. The reviewer supports the proposed work to look at the effects of impurities and additives on degradation reactions in the electrolyte. The PI is a talented organic chemist and his skills in elucidating reaction mechanisms in the organic electrolytes would be very valuable. In general, the BATT program is far too focused on polymer electrolytes. Batteries for PHEVs need to be low impedance and polymers will never meet that requirement. All battery companies focused on automotive applications are interested in liquid (or perhaps gel) electrolytes because of their power benefits, yet there is no component of the BATT program on liquid electrolytes.

Finally, Kerr's work has shown that ionic liquids are unlikely to help overcome the barriers to producing better batteries for HEVs and PHEVs.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

On a negative note, a reviewer said that Kerr's work is unlikely to lead to improved batteries. Other comments were more positive: a reviewer said that the technology transfer is well in place with well defined collaborations. Another said that the work is relevant for BATT activity, but the reviewer suggested including more fundamental work on ionic liquid electrolytes. The studies involving activity other than with ionic liquids provide directly transferable information of use to the marketplace. A reviewer stated that a lot of good work is being carried out by battery manufacturers in this area. It may be difficult to market if significant improvements are not made. Lastly, a reviewer offered that the PI needs to renew his contacts with industry to get re-calibrated on issues of interest to the battery industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

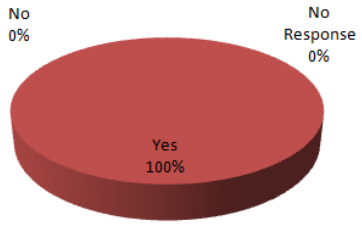
Comments varied on this aspect of the research, ranging from the view that the resources are adequate to the view that the PI does not appear to have sufficient resources to deliver focused results. Work is insufficient compared to the funding obtained, and according to this reviewer the investigators need to have better optimism and options for improvement. Resource focus should generally be re-directed from ionic liquids to the other activities of this project. The funding for this work is excessive relative to the useful results obtained, was the last comment offered.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

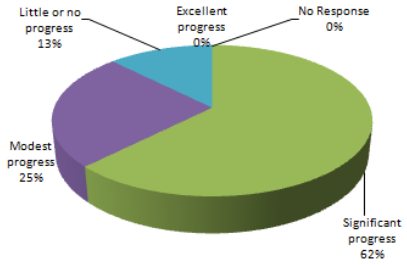
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Interfacial Behavior of Electrolytes

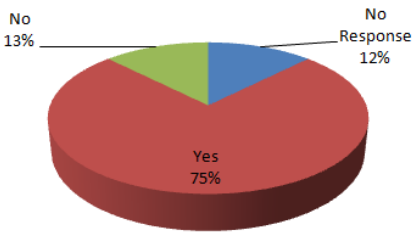
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



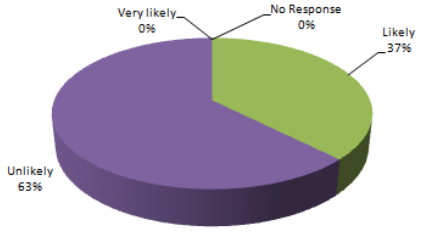
Question 3: Characterize the technical accomplishments and progress toward goals.



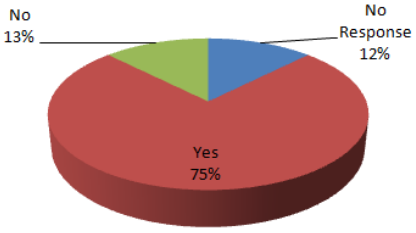
Question 2a: Are the goals of the project technically achievable?



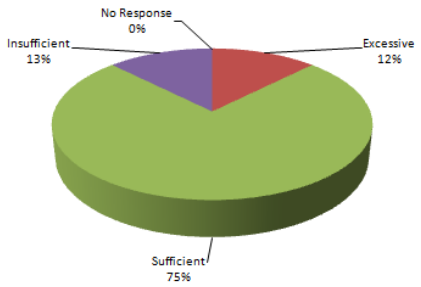
Question 4: How likely is the project team to move technologies into the marketplace?



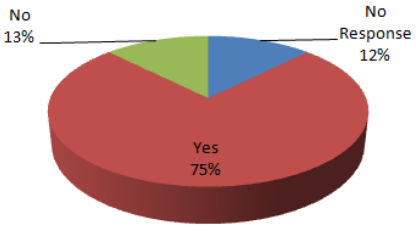
Question 2b: Have the technical barriers been identified and addressed?



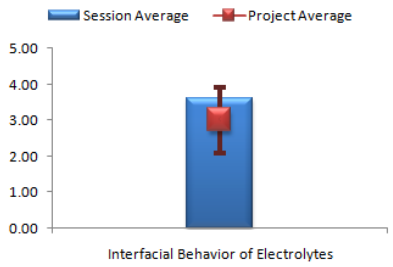
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Intermetallic Anodes (M. Thackeray, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer said that the novel high-capacity anode investigation is very relevant to DOE program. This project looks at new intermetallic anodes with improved performance. Another stated that the study of new anode materials is part of the goal for this program to obtain higher capacity cells for the PHEV program. Similarly, a reviewer commented on the development of intermetallic anodes for Li-Ion batteries. To another, intermetallics could replace anode as a high capacity (high volumetric capacity) anode material. A reviewer agreed with the focus on powders and Sn for cost and practicality. To another, this project supports overall DOE objectives, but only with a very long term focus. The final comment was that Thackeray's work on producing new Mn cathodes will probably reduce the cost of batteries for HEVs and PHEVs which would reduce oil consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Overall comments included that the defined goals are clear with well defined barriers to be overcome. The approach is original and technically reasonable in addressing solutions with new materials. The goals are challenging, but the approach seems reasonable. There is still too much focus on low specific energy materials, stated a reviewer. A reviewer characterized this as a challenging project, but it can be done. This reviewer thought it was a good change to move away from Sb. Study of new anode materials is the focus of this work to obtain a stable anode for future li-ion cells.

More specific comments included the note by a reviewer that $CoCu_5Sn_5$ shows highest capacity (400 mAh/g) and best stability (2-0 V) and was selected as the composition for further study. Further comments were that the authors are in the process of moving from present Cu-Sn system to Cu-M-Sn and finally Co-Sn system. This reviewer agreed that the ball-milling method is a good method for screening but moving to other methods like hydrothermal or thermal reduction could be used in a case-by-case basis. A reviewer noted that there are companies that can produce molten spherical metal particles - maybe this can help in the synthesis? This was clearly what was used in the "commercial sample". The improved first cycle efficiency shows that this can be beneficial.

Thackeray has shown that his intermetallic anode work to replace carbon will provide anode materials that will be safer than carbon in lithium ion cells. His work on Sn based anode materials indicate that it may be possible to generate a better anode that will be safer than carbon in lithium ion cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A broad range of comments were received. A reviewer said that the results are outstanding. Other comments are that the target of 400 mAh/g has been achieved. Process evaluation and scale up related aspects need some focus. $LaSn_3$ is interesting but a preliminary cost evaluation related to the use of La is suggested. The PI has covered a lot of ground starting from Cu-Sn to LaSn3. More characterization work of materials is needed to put this material in proper ground. Full scale cells with promising or established cathodes should also be tested. The task is doing a good job of trying to creatively invent new anode materials. A reviewer asked if Stan's data shows that the Sony Nexelion anode is already at 400 mAh/g and therefore haven't they already met your goal?

Another said that this is a long-term project. This reviewer liked the focus of 400 mAh/g alternative anode with an eye toward 1000 mAh/g or higher capacity anodes at a low cost. However, the PI continues to focus on materials which are rather expensive and also low capacity. That would not lead to the leapfrog being sought with respect to either cost or capacity. He should work on high payoff materials such as Si, though it might be rather challenging.

Further comments are that addition of surplus graphite and carbon to the electrode significantly improves cycling stability through improved electronic connectivity, cf. Si electrodes, but capitalizes on the capacity of the graphite component. A good study of different anodes has been carried out. Several anode materials available in the market including those similar to one used by Sony have been studied. The $LaSn_3$ is a good anode for study, but the presence of tin whiskers is a concern. With time these can grow and creep and there may be a loss of active anode material leading to not only loss of performance but also shorting.

A reviewer suggested the project team needs to carry out extended cycle life studies on the lanthanum type anodes to determine their limitations. The nature of electrolyte was not mentioned. What work has been performed on optimization of electrolyte for this type of anode?

Another suggestion involved the reviewer noting that the team has been working on similar systems for quite some time (except $LaSn_3$). They should move on to a more interesting anode system that has more energy capacity (volumetric and gravimetric). A further suggestion was that the team should include measurements of impedance - are these materials appropriate for high power applications? A reviewer offered that the PI needs to work with the BATT program to get materials into full cells for cycle-life testing: 20 cycles at low rate is not enough to see what is happening. What happens at rates of interest to automotive applications (PHEV and HEV)?

The increased cycling efficiency in the first cycle for the "commercial sample" is an important proof point for one deficiency seen in precipitated samples. If spherical particles can be made, also better electrodes can be made, which will help with mechanical degradation. The mixed materials are interesting as a first step towards commercialization and a good mitigator that still allows higher performance. Some electrolyte development will be needed for this, but that can come later.

A reviewer noted the great partner - the SEMs look really encouraging. This reviewer said that it was a good approach to be focusing on tin and a novel concept in the $LaSn_3$ material. Ensuring adequate cycle life will be very hard - need thousands, not tens of cycles for the DOE goals.

Thackeray has made progress on several possible new materials based on Sn for intermetallic anodes to replace carbon. His industrial material partner may be producing this material for evaluation by battery manufacturers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

On the plus side, most of the results have a commercial market and the technology transfer is guaranteed by the high quality publications. There are good chances for technology transfer if the barriers are overcome. Thackeray's results are encouraging and will probably be used in the marketplace as anode material for lithium ion cells. A reviewer said that the project is high risk right now, but worth pursuing.

Suggestions included that in regards to $LaSn_3$ – “go for it!” Future plans are good. This reviewer suggested adding synthesis through spray melt, which could improve properties and possibly be used

as a fast synthetic technique once proven out. A reviewer offered that addition of surplus graphite and carbon does not resolve the safety problem. The new anode materials would be tested electrochemically by industry for final capacity and optimization, stated another.

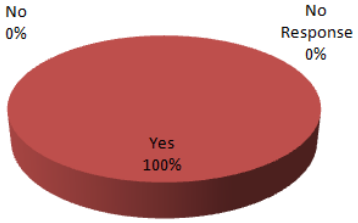
While the project may achieve advances sufficient for transfer to the marketplace, this would most likely be in the area of battery systems for consumer electronics (given the basic properties and present costs of intermetallic compounds), in the shorter term, rather than in the area of battery systems for automotive applications. Similarly, a reviewer noted that patents were filed and already getting some "bites". This may be something that the consumer electronics people will pick up first and implement (like Sony's Nexelion). However, goals are so challenging that the likelihood of success is inevitably only modest in nature.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Resources were felt to be adequate, and funding sufficient, to some of the reviewers. A reviewer did state that more work can be performed for the funding received. A reviewer said that the right people are involved and they have found an excellent external partner to help them along: this reviewer recommended funding at current level - longer term program. The final reviewer could not comment on resources.

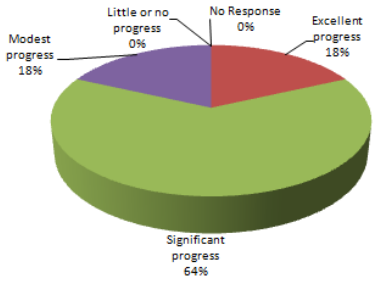
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Intermetallic Anodes

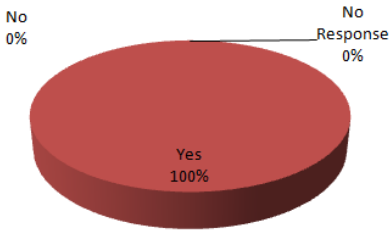
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



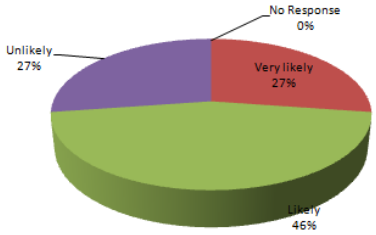
Question 3: Characterize the technical accomplishments and progress toward goals.



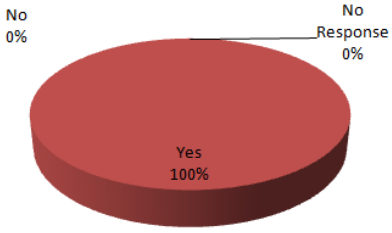
Question 2a: Are the goals of the project technically achievable?



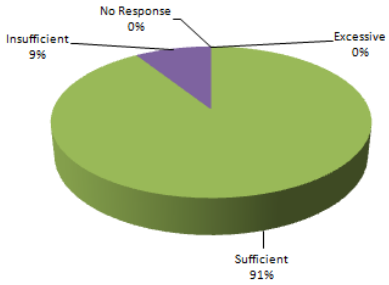
Question 4: How likely is the project team to move technologies into the marketplace?



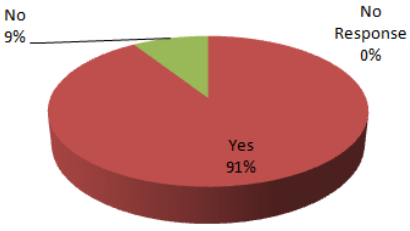
Question 2b: Have the technical barriers been identified and addressed?



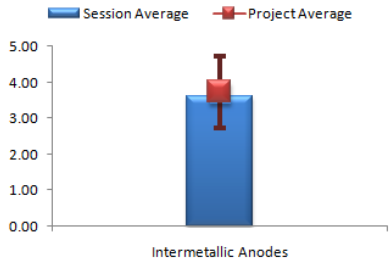
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries (N. Dudney, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments included that studies on non active components together with anode are highly functional to achieve DOE objectives. Another said that the study of new current collectors for improved safety and cycle life is within the goals of the PHEV program. The statement was made that the work is related to development of cathode and anode current collectors for Li-Ion batteries. A reviewer said that Li is needed for EV and maybe high range PHEV. Dudney's work would lead to reduced oil use if her work can be used to improve the performance or life of lithium ion cells for HEVs and PHEVs. A suggestion was made that the portion of this project devoted to metallic lithium anodes does not support the overall DOE objectives and should be terminated.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
On the positive side of the ledger, the strategy is reasonable and well structured to overcome identified barriers. Different forms of carbon have been looked at for improved current collectors that are more stable and safe over long life. This is in line with the program goals. The team is making good progress on their plan. Finally, Dudney's work on carbon current collectors for cathodes may result in better cells. Her work on lithium metal anodes may lead to useful since Oak Ridge National Laboratory has a history of success with a thin film lithium metal cell using a separator known as LiPON. It may be that Dudney's work will yield similar results for metal anode high rate lithium ion cells; however, her work to date has not produced a protective film for the Li metal in a lithium ion cell.

On the other hand, Li cycling is very hard to address and robustness of C foam is an issue. A reviewer said that there is nothing new in the approaches. This reviewer thought DuPont had worked on the graphite paper for quite some time. The work on Li anode is nothing new.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Dudney's work represents a reasonable start, but her results have not revealed anything new, stated the first reviewer. Although the work is quite relevant, a reviewer did not think it will lead to any significant achievement using the current concepts. A reviewer said that the limited results already achieved by this new project are stimulating. Foam collectors should be circulated in BATT for larger evaluation. The change to SEI study on Li metal anode is very appropriate.

The use of graphite foam or fiber is certainly an interesting idea to one reviewer. For coating the electrodes, slurry concentration increased sevenfold, still remaining very fluid possibly leading to higher energy density with single coat. $LiFePO_4$ particle size was also reduced to 0.3-0.8μm by Spex milling with 0.3mm media. Carbon precursors yielding graphitic carbon performed better than those giving glassy carbon.

After selection of the different forms of graphite, tests have been carried out with complete cells and studied for cycle life. In-situ diagnostic studies have been carried out to study the sintered bonding between the current collector and cathodes. Finally thermal conductivity analysis has also been

carried out. Comparisons have been performed with the existing 18650 type cells. With respect to the anode, interface instabilities at the li metal anode in a liquid or polymer electrolyte have been studied. Passivating layers using carbonate films and Lipon have been used and the li dendrite formation studied. Work on both electrodes is very promising for this reviewer.

Both anode (carbon foam) and cathode film optimization is relevant, stated another reviewer. The heat transfer properties are a novel aspect of their work. This reviewer suggested the team should be bit more specific on what they need to accomplish on their Li anode work. Is it removing the technical barrier for Li metal as anode or understanding the mechanism of dendrite formation?

The portion of this project focused on graphite current collectors involves promising electrode configuration alternatives. The project scope should be expanded to examine active materials other than $LiFePO_4$. Although there is new work accomplished in this project related to metallic lithium anodes, and although the work is of high quality, the basic subject of metallic lithium anodes does not warrant this type of activity and the basic subject has already been extensively investigated over many past years. Activity involved with metallic lithium anodes should be terminated, according to this reviewer.

A reviewer queried, is the carbon current collector compatible with the mechanical requirements for wound or prismatic cells? This reviewer requested the team show data and make pouch cells, not swage-type cells. Why are there three projects with the program (Vaughey, West, and Dudney) all looking at Li metal? Li metal has high impedance especially at low temperature. Is there any hope of overcoming that problem? Is there any hope of Li metal lasting 10 years under PHEV cycling conditions? This reviewer did not see anything new in this work over what has already been studied with Li metal over the past 50 years.

These are early days in Li work, according to another's view. The team still seems to have a fair amount of background knowledge to catch up on. Also, this reviewer suggested the PI try and tap into expertise at PolyPlus and/or Ohara on protective coatings for lithium metal. The carbon foam work looks interesting, but the reviewer would caution that the volume as well as weight impact has to be considered, since increasing the cell volume comes with an associated increase in weight and cost from the cell inerts.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments on tech transfer included that the technology has a good chance for technology transfer if it is made practical. Also, the information obtained from anode and cathode electrode films should have interest to industry. The portion of the work devoted to graphite current collectors may result in useful transferable technology. Current collector materials are for the moment a result of commercial and scientific interest.

A reviewer commented on a specific technical point in this section. It was shown that, on the Li anode, 'breakdown' of the resistive SEI barrier occurs instantly when higher current applied and after 'breakdown' resistive SEI recovers rapidly. No suggestions were given with respect to improving the safety when one uses highly reactive Li metal as the anode.

A reviewer said that Li cycling is very hard to address and robustness of C foam is an issue but the plan seems very good. Dudney's results to date have not generated information that will be adopted by cell developers.

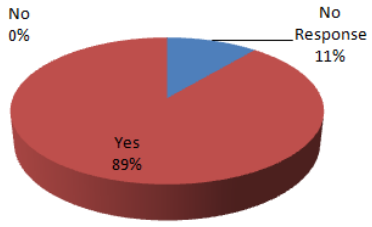
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Resources seem adequate and good work was done for funding obtained. Levels of effort are OK for this difficult, long range work. There were not enough results yet at this early stage for this reviewer to give a higher summary rating - not a reflection on PI or funding.

On the other hand, a reviewer said the funding for this project is excessive for the results obtained. Any resources in this project devoted to metallic lithium anode activity should be terminated immediately (in another's opinion) and redirected toward the graphite current collector study and development. The last reviewer cannot comment on this.

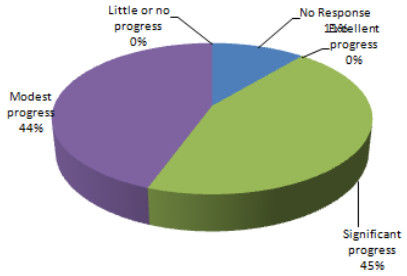
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries

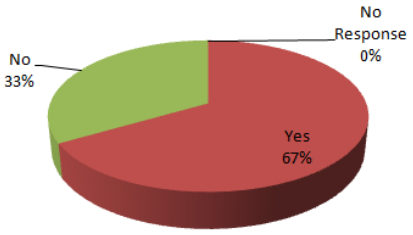
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



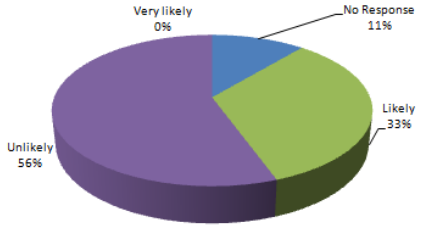
Question 3: Characterize the technical accomplishments and progress toward goals.



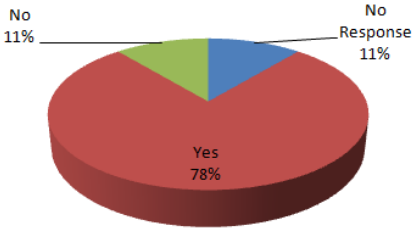
Question 2a: Are the goals of the project technically achievable?



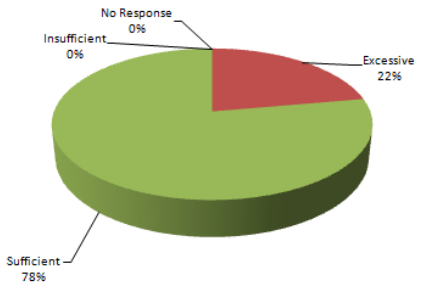
Question 4: How likely is the project team to move technologies into the marketplace?



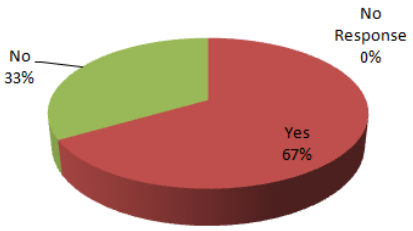
Question 2b: Have the technical barriers been identified and addressed?



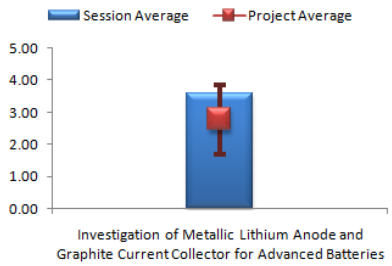
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Kinetics of Lithium Insertion into Silicon Anodes (V. Srinivasan, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated this work was very relevant, and another said that the modeling is relevant to support key technological targets in DOE OVT program objectives. A reviewer highlighted the modeling of Li-ion batteries: another said the work was addressing high energy anodes. A reviewer said that the work is focused on understanding the limitations of using alloy anodes for PHEV applications and is in line with the program goals. Srinivasan's work on Si anodes may lead to the reduction of oil consumption by providing better anode material for lithium ion cells for HEVs and PHEVs. The final reviewer noted that the basic modeling intentions of this work are useful, but the significant focus of this work on silicon and/or other alloy anodes is premature and should be re-directed.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A commenter said that this kind of support is needed to better understand silicon lithium alloys. A reviewer stated that the work plan is well laid out. Energy/Pulse power design curves look to be very useful for overall program direction.

To a reviewer, the modeling work in this project has very clear goals and a reasonable approach to adapt and validate model according to the change of the VT program. The estimation of PHEV battery performances starting from material performances is a very valuable work (a comparison with BYU modeling with Nelson to analyze).

For each new material synthesized and studied, a model is developed to perform thermodynamic and rate experiments. Comparisons are made between the model and data, extended to half and full cells and finally to battery systems. The project plan is an excellent way to complete studies on new materials.

The final reviewer said that Srinivasan's work on developing mathematical models of systems of interest by predicting the required characteristics of electrodes and separators in cells will lead to faster development of new material and its use in cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Overall comments were that this was very nice work in a new program. A reviewer said that the results are interesting in simulating the behavior of some new materials. A reviewer asked if the work could be extended to porous electrodes- that is where the reviewer believed ultimate interests lie. Srinivasan's methodology has produced useful results that can be used to focus the work of others who are developing materials for cells.

To one reviewer, the goal of this work was to compare the performance of various lithium-ion cathodes when used in HEV and PHEV applications using mathematical modeling. The model predicts that high energy efficiency can be obtained by 5 orders of magnitude I/aLi. However,

double-layer can sustain currents during short periods allowing lower resistance than predicted by the offset voltage. Models also provides guidance to material developers about how small a particle needs to be to achieve HEV power, and to cell developers about how thick should the electrode be for a PHEV battery application.

Extensive comments from another reviewer included that the offset potential between the lithiation and delithiation processes have been modeled and studied very well. This is similar to what is observed in real systems. The OCV at the different states of charge are very different from the OCV at the different depths of discharge. Improvements and further work on modeling will help understand the phenomenon better. An understanding of the side reactions occurring during the charge versus the discharge process may help understand the offset in potential. In-situ studies and characterization of surfaces may provide some insight into the two areas where there is a difference between the experimental data and modeling. This is an important aspect that can be extended to understand some safety characteristics of the li-ion cells. It has been observed that if li-ion cells are only 50% charged, their safety characteristics are very different from those at 100% SOC. Although this may not reflect the differences in the lithiation/delithiation process, it still looks like it may provide some insight into the better safety at lower states of charge.

The author presented modeling results on Si film anodes and explained the reason for hysteresis in terms of lithiation and delithiation voltages in silicon. Suggestions included that the modeling is based on thin films. But I understand this can be extended to real electrodes also.

While the basic modeling intentions of this work are useful, according to another reviewer, the significant focus of this work on silicon and/or other alloy anodes is premature and should be significantly re-directed toward carbon or graphite anode systems.

A reviewer pointed out a high rate of side reactions - is that an indication of poor purity in the cell fabrication? Could that be a reason for the high impedance? This reviewer said that fitting a model simply to charge-discharge curves is bad modeling. The team should make use of more available information - ac impedance, GITT, etc. The model does not seem to be matching the experimental data very well, and the proposed mechanism seems improbable.

A further commenter stated this was good work although obviously one has to be careful about using thin films for anything but fundamental work, as stated by the PI. This work seems to have shed new light on potential problems with Si not previously known (or at least not publicly appreciated). Energy/Pulse power design curves look to be very useful for overall program direction, assuming they are reliable and people actually use them. It was hard to form a judgment about this from the talk, which mostly was on the Si work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments included that the publications and BATT meetings are a good means to transfer the results to potential users and that the Energy/Pulse power design curves look to be very useful for overall program direction (this reviewer was not so sure about the applicability of the Si work).

The use of modeling to understand experimental data is a good method for understanding basic thermodynamic as well as kinetic properties. If a good model can be developed, it can have good marketing prospects.

The basic modeling capability which may be involved with this project may be useful to the wide community. The specific attempts to understand and model differences between lithiation and de-litiation processes has the potential to provide directly useful information but the scope of this particular focus seems to be too small compared to the total scope of the current project.

A reviewer stated that the PI needs to reach out to others within the BATT program to model their materials and help in identifying limiting factors. The PI needs to get a better feel for what "good" practical systems look like, and what are realistic magnitudes of the various components of impedance in well-made systems - that way, he would better be able to identify impedances that are artifacts of poor cell construction. This reviewer suggested that perhaps he could try modeling a commercial Asian-produced power-tool battery e.g. Panasonic's - such work would also benefit US battery companies.

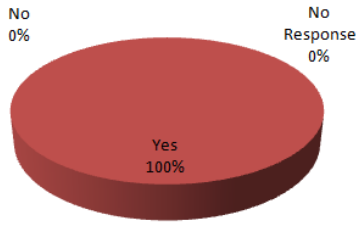
The final comment was that Srinivasan's methodology enables battery developers to determine what approaches may be useful to overcome technical barriers such as low round trip energy efficiency of cells at various rates. His methodology can be used to understand better experimental results that are not easy to interpret.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Please continue the good work, stated one reviewer. Another felt that the results and the work done justify the resources dedicated. A third said there was good work for funding obtained. Funding for this project is sufficient in another's view. A dissenting comment was that resources should be re-directed to focus totally or almost totally on graphitic or carbon based system modeling at this time. The last reviewer could not comment on resource sufficiency.

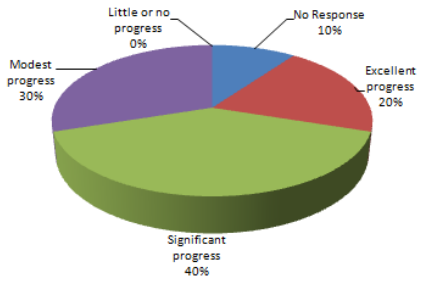
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Kinetics of Lithium Insertion into Silicon Anodes

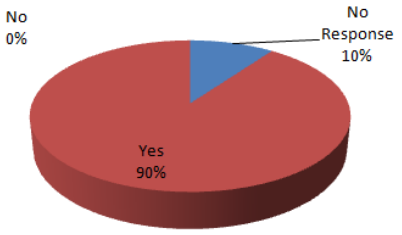
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



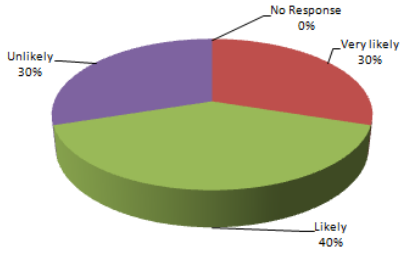
Question 3: Characterize the technical accomplishments and progress toward goals.



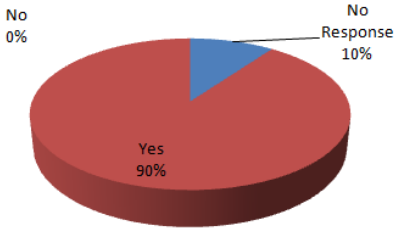
Question 2a: Are the goals of the project technically achievable?



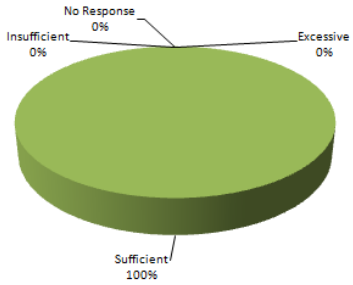
Question 4: How likely is the project team to move technologies into the marketplace?



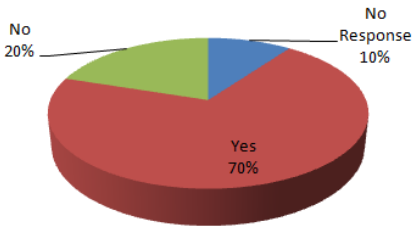
Question 2b: Have the technical barriers been identified and addressed?



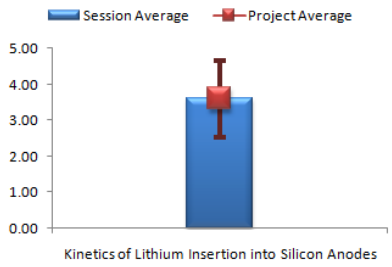
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Cost Graphite and Olivine-Based Materials for Li-Ion Batteries (K. Zaghib, of Hydro-Quebec)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments here were generally positive. Low-cost materials are a key factors leading to less expensive batteries. Low cost high power materials are obviously key to HEV requirements but PHEV applicability is not so obvious. Anode work by the only industry involved in BATT gives more relevance to the activity. Identification and use of suitable graphite materials for anode to reduce cost and improve performance is in correlation to the goals of the program. The work is related to development of materials for Li-Ion batteries. Information in the presentation is very useful for electrode manufacturing of $LiFePo_4$, which is a promising low cost material for HEV and PHEV batteries. Finally, Zaghib's work will lead to better batteries for HEVs and PHEVs, which will reduce our use of foreign oil.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
On a positive note, a reviewer said it was important to continue to evaluate negative electrode materials. To another, the project has valuable goals with an adequate strategy to achieve them. The PI has put forward a good team with National Labs to supply materials as per their needs for SEI study and characterization of carbon anodes. Good strategy and excellent implementation was how another characterized this very well-thought-out study. A reviewer said that if the PI finds something, he is obviously well-positioned to implement it as far as $LiFePO_4$ is concerned. A reviewer did think the goals were unclear, however.

A reviewer commented that new graphites are required due to the stoppage in production of MCMB by Osaka Gas Company, and the project has tested new synthetic graphites. Similarly Zaghib's development of a water soluble binder (WSB) to replace the more expensive PVDF may result in a lower cost cell with comparable performance. His work on an alternative anode carbon material to replace MCMB may lead to additional cost savings.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Reviewers offered many detailed comments here. A reviewer said that Karim's work is world class and his studies on moisture uptake by olivines are very useful. Very good results in various complementary areas, stated another reviewer. A reviewer said that several new materials were identified and under study. A reviewer queried whether the team could focus on cheap natural graphites as anode materials with some modifications. To another, the work shows how the phosphate needs to be handled and also some long term stability: all important parameters for a battery manufacturer to obtain long life for batteries having the iron phosphate material.

Accomplishments were noted by several commenters. A reviewer said that it was shown that OMAC-15 and SNG12 are suitable as alternatives to graphites. Comparable first cycle current efficiency was obtained with graphite fabricated with WSB or PVDF indicating WSB is a suitable substitute for PVDF in Li-ion cells with SNG12 anode and $LiFePO_4$ cathode showed higher rate capability than

comparable cells with MCMB and OMAC. High rate performance was obtained with SNG12 anode and $LiFePO_4$ cathode materials. Significant water absorption by olivine compounds is observed, but is reduced by appropriate drying and storage. Water content is concluded to be a determinant factor on the performance of olivines. Another said that comprehensive work was carried out to understand the performance of new graphites and the effect of water on the cyclability and performance of the cells with the new graphites. Different binders have also been studied. Zaghib has completed work that shows that it may be possible to use WSB and a new carbon material for the anode in lithium ion cells to reduce the cost of cells.

Several suggestions were offered. The project may benefit if completed cells are constructed and the thermal properties studied using calorimeter methods in collaboration with Sandia. The abuse tolerance of the cells with the new graphites should also be studied. The processing of graphite anodes with water soluble binder work and their comparison with PVDF should continue. More electrochemical characterization of water soluble binder binders should be done. Studying the mechanism of SEI formation on new anode materials should be encouraged.

A reviewer commented that the project is useful in terms of investigation of factors which affect electrode manufacture and in manufacturing electrodes to supply to other BATT researchers. Investigation and validation of WSB's is useful. However, it seems unnecessary or excessive to devote nearly an entire BATT project to these two topics. A project which would involve more focused and exploratory activity might be more appropriate. For example, investigation of the differences at the fundamental level between electrodes using PVDF vs WSB binders and investigation of the fundamental mechanisms for these differences might be more appropriate topics. As a BATT project, the project should not investigate materials cost (in this case, of graphite) as a significant factor.

Another stated that this task seems very unfocused - lots of incremental work on a variety of projects. What is the overall goal of this task? It is not clear, and it is not clear how this task contributes to the battery community as a whole. To this reviewer, the topics do not match BATT's goals of long-term high-risk research. The work is well done and the analysis is sound, it just isn't clear why this is part of the BATT program as opposed to ATD or the USABC developer program.

A final reviewer said that HQ has been an important and reliable contributor to many other groups in the program, and the water-based cathode work seems successful. This reviewer was unsure on the benefit of going down this road vs. addressing all the other problems the program is facing.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The move to the marketplace was encouraging to some. These are key materials for usage in advanced batteries, stated one. Another felt that this was good work that shows promise for identifying new anode materials, and will lend itself easily for technology transfer as well as marketing. A reviewer noted that the company has products already in market place or in the process of commercialization. Similarly, a reviewer commented the technology was already in batteries that are high performing. A reviewer said that the project will help other BATT researchers in their activities. Presentations and collaborations are reasonable ways to transfer knowledge and technology. Zaghib's work is probably being adopted by battery producers based on the success he has had in this project. A final reviewer stated that other companies are already using water-based coating technologies for various systems. This reviewer did not see that HQ's will necessarily add to the state of the art nor be the one that is implemented.

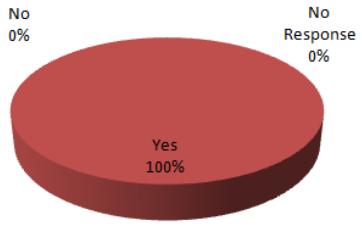
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Funding was sufficient to one reviewer: to another, the question was hard to analyze, but resources seem adequate. A third said that there was good work for the funding obtained. A fourth reviewer could not comment.

A reviewer was glad to see that they are building a dry room to make real cells for the program. This should address a key failing in previous years where contracting the work out basically failed in that the cells had poor quality, were expensive and not well-defined or understood. In particular, those cells actually wasted PI time by generating data on poor cells that were very misleading and diverted attention from the real issue - making good cells to test. This reviewer was glad to see the DOE program is going to fix this problem rather than trying to live with it. Expect rating to increase next year to reflect this work.

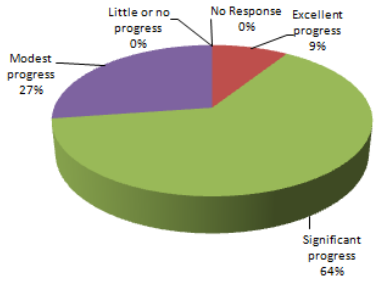
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Cost Graphite and Olivine-Based Materials for Li-Ion Batteries

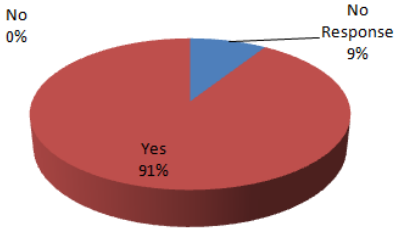
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



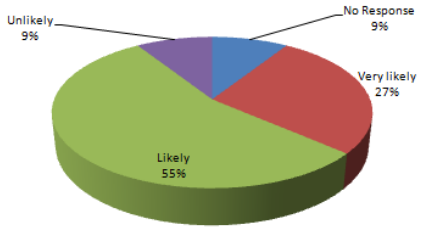
Question 3: Characterize the technical accomplishments and progress toward goals.



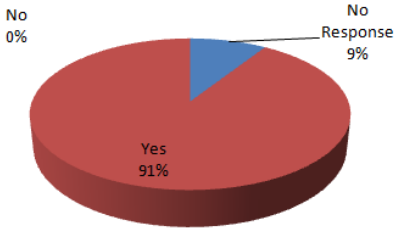
Question 2a: Are the goals of the project technically achievable?



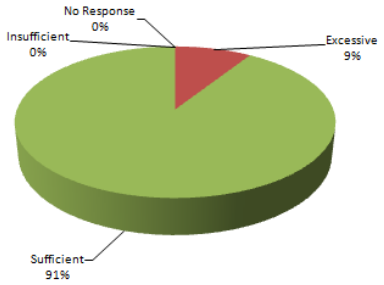
Question 4: How likely is the project team to move technologies into the marketplace?



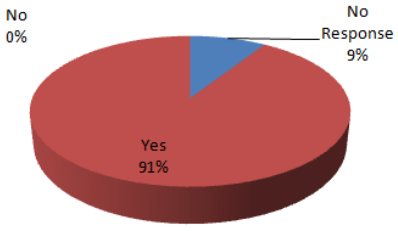
Question 2b: Have the technical barriers been identified and addressed?



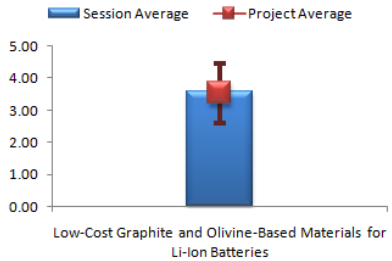
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Microscale Electrode Design Using Coupled Kinetic, Thermal, and Mechanical Modeling (A.M. Sastry, of University of Michigan)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were generally positive. One reviewer felt it is very relevant to the understanding and development of cell technologies, while another person stated that modeling is a cross-cutting technology very relevant to achieve DOE objectives on battery development. One other respondent stated that using simulations to determine optimum electrode compositions is in line with the goal of the program. Another wrote that the work is related to modeling and optimization of electrodes for Li-ion batteries. One reviewer commented that this work has great insight in understanding electrode design, which is needed for any HEV battery. One final reviewer added that Sastry's work will probably lead to better batteries for HEVs and PHEVs, which will result in lower oil consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were again generally positive. The first respondent wrote that the project has a productive strategy with clear vision and actions. The previous year work has already demonstrated the capacity of the research team to identify technical barriers and solve them. Another reviewer commented that Sastry uses highly sophisticated tools to model and analyze the electrode characteristics, while one other reviewer indicated that there is a very good team in place to address the technical barriers encountered in electrode material optimization. One reviewer noted that understanding the electrode compositions, morphology, etc. with modeling is the basis of the strategy. It is an important piece of work that needs to be done to provide a place to start. Experimental results can then be used to refine the models and continue with providing guidance to electrode manufacturing. These studies will provide insight into limitations for short life and can help improve life by improving materials and compositions. Another individual remarked that the group is looking at real problems that have applications to many cell designs, both in and outside EV/HEV program. One reviewer stated Sastry's work on modeling mechanical aspects of materials for cells is useful to companies in their quest to overcome barriers to produce better batteries for HEVs and PHEVs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer indicated that the project is producing valuable and effective results of importance for material developers and battery manufacturers. The approach must be continued to be systematically applied to all the materials and key barriers affecting battery performances, including battery production processes. Similarly, one person wrote that Sastry's work is really helping us in theoretically understanding the complex relationships that govern the properties of an electrode. These are great results and this reviewer would love her to continue this work with an eye towards PHEV systems. One other respondent commented that Sastry's group has produced results that are relevant to battery manufacturers. Sastry's results indicate that coating active particles instead of using carbon conducting filler material may be worthy particularly of consideration by cell developers. One reviewer suggested that the group should continue working with an experimentalist to redefine theoretical parameters like intercalation stress, morphology versus cycle life, etc. The authors have

addressed very challenging modeling work which includes packing or tapping density, particle morphology, and intercalation stress. These effects are often interrelated and the authors have done a very good job in decoupling these and studying the effects. One reviewer concluded by commenting that the researchers presented very good progress and the results could help the OEMs achieve better cell performance.

One response noted that Dr. Sastry showed that conductive coatings result in low contact resistance, which is obvious, but using carbon black/PVDF composite coatings was shown to be more advantageous than the addition of conductors (e.g. graphite) to composite cathodes in improving conductivity for all baseline materials investigated. Another reviewer remarked that it was hard to follow as there was so much presented, but this PI does world class modeling and offers excellent insight into electrode design – bridging the fundamental and applied parts of the program.

One reviewer asked why the PI cannot work on a concrete system such as L333 material or olivine? That would be a platform for testing the models. Another reviewer pointed to the effect of aspect ratio on stress - please consider the orientation of the long axis with respect to the crystallographic axes. Most materials of interest have an anisotropic volume change with the degree of intercalation. One final reviewer wrote that modeling, electrode designing, experimental testing (by collaboration) and then analysis and then remodeling at the 3D level are the focus. The composition and electrode manufacturing methods have been found to be very important. Determining the effect of packing on conductivity is a good approach. Ionic as well as electronic conductivity have been studied. In the stress study, there is a disagreement between theoretical and experimental data. Consideration of activation energy and polarization effects may help with getting better results for the intercalation process understanding. There needs to be more 3D modeling to better understand real systems.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first response commented that these results can be easily transferred to developers, while another reviewer indicated that there are many technology transfers in place via publications and direct contacts. One person felt that the results are relevant for industry in the fabrication and optimization of electrodes for Li-ion batteries. Another reviewer stated that the group is looking at real problems that have applications to many cell designs, both inside and outside the EV/HEV program. One other response commented that Sastry has produced useful modeling results concerning the design characteristics of cells for better batteries.

One person stated that, if the modeling method were more flexible, it may have better marketability. This is an excellent starting point for students and researchers, but there is a long way to go before this model can be used for comparison to real systems, as there are a lot more factors involved in a real system than just a one-dimensional model. One final reviewer commented that many of the results seem somewhat disconnected from what is seen in the industry experimentally.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

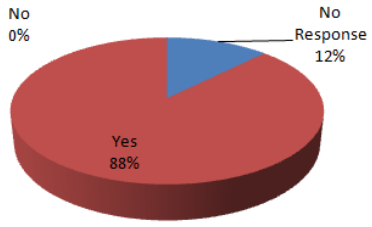
One reviewer recommended that the funding be increased. Others felt the funding was sufficient as is. One person commented that the resources are adequate to the work done, while another wrote that there has been good work for the funding received. One individual suggested keeping funding at the current level; the PI is doing value-added work with what she has and the amount of work done is actually very impressive. One response stated funding for this project is sufficient.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

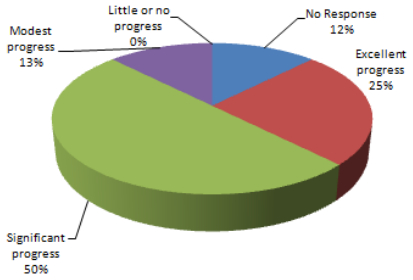
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Microscale Electrode Design Using Coupled Kinetic, Thermal, and Mechanical Modeling

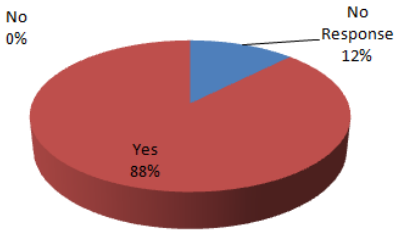
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



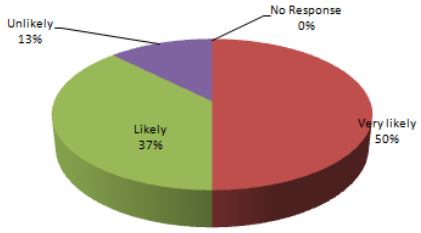
Question 3: Characterize the technical accomplishments and progress toward goals.



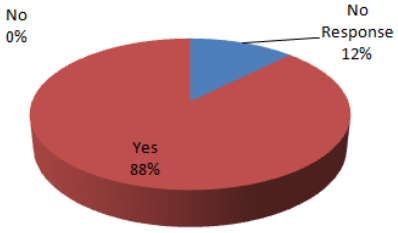
Question 2a: Are the goals of the project technically achievable?



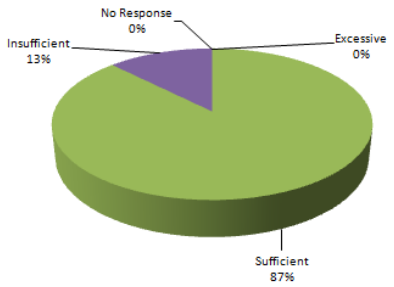
Question 4: How likely is the project team to move technologies into the marketplace?



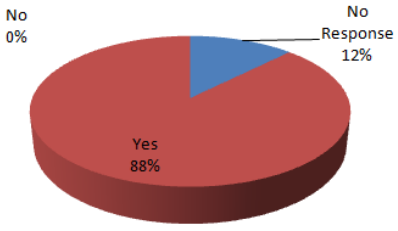
Question 2b: Have the technical barriers been identified and addressed?



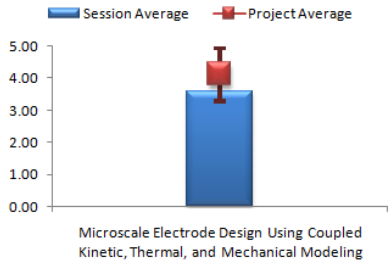
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces (G. Smith, of University of Utah)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The work is related to modeling of electrolyte system for lithium-ion batteries. Modeling and simulation is essential in understanding and developing new electrolytes. Similarly, modeling of Li components is functional to the development of optimized Li batteries, and is relevant to the DOE program. Modeling is used to study lithium-ion transport and provide models and suggestions to improve transport properties at low temperature which is in conjunction with the program goals. The dissenting review opinion was that Smith's work is unlikely to produce better batteries for HEVs and PHEVs. Consequently his work is unlikely to result in reduced consumption of oil.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The authors are using sophisticated methodologies to come up with tools to understand the interfaces. The PI is addressing the modeling challenges for understanding the interfacial behavior at the surface of the electrodes and electrolytes with respect to Li-ion diffusion. After the revision two years ago, the project has defined clearer and more reasonable targets and an acceptable strategy to perform simulation in strict collaboration with the experimental groups, better supporting the material and component R&D. A reviewer noted the use of quantum chemistry calculations to understand basic transport properties, and that the team will provide models to users and collaborate with experimentalists to compare data and then predict new materials for future use. A reviewer expressed the viewpoint that Smith's approach is unlikely to yield useful results for battery developers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Reviewers had positive comments for this prompt: a reviewer felt there had been excellent progress, and believed their current and future work are well thought out. The reviewer was optimistic that these will lead to a better understanding. The project is starting to give interesting results, even if the progress is quite slow in supporting material and components, stated another reviewer. However, the established collaborations are being effective in improving the effective use of this modeling activity. Alternatively, Smith's work has not produced much useful information for battery developers, according to another reviewer.

In more detailed commentary, a reviewer wrote that the authors state that they have established a first-generation atomistic model for $LiFePO_4$ based and a quantum chemistry-based atomistic model for poly(vinylenecarbonate). It was not clear how these findings can lead to improved performance of these materials.

The team has developed simulations for carbonate-based solvents with different salts and salt concentrations. Interfacial properties have been shown to be dependent on the choice of electrolyte and salt. Lithium transport properties have also been modeled for different electrolytes such as ionic liquids, liquid electrolytes and polymeric electrolytes. Other work includes models for cathode materials and additives as well as to simulate chemical reactions. The model is insufficient as it does

not take into consideration all the components of an electrode. The growth in modeling methods with the use of cathode active material and an additive shows that it is positive. But all the components in the electrodes (active material, carbon, binder, additives, etc.) and then a completed cell need to be considered to get a practical picture and to make predictions for practical use. Several modeling techniques and programs exist in the market. Sandia, in collaboration with Dr. White (USC), has done some very good work on modeling li-ion batteries. Some collaboration or consultation with them may help.

Modeling of temperature dependence of Li ion conductivity in ionic structures is an important step to the understanding the transport property. The reviewer suggested that the authors should continue this work as they are in collaboration with experimental groups like Clemson University.

The scope of the project may be too great. Narrowing focus to concentrate on non-ionic liquid electrolyte conductivity modeling, phenomena involving non- ionic liquid electrolytes, SEI formation phenomena in non- ionic liquid electrolyte systems, and the future planned work with modification of the anode with polymers and transport in SEI components may be more productive.

A reviewer was glad to see the new work on liquid electrolytes. However, the particular electrolytes selected for study are not of interest to industry for a variety of reasons. The PI should talk more with industry or with people in the ATD program (e.g. Jansen at ANL, Smart at JPL, and Jow and Xu at ARL) to learn what electrolytes are of more relevance to the battery industry. This reviewer was very glad to see that future work will focus on issues at low temperature - this is very important. The PI should collaborate with Xu, Jow, Jansen, or Smart on that project - they are much more in tune with state of the art than the PI presently is.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

On the positive side, technology transfer is now acceptable to one reviewer. To another, much of the work in this project provides information which is directly transferable to the marketplace.

A reviewer was of the opinion that the work was not advanced enough for technology transfer or marketing. But the reviewer thought this work is very important from fundamental science view and is a very good match for BATT program.

A reviewer suggested that the PI needs to learn the state-of-the-art so that he does not continue to focus on irrelevant electrolytes. A final comment was that Smith's work is not yielding useful results for battery developers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

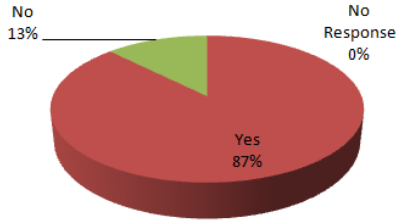
The resources are adequate to one, and excessive to another relative to the useful results. A reviewer did say that although the modeling work is behind with respect to technology level, the volume of work done is sufficient for the funding obtained. In general, resources in this project which are devoted to the study of ionic liquids should be re-directed toward the other current and planned areas of activity for this project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

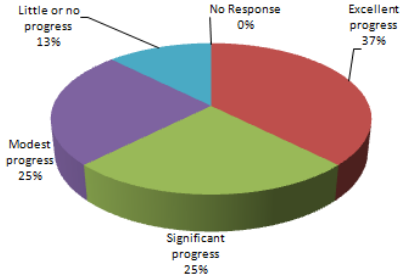
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces

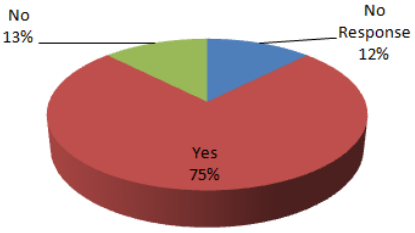
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



Question 3: Characterize the technical accomplishments and progress toward goals.



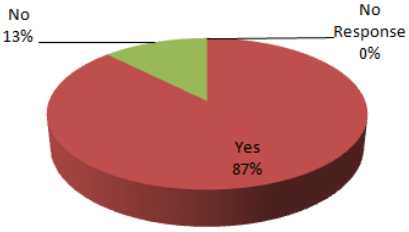
Question 2a: Are the goals of the project technically achievable?



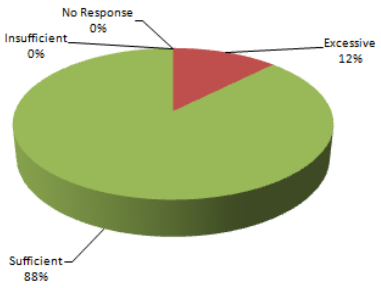
Question 4: How likely is the project team to move technologies into the marketplace?



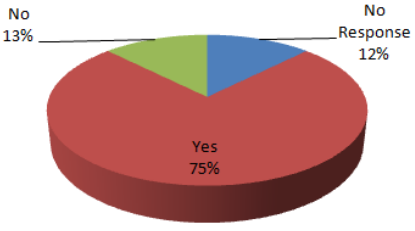
Question 2b: Have the technical barriers been identified and addressed?



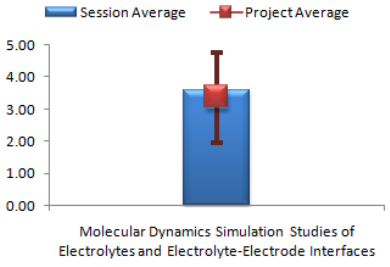
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Nano-Structured Materials as Anodes (S. Whittingham, of State University of New York-Binghamton)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer said that work on safer and less costly anodes is very relevant to the DOE program. Similarly, a reviewer felt that the project is looking for new anodes to replace the carbons to have anodes compatible with the improved anodes, which is in support of the program goals. A reviewer said that metallic anodes can lower the volumes of batteries and provide higher volumetric capacities. They could also be potentially safer compared to carbon anodes, all of which is the goal of PHEVs and HEVs. A reviewer said these anodes are needed for long range PHEVs and EVs. One reviewer simply highlighted development of anodes for Li-Ion batteries. A reviewer stated that Whittingham's work will probably lead to development of better anodes for use in lithium batteries for HEVs and PHEVs which will lead to less oil being used for transportation. A final reviewer said that this project supports overall DOE objectives, but only with a very long term focus.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Statements regarding the goals and barriers included that the program still does not have a strong focus, and that the project focuses on a few and well defined targets with a clear approaching strategy. The scientific and technological choices and activities should be integrated by economical evaluation. A reviewer said that the study of alternate cathodes for safety, low cost and high volumetric energy density is in sync with the program's strategy of achieving high energy density and power density li-ion cells for PHEV. A reviewer felt that the author has a comprehensible plan with industry and National lab for studying their anodes. One characterized this as a high risk project, but very worthwhile pursuing. A final comment was that Whittingham's work on producing new anode material will help battery producers break through technical barriers associated with the anode material in lithium ion cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Technical comments on this question were received in several areas. A reviewer stated that the increased capacity has been achieved for various materials. Another noted that stability is improving: this should be the main focus of next year. Behavior at low temperature should be analyzed. Cost analysis should support the material selection. A reviewer said that given the challenging task, this program has made great progress. The Si-Co-C looks very promising. Further, Whittingham's work on MnOx as an anode material has produced results that may be used by lithium ion cell producers.

More specifically, a reviewer offered comments that a wide range of new anode materials have been studied. New materials are being explored that will be compatible with low cost manganese based cathode materials especially those that will help prevent gas accumulation in pouch cells. Improvements in volumetric energy densities in comparison to the existing carbon have been studied by going to these new materials. The testing using suitable electrolytes provides a more comprehensive understanding of the workability of the new anodes. The safety of the new materials needs to be studied at the cell level.

Another reviewer's detailed comments stated that Sn-C0 and MnO_2 anodes look promising but how does the capacity retention look at 50 cycles or above? How much is the volume expansion at full lithiation? This reviewer said that it looks like the team has been working on similar stuff (like MnO) for quite a bit of time. It is time to move on to other high capacity anode systems.

A further set of comments began with the observation that the voltage profiles for the Mn oxide anode show very high resistance - why for a nano material? Is this material appropriate for high power applications? What C rate is used for cycling? This reviewer wanted this included on the graphs. For future work on Sn the team should include C rate as well as DOD as a variable in the cycling study. The PI claims to be focused on safety, yet no safety data is shown. How do we know that nano materials are safer than micron-sized carbon? Please collaborate with ANL or SNL to compare safety to carbon.

A final commenter said that Si cells seem to be nosediving. Hopefully with the new cycling and more time, cycle life testing can be extended out further. Sn looks better to this reviewer.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that the topic is very sensitive to industry interests. The collaboration with various national labs is an effective way to favor technology transfer. Another said that technology transfer has been carried out and the product has great prospects for commercialization based on the extensive collaboration with battery manufacturers. A reviewer said that if successful, every battery company would like to have this type of material. A reviewer observed that technology transfer is occurring through peer reviewed publications and work with industry. The collaboration with Primet is good. While the project may achieve advances sufficient for transfer to the marketplace, this would most likely be in the area of battery systems for consumer electronics (given the basic properties and present costs of intermetallic compounds) in the shorter term, rather than in the area of battery systems for automotive applications. This is a long-term low likelihood-of-success goal, stated another commenter. But the fact they are working with an outside company to make the materials and also teaching them to make and test cells is encouraging. Finally, Whittingham's results on MnOx are useful and will probably be adopted by lithium ion cell developers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One felt that the effort planned for the coming year seems to require more resources. Another similarly stated that more funding could be provided for the good work performed. One said that funding for this project is sufficient. One could not comment on the resources.

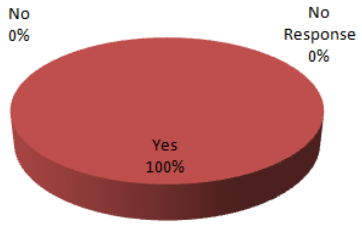
More detailed comments included that the future work is good but that some emphasis should be focused on electrode making, so that optimum cycling can be obtained, which is a challenge with probably a very hard to formulate material. Another said it was a bit early in this work to judge, but this reviewer remained optimistic. The program needs to be coordinated with ANL's - they seem in part to have very different beliefs regarding Si. The differing beliefs may be OK, but the labs should still be working together.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

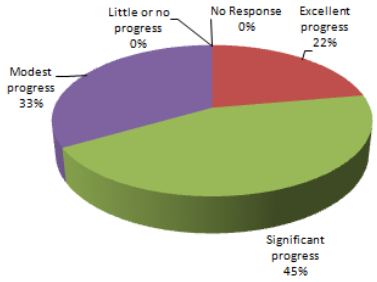
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Nano-Structured Materials as Anodes

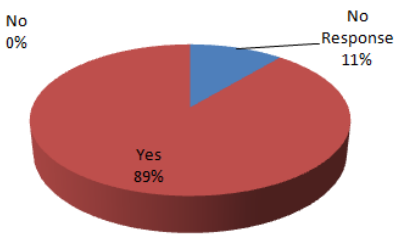
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



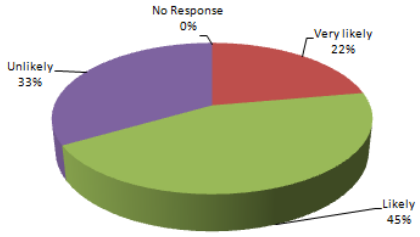
Question 3: Characterize the technical accomplishments and progress toward goals.



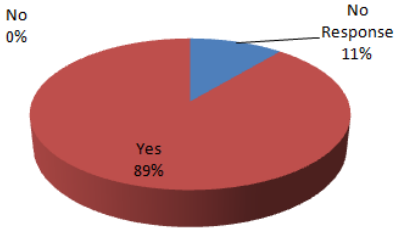
Question 2a: Are the goals of the project technically achievable?



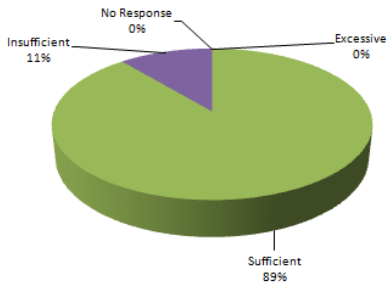
Question 4: How likely is the project team to move technologies into the marketplace?



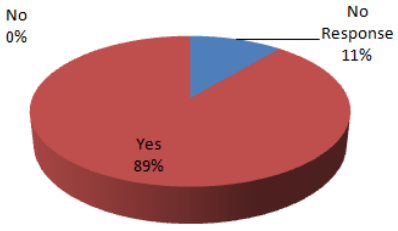
Question 2b: Have the technical barriers been identified and addressed?



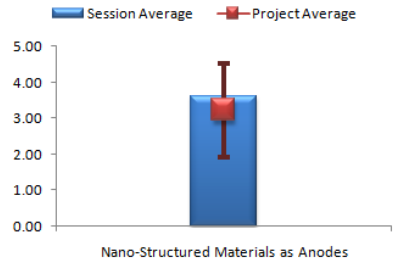
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Nano-Structured Metal Oxide Films (A. Dillon, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer saw the project as very relevant. Another comment was that novel anode materials are necessary to meet better DOE objectives of lower cost and higher performances. Similarly, the use of a less expensive anode material with the goal of less cost, durability and performance are in line with the goals of the PHEV program. The work involves synthesis of high capacity anode materials for Li-Ion batteries. Dillon's work may lead to better anodes for lithium ion cells which will lower oil consumption through HEVs and PHEVs.

A more detailed comment was that the project provides some new useful information regarding MoO_3 as a potential future anode material which may be of interest in the long term. However, it is unclear that the process used to produce the nanoparticles could ever be developed into a practical or feasible high-volume process. In a related statement, a reviewer felt that with its high potential (1.5V vs. Li), MoO_3 cannot be used (in this reviewer's opinion) for PHEV despite its high capacity. For HEV this reviewer did not believe there would be an advantage anyway - do we even need a new anode? MoO_2 may be worthwhile.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The approach is well described and reasonable (to one reviewer) with activities of fundamental (characterization) and practical/technological (low-cost production process) nature. The technical barriers are appraised and well-addressed with an organized planning. The choice of MoO_3 deserves interest for the intrinsic technical features (high specific capacity).

Another reviewer noted that electrodeposition methods have been used to make porous MoO_3 materials for anodes. The project strategy is in conjunction with the goals of the program. Another said that good work was done on MoO_3 but this does not seem to be a promising material: future work with MoO_2 may be worthwhile.

Dillon's work may lead to low cost MoO_3 anodes for lithium ion cells. This anode material has demonstrated value in the form of nanoparticles. Dillon's work may provide help to cell developers produce practical electrodes from the two micron particles. Her hot-wire chemical vapor deposition process may be capable of producing useful MoO_3 particles which can be harvested and used as an anode in a lithium ion cell.

Other comments were that the project team has already made good progress in the project, but that the determination that the related process could be scalable or viable is unclear.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
To one reviewer, good progress has been made in obtaining a good method to obtain the materials for the new anode. Testing has shown that at least 150 cycles have been obtained with negligible loss of performance. This was a good synthesis effort to a reviewer's eye and the electrochemical performance

is robust till 150 cycles. The scale-up effort looks promising. The reviewer suggested the team must pursue an effort towards enhancing the rate capability.

To another, these are excellent results: this reviewer had one suggestion for experimentation. Have the authors looked at tuning the voltage (lower) by using dopants? A reviewer stated the determination that the related process could be scalable or viable is unclear.

This is good technical work on MoO_3 - combination of synthesis, characterization and modeling. But this reviewer did not see how the voltage penalty of 1.5V vs. Li with MoO_3 could be overcome. Dillon's material has a high capacity, but also a high potential. However, her material may be suitable for use in high potential cathode cells.

The accomplishments are very interesting and complete, stated another. The technical performances are impressive (in excess of 500 mAh/g). The cost aspect of the inexpensive process is another important achievement of the project. Samples of the anode should be circulated in BATT for parallel evaluation with various cathodes and electrolytes.

Detailed comments from another noted that MoO_3 nanoparticle electrodes fabricated with electrophoresis are shown to have a reversible capacity of 630 mAh/g, delivering around 500 mAh/g at 2C rate (2 μm thick). The nanoparticles are made with an inexpensive HWCVD technique that has been scaled-up such that properties in thicker electrodes may be optimized. Coin cell testing, employed for 100 μm thick films with 70% MoO_3 nanoparticle active material in collaboration with the University of Colorado, revealed the same high reversible capacity as the thin film electrodes with only slightly diminished rate capability. By modifying the HWCVD synthesis conditions it may be possible to produce MoO_2 nanoparticles.

This task has covered a lot of ground in little time and is doing a great job of getting up to speed in the lithium-ion world. The PI is showing creativity in developing new materials and in combining diagnostic techniques with modeling to understand the materials.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Dillon's material shows promise for further development by cell manufacturers. The technology will move forward (in one reviewer's opinion), as evidenced by the license agreement they are working on. This new material already has interest from industry and adequately transferred, stated another. A reviewer saw that technology transfer seems to be in work already. A reviewer felt there was good progress in technology transfer, both industry and technical publication. A reviewer did reiterate the voltage penalty of MoO_3, however.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

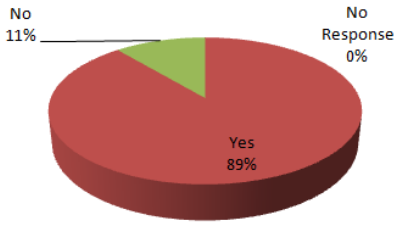
Funding for this project is sufficient, stated one reviewer. Likewise, the resources are adequate to the planned efforts for another reviewer. Similarly, a reviewer noted there was good work for the funding provided. A reviewer expressed the view that for future work, the intent or scope of activity related to pre-lithiation is unclear. A reviewer recommended discontinuing MoO_2 work, but DOE should continue to fund MoO_3 if it is believed high capacity at <1V vs. Li can be achieved. The final reviewer could not comment on the resource sufficiency.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

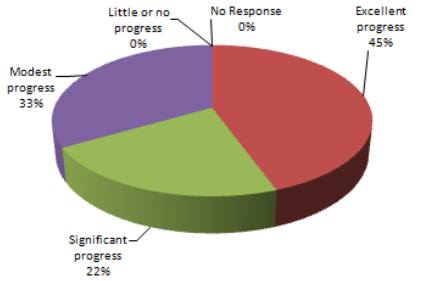
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Nano-Structured Metal Oxide Films

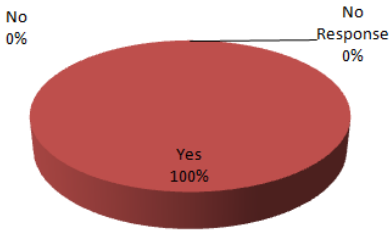
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



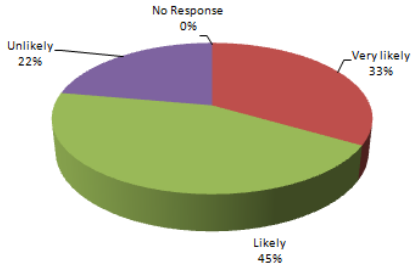
Question 3: Characterize the technical accomplishments and progress toward goals.



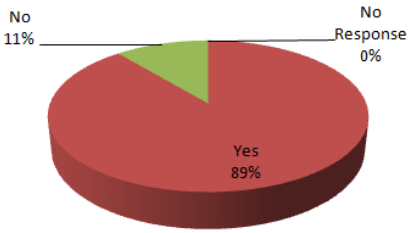
Question 2a: Are the goals of the project technically achievable?



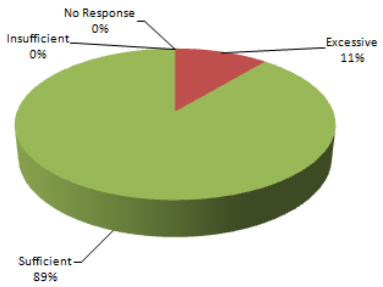
Question 4: How likely is the project team to move technologies into the marketplace?



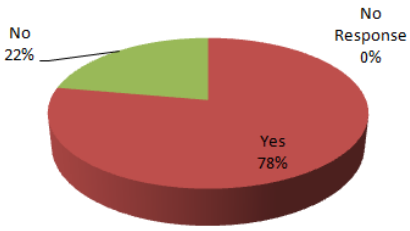
Question 2b: Have the technical barriers been identified and addressed?



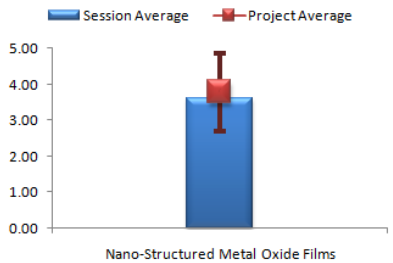
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization (D. DesMarteau, of Clemson University)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Lithium salts are key to cells with improved performance and safety, stated one reviewer, who also felt the U.S. has fallen behind in this field. New electrolytes are important for meeting DOE goals, said another. Development of new electrolytes for li-ion batteries was highlighted by a third reviewer. Improvements in electrolytes will be used to meet the goals of the program by improving ionic transport leading to increased capacity and increased power capability and in the end longer life. Finally, DesMarteau's work will probably not lead to better batteries for HEVs and PHEVs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The PI has addressed all the above points and looks like the project is well on plan, said a reviewer. A reviewer also stated that the team has done good technical work, and the focus on binders seems appropriate as long as stability to high voltage is acceptable for these materials. The reviewer noted that the selections in the multiple-choice questions refer to the low likelihood of success for the past work on using a salt as an electrolyte.

A reviewer said that ionic melts were used to improve ionic conductivity, and new flouropolymers were also synthesized for use as binders for cathodes. The approach is interesting because it aims at solving key problems of current electrolytes by studying novel electrolytes.

On the other hand, a reviewer would recommend that the authors pay attention to the cost of these exquisite electrolytes. Even if they come out with a solution but it is expensive no developer will have any interest. Also, this reviewer would shy away from using plasticizers. The final comment was that DesMarteau's work is unlikely to yield material that will be useful for batteries.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Good technical work, said one reviewer. The PI did what he set out to do in making these new materials and characterized them properly. There was nice collaboration/learning from Kerr at Berkeley to address the cathode manufacturing issue. In view of the synthetic work involved, they have accomplished a lot in the time. Furthermore, results on both the ionic liquid-based electrolytes and the new additive for cathodes are promising. More experimental work is required to confirm them: (1) At low temperature, and (2) in higher voltage cathodes and cells.

The authors have designed new electrolyte which addresses existing problems in Li salt electrolytes like low transference number, conductivity, etc. The effect of these new electrolytes on cell capacity and cyclability was examined. The second part of the work involved new ionomer as cathode binders. The reviewer suggested that work should be directed towards understanding the SEI formation on anodes for these ionic liquids. This work should be continued, but greater focus should be put on the lithiated fluoropolymer activity, and more specifically on demonstration of improvements in any areas of performance via implementation of the fluoropolymer as a binder in the cathode.

In this presentation, it was stated that the lithiated electrolytes comprised of low-lattice-energy anions on a fluoropolymer backbone have been synthesized and are available for use in formulating high-voltage cathodes. Although the authors stated that improved performance is expected in terms of high-rate charge/discharge, capacity utilization, and capacity fade, no results are there yet to support the claims. It was also stated that (1) the use of $Li_4Ti_5O_{12}$ electrode provided zero-strain intercalation / deintercalation of Li+ and does not form SEI, (2) Adding PEGDME to the electroltye increased transport by decreasing viscosity and decreased Li+ transference number, and (3) adding di-lithium salt of fluorosulfonimide Fluorolink E electrolyte to the cathode formulation increased transport properties within the bulk of the cathode. These are good accomplishments, but need to be independently verified.

The ionic conductivity was characterized and the ionic melts were tested with typical cathodes and anodes in a complete (swage-type) cell and changes made to make it work. Good work was done on completed cells. Good work has been done with the electrolytes for cathode binders. It will be good to carry out tests on completed cells as planned. Use of additives or other changes in the structure may improve its room temperature performance. Its compatibility with the rest of the cell components should also be determined if used as binder in cathodes.

For the ionic melt polymer electrolyte, the reported conductivity is 100 times lower than the liquid electrolytes in use in batteries today. This poor conductivity is reflected in the dismal cell performance - major rate limitations even at C/5. This reviewer was glad to see that the PI has realized these limitations and is stopping work on this project. The reviewer thought that the ionomer binder was an interesting idea. The main performance criterion for binders is how much binder (weight percentage of electrode) is required to achieve adhesion to the current collector. The reviewer asked that the PI show adhesion measurements. It may be useful to work together with Gao Liu at LBNL on this work. The reviewer also asked that the PI show measurements of cell impedance indicating whether the new binder actually gives any benefit to cell impedance.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Technology transfer is underway by publications and confirmation of the results may open the way to commercial implications. Important ionic liquid electrolyte work was another positive statement on this work.

The PIs have acknowledged the issue with low temperatures and are redirecting the work appropriately to binders. Also, the materials being considered are PEO-free and should overcome the instability of PEO to high voltages. Going forward this reviewer would still like to see them clearly identify what benefits their proposal to work on binders would give over conventional binders – this reviewer “must have missed that.”

According to a less-positive comment, the current electrolytes are not novel enough (they need plasticizers) to be of commercial interest. DesMarteau's work has not produced material that is on interest to battery developers, stated another.

There are a lot of different electrolytes already available in the market for polymer li-ion cells. But if really outstanding results are obtained there is a good chance for the technology transfer and marketing. At this point the results are not significant.

Other statements included that continued work with ionic liquids may result in transferable technology, but the activity with fluorinated polymers as binders may offer a greater opportunity for

more significant transferable technology. It was suggested that the PI might wish to talk with companies like Arkema and Solvay that make PVDF.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

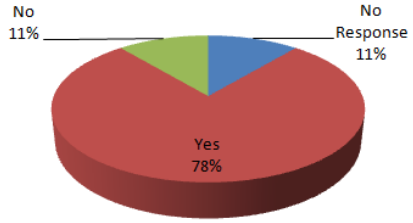
Several comments were received here: first, the resource and efforts seem reasonable even if some acceleration would be desirable in verifying performances. The second commenter said there was reasonable work for funding obtained. A reviewer suggested that the resources should be split more evenly between the work with lithiated fluoropolymer binders and the work with ionic liquids, with more focus on lithiated fluoropolymer binders. A reviewer recommended continuing this work at the current level. This reviewer's overall rating reflects the fact that the past work has not really led to practical materials, but the future work on binders is promising. The reviewer liked their approach and they have learned a lot in the last 18 months. The final commenter dissented, saying funding for this project should stop because no useful material has been produced even though this project has been funded for many years.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

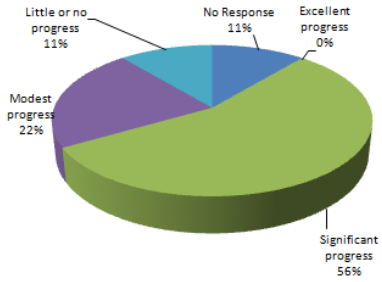
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization

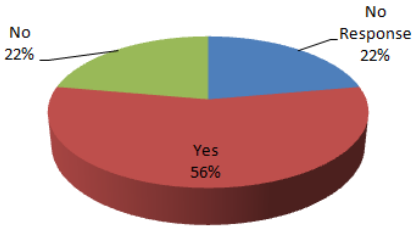
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



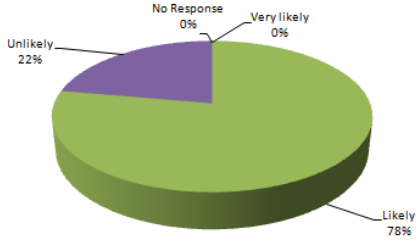
Question 3: Characterize the technical accomplishments and progress toward goals.



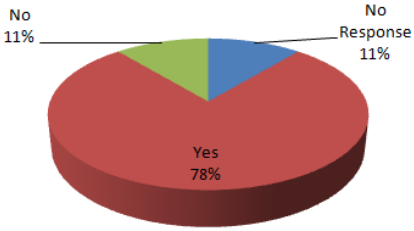
Question 2a: Are the goals of the project technically achievable?



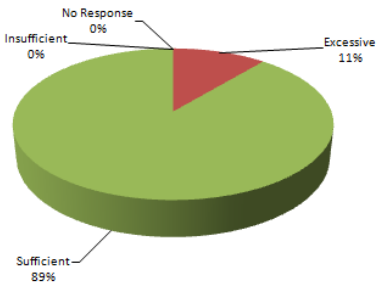
Question 4: How likely is the project team to move technologies into the marketplace?



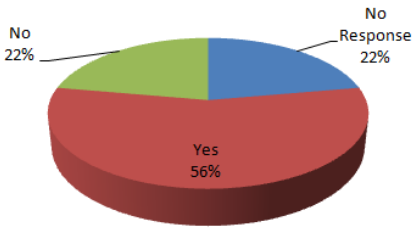
Question 2b: Have the technical barriers been identified and addressed?



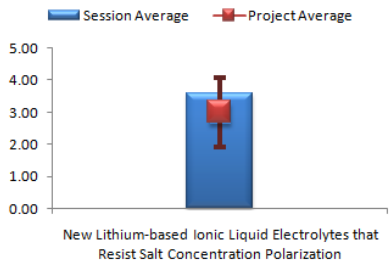
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Olivine and Layered Materials (Characterization, Rate Performance, and Stability) (G. Ceder, of Massachusetts Institute of Technology)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that the work was very relevant and the principal investigators do great science. Another said that basic research on cathodes is relevant to DOE program. A reviewer stated the two major types of materials, layered oxides and olivines, are important for DOE and industry battery programs. The work relates to computation and experimental study of advanced cathode materials for li-ion material. Understanding the limitations of electrode materials using material characterization techniques and modeling meet the goals of studying better materials to improve stability and performance of new materials that will provide higher energy density. Ceder's work will lead to better batteries for HEVs and PHEVs, which will reduce oil consumption. Finally, a reviewer said the team is working on critical problems, although the reviewer was still not sure that materials with Co are ever going to be low enough in cost to meet this program's needs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Positive comments include that the authors have a sound and cutting-edge plan to push the state-of-the-art and that the team has the right experimental and theoretical expertise to make rapid development in design of high rate and capacity cathode materials. A reviewer said that the strategies involve first principle calculations combined with experimental evaluations: this has proved to be a powerful combination. The computational and experimental mix is a well-combined approach in analyzing material behavior and optimizing synthesis, stated a reviewer. The program is trying to identify novel and unique materials to improve the rate capability of li-ion technology. Ceder's work on predicting the stability of cathode materials will help cell developers' quest to reduce the cost of materials and improve performance. Finally, a reviewer noted that some of the barriers may be "laws of physics type of things." But this work is critical to understanding the problems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Positive comments were found here as well, including that these are outstanding studies and results (this reviewer was highly impressed.) Another said that results have set the standard for material understanding both for equilibrium consideration and also dynamic processes. This has been direction-setting work. Another commented that the results on olivine and layered cathodes are interesting but the focus on new materials should be increased. The project addresses key technical barriers in terms of both first-principles modeling and actual active materials properties. The activity involved in this project should be expanded. A reviewer would suggest the authors focus more on novel materials for the future than on understanding behavior of currently available commercial materials. (Developing new techniques however is highly appreciated, like the PI has done).

The reviewer noted the computationally investigated quaternary phase diagram of Li-Fe-O-P to understand synthesis and thermal stability and also noted the team was planning to investigate the effects of surface and particle size on electrochemical properties of $LiFePO_4$ and $LiMnPO_4$. These findings will be quite useful. More capacity at higher rate of discharge for $LiMnPO_4$ is unusual and

interesting. Also noted was that a systematic study of the surface morphology has been undertaken. Surface modifications have also been studied to understand if there are improvements in the cyclability. The in-situ MAS NMR is a very good diagnostic tool. This is an excellent new method to study a practical environment as in a complete cell. It may be useful to study the cells with a carbon anode.

From excellent computational modeling combined with experimental efforts, the PI team has designed and demonstrated a very high power cathode material that looks very promising. Modeling li-ion extraction potential at different sites (like surface and bulk) is a good estimate for designing the right cathode electrode. The other interesting aspect of their work is improving the rate of these cathode and correlate with particle morphology. The NMR technique for applying to such cathode is unique and should be encouraged as it a very local probe to study lithium.

For the mechanism of Li diffusion a reviewer suggested the team work with Richardson and Chen to try to come up with a consistent story. With respect to $LiMnPO_4$ and the effect of capacity on rate capability (e.g. 1C versus 2C), does this depend at all on the charge conditions or other previous history that precede the discharge? The computational searching for materials is very exciting. In-situ NMR is quite an accomplishment. The reviewer looks forward to seeing how this can improve understanding of materials.

A reviewer said there was excellent collaboration between Ceder/Gray/ANL/Berkeley and focus on critical problems that are hindering implementation of high-rate/low-cost materials. This is a great approach to almost designing a material and is critical work to understand materials and identify the main issues. Very nice work, stated this reviewer. This provides an invaluable service to the BATT/ATD groups.

Ceder et al.'s work helps clarify where the opportunities are for reducing the cost of cathode material through, for example, a deep understanding of the rate dependence on the morphology of cathode particles.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Cutting-edge and novel materials will result from this work, according to one reviewer. Ceder's claim of greater than 100C rate with high potential material based on surface layer modification is exciting and may lead to better material for cathodes. The main technology transfer is in direction setting for material types, stated another reviewer. Another viewed the results and the actions (publications and patent) as showing a clear attitude to technology transfer. A reviewer said the work was focused on key materials. Even negative conclusions are very useful as they can stop work on dead ends.

Good work, stated a reviewer, who continued by observing that the capability for in situ NMR especially in a complete cell is a very novel and highly useful technique that many cell manufacturers would also like to adopt to get quick data on material improvements they make. Another said that the new cathode materials show very low capacity loss even at 40C rate. The new material and the processing parameters for cathode fabrication hold the key for achieving this.

The development of a $LiFePO_4$ material of extremely high rate capability is a very significant accomplishment with direct transfer potential. The in-situ NMR methodology should be of direct value to other researchers and should help to provide greater fundamental understanding of many cell chemistries.

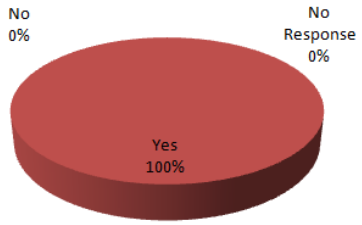
Grey does an excellent job of collaborating with other members of the BATT program and with industry to improve understanding of many of the materials being developed; she should continue to reach out to other members in the BATT program. Ceder should reach out more to other members of the BATT program to work with them to experimentally validate his quantum mechanical calculations.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The first reviewer would not mind increasing the funding considering the volume of results they have produced. The second said there was excellent work for the funding obtained. The third opinion was that funding for this work is sufficient. Another said that resources for this project should be increased. The large budget and the amount of work done gave confidence on the right balance of resources to another reviewer. Very good collaboration and utilization of resources was the view of a reviewer, who just questioned the work on Co-containing materials (acceptable for the method development of course). The final comment here was that this task is really two PI's, why are they lumped into one task? There really is insufficient time to review all the work done.

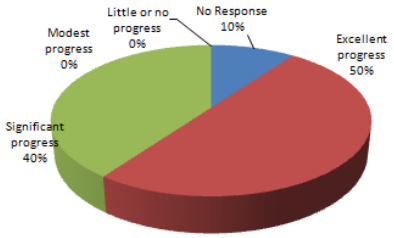
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Olivine and Layered Materials (Characterization, Rate Performance, and Stability)

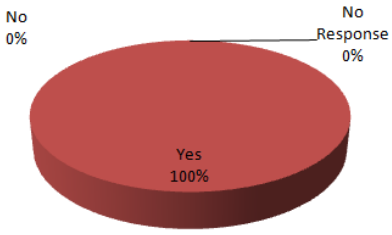
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



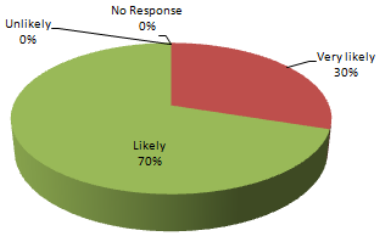
Question 3: Characterize the technical accomplishments and progress toward goals.



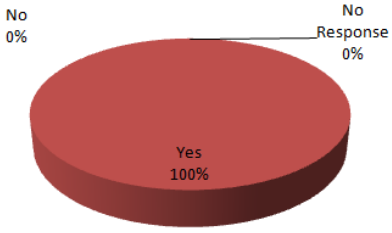
Question 2a: Are the goals of the project technically achievable?



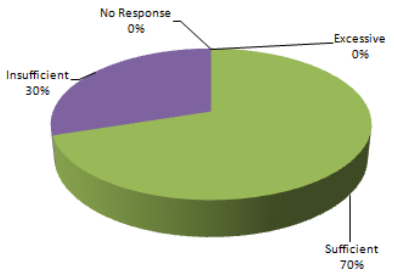
Question 4: How likely is the project team to move technologies into the marketplace?



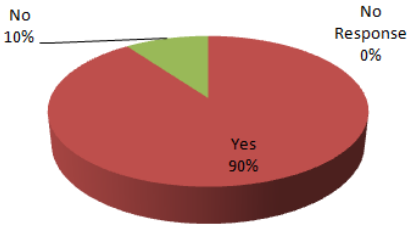
Question 2b: Have the technical barriers been identified and addressed?



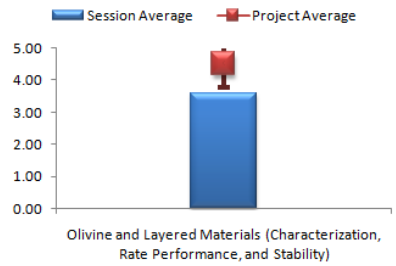
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Olivines and Substituted Layered Materials (M. Doeff, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer said the work was very relevant, with a focus on low-cost, benign materials. Another stated that the novel cathodes development is relevant to the DOE program. A reviewer further noted that all materials studied are important for PHEV and HEV development. To another, the low cobalt layered oxides are well placed for petroleum displacement with batteries. The use of low-cost high energy materials with stable performance is in line with the goals of the PHEV program. Additionally, the work is related to synthesis of low-cost cathode materials for li-ion batteries and optimizing the cathode properties. Another opinion was that improved power capability in relevant cathode materials (as demonstrated in this program) is directly relevant to overall DOE objectives. A reviewer stated that the carbon coating seems to have advantages for many materials (anodes and cathodes) and so the studies have a general applicability. The reviewer is still concerned about the use of Co for this program, even at only the 10% level. The team will have to look at what Co price is likely to be if this technology were to be implemented. It may increase a lot depending on how large the HEV business would be in relation to other industrial uses. Finally, Doeff's work to reduce the amount of Co in cathode materials and her $LiFePO_4$ carbon coating work may lead to cheaper batteries which help expedite the use of HEVs and PHEVs thereby lowering the use of oil for transportation.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that the project has well-defined targets (may be too many but consistent with the large budget) in improving various cathode materials. Olivine and metal oxides are very interesting cathodes and they require an in-depth study. Another pointed out the PI worked on quite a few systems, but this reviewer was not sure that she can then focus on the different systems. To another, the program is too spread out between the different materials. It appears that the work done on mixed metal oxides is taken care of in other programs within DOE. Also the high voltage efforts are hindered until a good electrolyte has been demonstrated - appears to not be fruitful. However, the work on Mn-based olivines is an interesting area, and would be worth pursuing going forward. A reviewer thought that Co levels still seem to be a real killer from a cost performance for PHEV and maybe even for HEV applications. A reviewer highlighted the selection and study of low-cost benign cathode materials. Methods used include optimization of carbon coatings, reduction of Co content in mixed oxides by substitution, and investigation of the compatibility of electrolyte with ionic liquids for stability above 5V. The strategies focused on are good for obtaining the goals of the program. Lastly, Doeff's carbon coating process may lead to better performing cathode materials, which may be used by industry.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
General comments included that the progress has been very good with some original results. Also, only the work on Mn based olivines represents new matter. A reviewer stated that the aluminum substitution for cobalt could be a significant finding. Low cobalt has a very beneficial economic effect on materials. Maintaining the rate capability in low cobalt materials will be the key to the benefit.

A reviewer commented that the goals of the project are generally good, but the focus of future work and goals should be narrower. The work investigating Al substitution is valuable and should be expanded further. Any future activity involving cost or high voltage electrolytes or specific to high voltage cathodes should be accomplished in a program(s) separate from this one.

A reviewer noted the interesting and innovative approach to "wiring up" a cathode with carbon wires that could have very wide applicability. This reviewer questioned if the PI understands the reason for the Al/Co doping differences. For example, the measurements of electronic conductivity versus temperature to get at activation energies was useful from a fundamental level, but the PI should check this at a state of charge at ambient just to see if the electronic conductivity changes during charge and discharge (unless they have reasons for expecting this not to be a factor). They seem to have assigned the lower performance to diffusion really by default and this reviewer is not sure that they have done enough to rule out electronic conductivity effects.

A reviewer said the analysis shows a quite low storage capacity with no proposal for improvements. The work to find substitutes to Co must be increased in the cost reduction direction. The choice to stop work on ionic liquid cells is not justified: there are new ionic liquids with improved performances able to favor the use of high voltage cathodes.

Extensive comments were offered by one, who said that elaborate studies have been performed with the nano-manganese phosphates, Al substituted mixed oxide and the room temperature ionic liquids. A good understanding has been obtained regarding the limitations of each aspect studied. Several other groups have also used carbon coatings for the manganese phosphates, so it might be good to bring out how this work is different from that of the others. The aluminum substitution was explained well but the highlight was on the improved performance. However, at ratios above y=5%, the capacity and performance at higher rates drops. This was not explained well. There seems to be an optimum Al ratio which needs to be further pursued. The work with the room temperature ionic liquids was not comprehensive enough and did not address if the combination of Ti coating and the ionic liquids were a benefit. Program could benefit from some safety tests.

The correlation between composite conductivity and capacity retention is an important step towards standardizing and optimizing the cell performance. Room temperature ionic solvents for 5V are a good research effort and the direction we should be taking for future li-ion cell for high power. The other interesting research effort of this team has been substituting Cobalt and replacing with other cheap and safe elements like Al.

The reported rate capability of the $LiFePO_4$ synthesized is not state-of-the-art compared to what other groups have reported. Is the issue the electrodes, cells, or materials?

The Al-Ni-Mn-Co work offers a nice look at new compositions, and good use of collaborations and complementary techniques to understand fundamental mechanisms of dopants. Ionic liquids suffer from low transfer numbers so they have low power at times greater than one-second - what was the point of this work?

Doeff's work is similar to the work of others in the BATT program. It may be possible to reduce the overlap of effort by having quarterly meetings of the PIs in the program who are doing similar material development work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The work is all relevant to developers, according to one reviewer. In particular, aspects of this work related to Al substitution are directly relevant and transferable. Another observed that there are already agreements underway. If high-capacity materials stable at higher voltages are obtained, this technology could be transferable for marketing. To another reviewer, the project team has optimized the materials which can make commercial inroads. They seem to have already some effort in that direction. It is good to see that the PI is making more of an effort to transfer technology and work with industry; this reviewer hopes that trend continues. Doeff's work on Al substitution for Co in mixed oxide cathodes may lead to cheaper material that performs as well or better than currently used, more expensive material.

Carbon coating seems to have advantages for many materials (anodes and cathodes) and so the studies have a general applicability, maybe even beyond the particular materials being coated in this work. The low-Co design work might be a good fit for power tool and consumer electronics, but this reviewer thought it is still too costly for the DOE programs.

A reviewer dissented with the others on this point, stating that at this point in time the work is very exploratory and is not likely to transfer in the near future.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The funding was characterized as substantial by one reviewer and sufficient by another. A reviewer said that there does not seem to be anything very innovative for the funding obtained. The quantity of work is reasonable for the time period but does not reflect reasonably the funding provided.

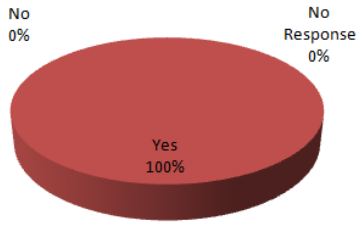
A reviewer recommended scaling back to Mn-based olivines and funnel the mixed metal oxide funding to other efforts. The licensing of olivines to a small Bay Area company appears to be a distracting activity. It was not clear to the reviewer that this technology is ready and that would reduce the chance of success as the new company would fail in their attempts to commercialize. The project team perhaps should have waited with commercialization until the technology was ready, which would have a higher impact in industry. The last suggestion was that any resources on high voltage electrolytes or specific to high voltage cathodes in the future should be redirected towards the other goals of this project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

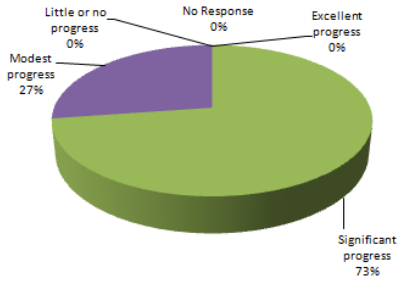
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Olivines and Substituted Layered Materials

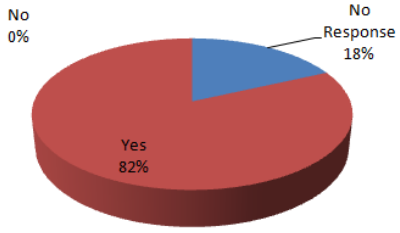
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



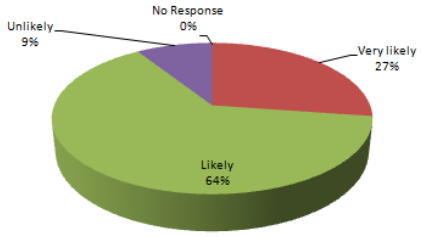
Question 3: Characterize the technical accomplishments and progress toward goals.



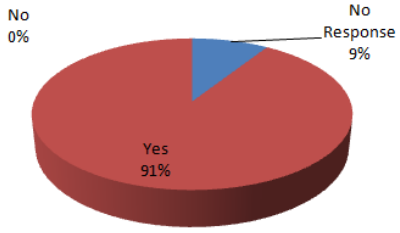
Question 2a: Are the goals of the project technically achievable?



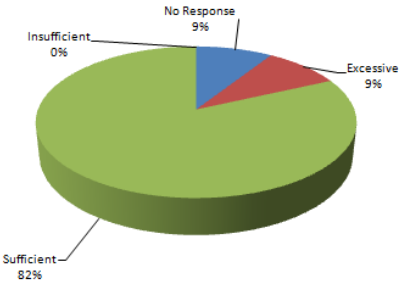
Question 4: How likely is the project team to move technologies into the marketplace?



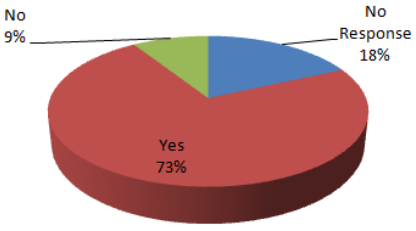
Question 2b: Have the technical barriers been identified and addressed?



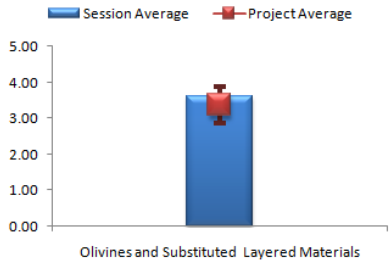
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Origin of Surface Instability of Lithium Positive Electrode Materials upon Cycling (Y. Shao-Horn, of Massachusetts Institute of Technology)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person commented that the program is very relevant. Another person commented that the program focuses on fundamental studies to improve the life of the lithium battery: a key target of the DOE Program. Another person noted that the program is directed to understanding methods of stabilizing high voltage cycling which is essential in obtaining high capacity in many materials. One person pointed out that the program is aimed at next generation li-ion battery: hence it is a petroleum displacement technology.

One reviewer indicated that an improved surface of a material can enhance the performance characteristics. Another person agreed that the project supports DOE's objectives if the fundamental understanding can be applied in the future to materials of more interest for vehicles, e.g. Ni and Mn-based. The last person remarked that Shao-Horn's work may lead to longer cycle life of batteries for HEVs and PHEVs which would lead to less oil consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the PI's work on coated materials may lead to a better understanding of the role of the coatings on $LiFePO_4$, e.g., which may lead to longer-life cathodes in lithium ion cells. Another person commented that the methods chosen for the analysis of surfaces are very well deployed both in the investigator's laboratory as well as with collaborations. Another person noted that the study aims at analyzing fundamental aspects of the interface behavior of the coated cathodes. They also commented that the chemical and structural analyses drive the interpretation of the working mechanisms. One person thought that the use of surface coating with the aluminum phosphate is a good approach, adding that this is hypothesized to provide protection to the electrodes and provide higher cycle-life and lower impedance growth. Another reviewer mentioned that the correlation between the interfacial phenomenon and capacity degradation is important to understand stability and the mechanism of capacity loss and durability. The last person commented that the PI needs to work on techniques of making good electrodes. Cycling data is relatively poor for the materials and no baseline is established, from which the formulation can be verified. If the focus is on cycle life, then a baseline needs to be established that allows verification of the improvements, which will quantify the improvement. The reviewer suggested that a small adjustment here would go a long way. They point out that the PI is obviously skilled in the art of synthesis and characterization of these materials. The choice of operating at 4.7V as highest oxidation potential will affect most electrolytes, which yields effects of less interest to the reviewer. They felt that the potential is too high to be interesting for the battery developers. They concluded by commenting that the methodologies for the safety (abuse tolerance) measurements are on the other hand good.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person commented that the progress is very good with results and hypotheses answering to the goals planned. Another reviewer acknowledged that the characterization of the interface for coated

cathodes is very important for understanding the lithium ion transport in these materials. They added that the XPS and STEM work of coated cathodes is important and timely. Another person also mentioned that the PI is using modern tools such as TEM to develop a better understanding of the structure of coatings on cathode particles as well as using XPS to determine the composition of these coatings. The reviewer indicated that the results may help battery developers produce better coatings. One person commented that this is a relatively new program and the methods are difficult to implement; however, significant results that have changed the understanding of coatings have already been obtained. Another reviewer mentioned the researcher presented good data with analytical tools to show that the coated electrodes provide better cycle life and lower impedance. The methodology that describes the capturing of HF by the aluminate is good. The use of cobaltate cathode is also a good choice since this is an established material with very high energy density. The reviewer concluded by asking whether any study been carried out to see if the coating prevents the loss of oxygen or if the oxygen lost combines with other side products to reduce the hazards brought about by the release of oxygen. Another reviewer commented that this task has done a very good job of combining complementary diagnostic techniques to answer a fundamental question of high interest to the battery community. They add that charge transfer impedance is not usually associated with frequencies below 0.1 Hz; the source of the impedance difference below 0.1 Hz would more likely be diffusion - complementary experiments like GITT, including looking at the relaxation during rest, would resolve that question, which is key to verifying the proposed mechanism. The reviewer concluded by suggesting that the PI use thin electrodes with a good formulation (conductive additive) to focus on the question of charge transfer vs. diffusion resistance. One person noted the good initial progress for this complex issue, however they have several reservations about coatings, including (1) If they are porous, they will not survive in the long run because of continuous attack by the electrolyte, (2) It is not going to change the thermal properties significantly, and (3) How about the resistance due to coatings? Another person noted that the presentation provided evidence for surface CoFxOy and AlFxOy on the cycled electrodes, but it was not clear how exactly these compounds affect the cycling characteristics. The last person commented that some cycling results are in question, which erodes the impact of the work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The work focus is on basic chemistry, so it is unlikely that the fundamental results will be commercialized. Another reviewer had similar comments, stating that the project involves more fundamental characterization but results are important for basic research. One person remarked that there is no clear evidence of possible technology transfer even if the accomplishments may support the development of new coating materials and processes. One person applauded the project's good work and indicated that the results obtained so far look very good. They point out that the use of the coating, if proven to be safer with respect to oxygen release, may help in the technology transfer and marketing. The last person commented that while Co is more of interest for batteries for portable electronics, this work may be applicable to materials of more interest to vehicles, such as Mn and Ni. The researcher hoped that this task plans to address these other materials in the near future.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer simply observed that the PI and the team have the right technique and know how to keep in track. One person commented that the resources seem adequate even if there is a lack of information in the presentation. Another reviewer noted that the PI has done good work with less funding than other projects and suggested that more funding may accelerate the work being performed. Another felt that the resources appear sufficient for the amount of work done, but noted

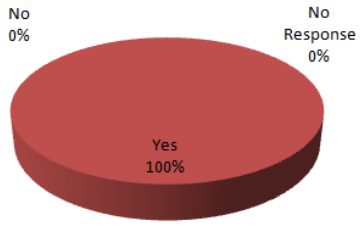
that the results are not that promising. The last person argued that the funding is excessive for this project based on the results obtained to date.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

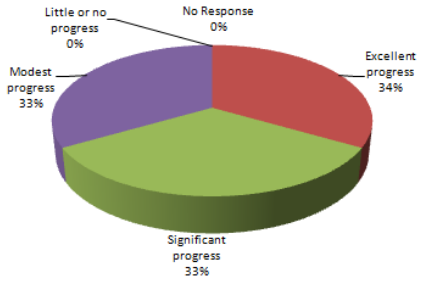
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Origin of Surface Instability of Lithium Positive Electrode Materials upon Cycling

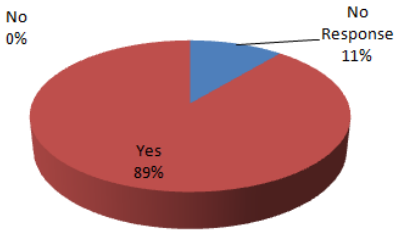
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



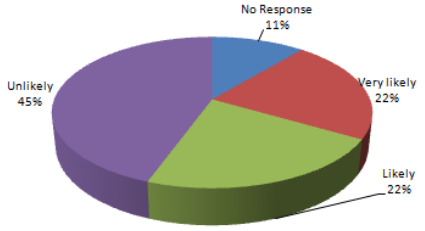
Question 3: Characterize the technical accomplishments and progress toward goals.



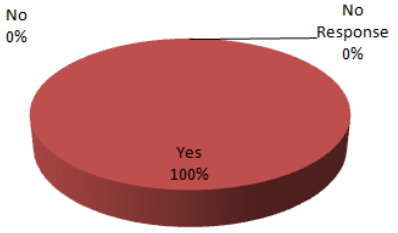
Question 2a: Are the goals of the project technically achievable?



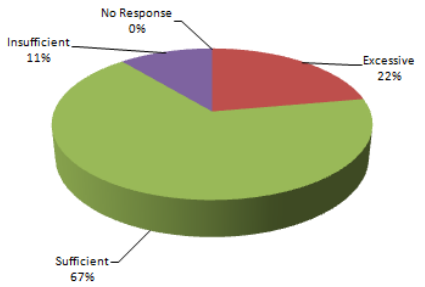
Question 4: How likely is the project team to move technologies into the marketplace?



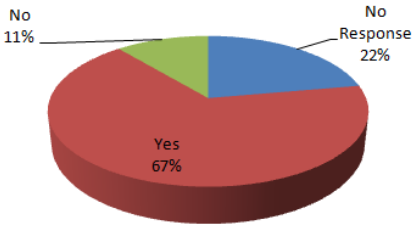
Question 2b: Have the technical barriers been identified and addressed?



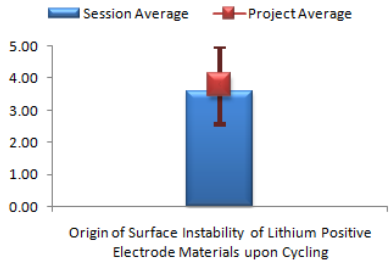
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Overview: Batteries for Advanced Transportation Technologies (BATT) Program (V. Srinivasan, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size

This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

One person felt that this project is absolutely necessary for the above long-term objective, while another added that it is important understanding and search for new materials. One person commented that the project involves basic research is addressing key objectives of DOE OVT program on batteries. Another reviewer indicated that a roadmap to reach the DOE goals was presented. Another person remarked that the BATT program will lead to a reduction in oil consumption because the work in this program will lead to batteries for HEVs and PHEVs. One person commented that we need a strong focus on materials research aimed for next generation energy storage materials, and that such exploratory research could potentially bring some revolutionary breakthrough as small evolutionary changes would not be sufficient to make electric vehicles a reality in terms of technical capability and cost. The last person commented that improved materials produced through means of surface modifications are promising for forming materials that can have long life. They added that approaching modeling and synthesis hand-in-hand is very useful for accomplishing this. Also, they mentioned that the electrode fabrication needs to support that type of development, so the program is well rounded to support the goal.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One person pointed out that since these are long-term projects, questions 2a and 2c are not easy to answer. Another person indicated that the project's strategy is directed toward fundamental research. Another felt that the scientific and technological barriers are very challenging but the approach and the research strategy show appraisal of the risks and adequate commitments on key aspects. One commented noted that each area of study has several groups working on it to study the necessary modifications; the reviewer thought this strategy is a great approach. Another reviewer liked the idea of teaming up in the BATT program and thought this would make the effort more coherent so that Battery ATD folks can get the benefit, something like a pyramid model which is a good start. One person mentioned that the project employed a good approach and balance of the right people. They cautioned that low costs for PHEVs are essential, so looking at inherently costly systems is not going to help much. (Costing was not really mentioned much after the introduction.) One of the reviewers highlighted that BATT has issued an RFP in the area of "Synthesis and Characterization of Novel Electrolytes and Additives for Use in High-Energy Lithium-ion Batteries", which they thought was a good strategy to attract innovative ideas. The last reviewer commented that the materials synthesis combined with electrode fabrication and measurements along with modeling is a good approach for understanding the system, which leads to a deep understanding of limiting mechanisms in the various systems. It is a good idea to study what happens above 4.3V, as that area can be accessed frequently during fast charge pulse. Study of the mechanisms to limit imbalance in the cells, localized deposition of lithium, and other local degradation mechanism and their dependence on formulation and materials can identify system that lends themselves to be "safely" overcharged temporarily, which the allows higher charge currents and hence smaller batteries, which in turn leads to decreased cost and smaller systems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer remarked that Venkat and Professor Newman are doing a great job in managing this program, adding that Venkat is an excellent pick to lead this program. One person stated that the program is going on well and progress is made in the area of exploratory scientific research on batteries. Another person noted that the BATT program has produced information about materials of interest to the battery community. One commenter noted that the good coordination among various projects and principal investigators is quite impressive and very essential for the success of the BATT program. One person observed the collaboration between basic research and applied research is good. They added that using modeling techniques to compare and confirm the data is a good way to go. The reviewer concluded by mentioned that the PI presented a very good map of work allocations. One person stated that the presentation provided an overview of the BATT program and the rationale behind the choices, but the technical accomplishments will be better evaluated during single project presentations. They noted that the key activity line and good ideas have been not illustrated. They concluded by observing that the proposed changes from the previous Review are not evident in the program description. The last person thought that it was hard to say from an overview, so they really need to wait for individual reports to make a determination.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person commented that the BATT program may have many results able to be transferred. Another person noted that the improved systems will help with cost and performance optimization. The last person commented that this program is focused on basic work which will ultimately reach the marketplace.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

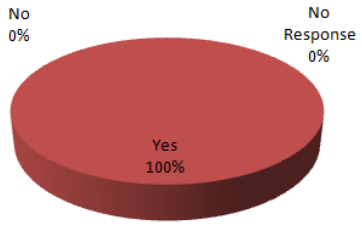
One person stated that the question is not applicable for the time of question, but the presentation was excellent and was very well delivered. Another person observed that no indication is given in relation to the resources that seem adequate in terms of high expertise. One person commented that the funding is sufficient for this program, and that the program would benefit from co-funding from industry to form industry/academic teams to address urgent needs of industrial researchers. One reviewer suggested that BATT activities should be expanded in terms of resources so that more number of university PI's get funded to carry out exploratory research in the area of energy storage. Several European and Asian nations are spending a lot more in this area. The last person however felt that research activity on lithium metal systems should be significantly, or totally, re-directed towards li-ion systems. They concluded by also noting that some significant level of resources devoted to ATD program should be re-directed to BATT program.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

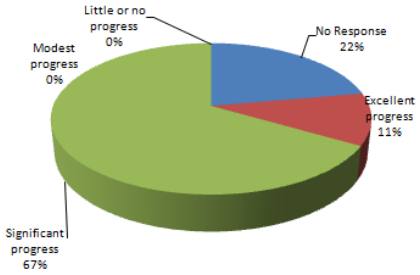
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Overview: Batteries for Advanced Transportation Technologies (BATT) Program

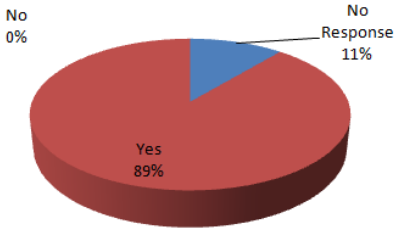
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



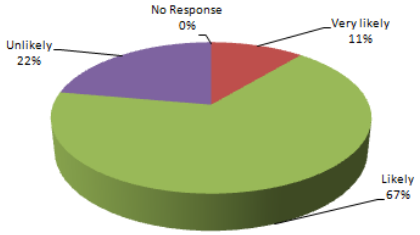
Question 3: Characterize the technical accomplishments and progress toward goals.



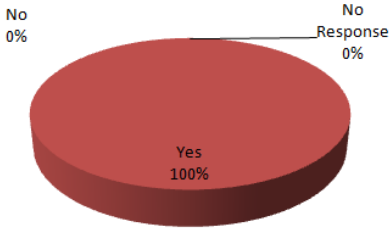
Question 2a: Are the goals of the project technically achievable?



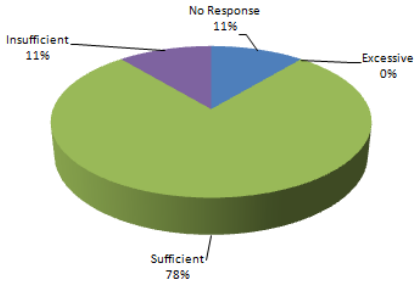
Question 4: How likely is the project team to move technologies into the marketplace?



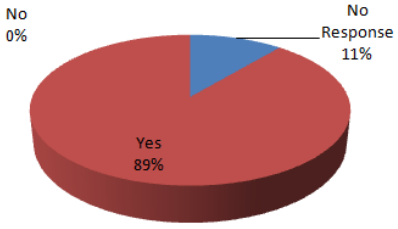
Question 2b: Have the technical barriers been identified and addressed?



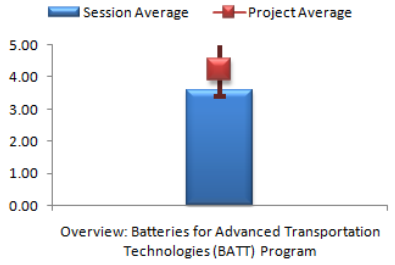
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Performance Enhancement of Cathodes with Conductive Polymers (J. Goodenough, of University of Texas at Austin)

Reviewer Sample Size

This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewers were in favor of this project's contribution to DOE objectives, stating that the new material focus is very supportive of DOE goals, that low-cost cathodes are important, and that cathode development remains extremely relevant to DOE objectives. Further, the goals and objectives of cost, safety and environmental compatibility are in sync with the program goals. Also, the work is related to synthesis of stable cathodes for Li-Ion batteries. To one reviewer, the purpose of this work was to improve capacity and rate capability of composite $LiFePO_4$/C/PTFE cathodes by replacing inactive C + PTFE with an electrochemically active, conductive polymer, such as polypyrrole (PPy), polyaniline (PANI), and thus, supports the DOE objective. A reviewer said that the polymer work addresses improving the most promising cathode material for HEVs, which is important for braking regeneration and possibly for fast charge during long trips. Lastly, a reviewer said that Goodenough will produce material to build better batteries to reduce oil consumption. He has demonstrated his remarkable skills many times.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

Reviewer comments included that this was a novel idea in advancing the cathode technology, that the strategy is well developed and proven to be successful in the past, and that the project proposes innovative materials with a clear vision of the challenging barriers and with interesting scientific and technical approach to overcome them. A reviewer said that selection of a conductive polymer workable in the required voltage range and that has less resistance between it and the current collector and one that has a convenient synthetic route has been the project plan. A reviewer added that the authors have demonstrated stable $LiFePO_4$ stabilized by polymers and solved a few technical and scientific challenges. A reviewer noted that Goodenough's work on conductive polymers will provide a basis for cell manufactures to consider in their development work. A reviewer dissented moderately with the rest of the group, stating that the study shows that the method could be used and improvements are available, but it was unclear if the best polymer has been chosen: other work can follow, so there is a bit of success there.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Positive comments about the technical accomplishments included that the high rate capability of a novel polymer doped cathode has been demonstrated with experimental evidence, and that the authors have synthesized new cathodes with higher stability and rate capability using a polymeric method. They also are developing novel anode materials which can put more lithium per redox center. The work is an extremely important step towards development of novel anodes and should be encouraged. Furthermore, the authors developed synthetic routes for PPy and PANI electrodeposition of PPy on C-$LiFePO_4$ shown to be superior to chemical deposition of PPy and PANI. They showed that the capacity and rate capability of the chemically synthesized $LiFePO_4$/PPy composite cathode is comparable with the electrodeposited film and higher than the parent $LiFePO_4$. The composite $LiFePO_4$ material presents a useful development for theoretical consideration.

Other positive comments included that there was a good description of work performed and data shows good correlation between synthetic and deposition techniques to the cycle life and rate capability of the materials. Also, the PI has laid out a clear, logical, and ambitious strategy for trying to invent new materials. Goodenough's work has produced useful information about conducting polymers, stated another. To a commenter, the past year's work has successfully obtained cycling of carbon coated lithium iron phosphate in the presence of conductive polymers at high rates. The search for new materials in next year's program is higher risk, but the potential payout is greater. Finally, the polymer work showed some progress but only with low voltage cathodes - fortunately it is with a very important low voltage cathode.

A reviewer was concerned about the stability of such materials in automotive environment for 15 years. This reviewer suggested that stability should be a key task in these studies. A further suggestion was that behavior at low temperature should be verified in cells. The planned work on novel cathodes and new anode materials should be accelerated and reinforced. Finally, a reviewer suggested that the cathode work was not so new but the anode work should continue.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments received here include that this is a unique idea: any positive result can easily be transferred to the marketplace. Goodenough's work has produced products and will probably do so again. Two reviewers noted that technology transfer is already in place with patent licensee (Phostech) who is marketing the technology. The achievements of polymer work were notable and useful to a reviewer, but the longer term approach is obviously a high risk fishing expedition, but with a very experienced and successful angler. The likelihood of success still seems low, but "we won't catch anything unless we start fishing somewhere."

A reviewer said that the conductive polymer approach does not easily yield to manufacturing methods, but the new material search has a better chance of moving to the marketplace. Similarly, the method of producing the composite $LiFePO_4$ material may not be practical to another reviewer's belief from an economic viewpoint.

Finally, the goal is to improve the rate capability and capacity of cathodes. New synthetic routes were developed which has higher rate capability. New results would be disseminated by external publications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

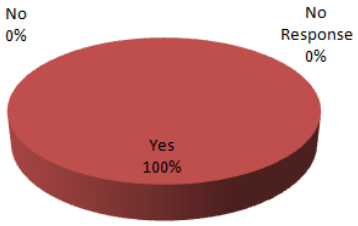
Commenters felt the project was sufficiently funded or in need of some additional funds. Resources should be increased to take into account the extension to new materials development, stated one reviewer. To another, this was good quality work that could benefit from more funding. A third reviewer said the future plan looks interesting and is worth pursuing. This reviewer thought that if someone can come up with new materials it would be Goodenough, so DOE is cautioned to make sure he has the appropriate funding for this. A reviewer said that this was a well-chosen recipient of seed money for new materials. This reviewer recommended that DOE keep this at relatively modest funding level, but be patient and not expect too much for a year or two. The final reviewer could not comment on resources.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

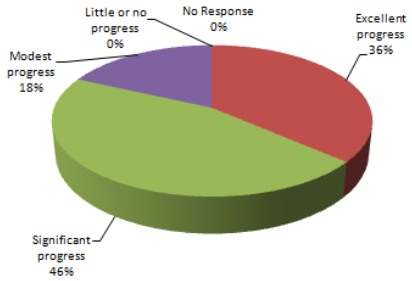
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Performance Enhancement of Cathodes with Conductive Polymers

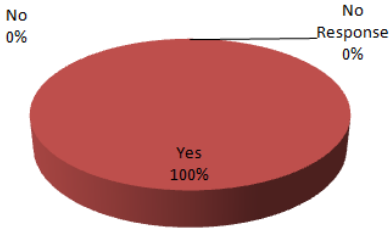
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



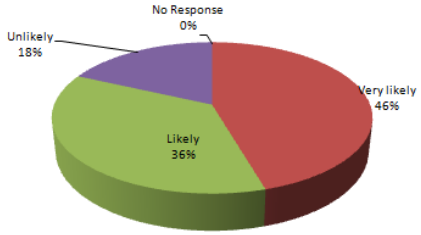
Question 3: Characterize the technical accomplishments and progress toward goals.



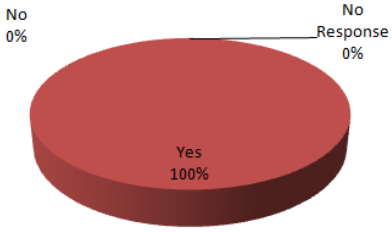
Question 2a: Are the goals of the project technically achievable?



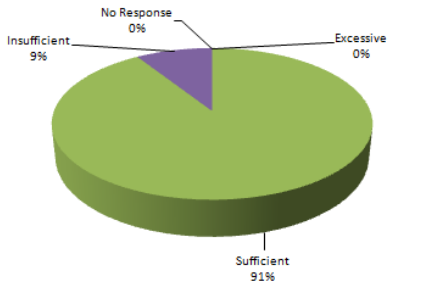
Question 4: How likely is the project team to move technologies into the marketplace?



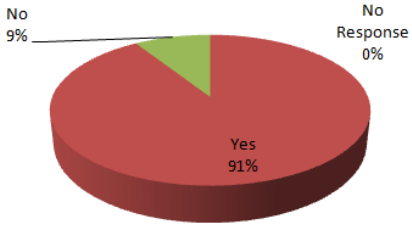
Question 2b: Have the technical barriers been identified and addressed?



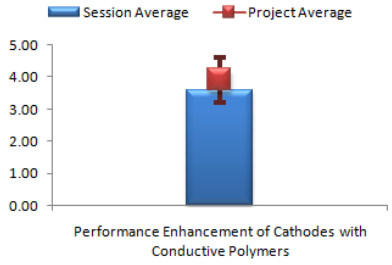
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Phase Behavior and Solid State Chemistry in Olivines (T. Richardson, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Cathodes dictate the capacity of cells, stated one reviewer. Another observed that cathode development is very relevant to DOE EV and PHEV program. Richardson's work will lead to better cathode material for batteries for HEVs and PHEVs, which will reduce use of oil for cars. A reviewer felt the goals of the PHEV and EV program have been taken into consideration. Similarly, another stated that the work is very well suited towards PHEV and HEV goals. A reviewer noted that the high density (tap density) is important for PHEVs, so the PI has selected a good area that (if successful) will help commercialization of PHEVs. The final reviewer said that the team is trying to get a practical $LiMnO_2$ chemistry.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The goal and technical details has been extremely well thought out, according to one reviewer. Another said that the basic fundamental research has been clearly structured to screen and select novel olivine compositions. The strategy can support the development of higher performance electrodes for EVs and PHEVs. A reviewer stated that synthesis of novel materials has been pursued with several material characterization techniques to understand the nature and structure of the materials and crystals synthesized. Richardson's work shows that it may be possible to produce higher potential material by using Mg instead of Fe in olivine material.

The choice to focus on high tap density is good, said another reviewer. This will help create good electrodes and true effects on cyclability can be studied instead of just studying chemical and electrochemical effects, which is the case in most programs. Here also good mechanical stability will be achieved, which is critical to success.

The project provides valuable fundamental materials information, in another's view. However, it does not yet appear to address or explore rate capability issues of the studied materials, although this is intended for future work. Rate capability and/or conductivity observations would be critical for consideration of deployment.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer highlighted the results on impact of cathode particle size and shape. Another spoke of the team having identified $MnPO_4$ decrepitation as a contributing factor in the poor performance of $LiMnPO_4$ cathodes. The severe limitations of the manganese phosphates and the decrepitation are well understood. But the future work and how this could be overcome was not well explained. There was no optimistic tone at the conclusion of the talk. It may not be advisable to pursue the manganese phosphate work in the future based on the lack of direction or options to improve the work. The option for other materials to be studied is a good future goal. Another said it was very good work into fundamental mechanisms of $LiFePO_4$; the team should keep working to wrap this up into a complete story of the mechanism of phase-boundary movement. Does the decrepitation actually affect cycle life

with $LiMnPO_4$? It is not clear how the observations from chemical delithiation correspond to behavior in a cell. Why was the PI not given time to present his anode work?

Another felt that the team members are addressing a key problem where they could probe lithium ion diffusion in planes of $LiFePO_4$. To this effect they have synthesized $LiFePO_4$ plates having the right crystallographic orientation and shapes. Subsequently using micro-Raman they have shown Li ion distribution in the right crystallographic plane (AC plane). The experiments validated their model in terms of li-ion diffusion in olivines. The PI has also made progress in addressing the mobility of li-ion in various crystalline directions. The reviewer concluded by stating that this work must be supported.

The directional aspects of the olivines are important and well worth pursuing, according to a reviewer. Synthetic methods to stimulate the optimized morphology for this will lead to improved performance, and possibly improved energy density, which is next year's target.

The project appears to have achieved some useful and valuable accomplishments. However, one of the accomplishments is identified as addressing safety, and there is no apparent evidence to this reviewer's view describing this activity or the specific development.

Finally, Richardson's work is very useful because he is showing through careful experimentation with modern tools such as TEM why olivine materials function as they do. He has presented work that indicates the Mn olivines may be very difficult to produce; however, Mg stabilized material may be possible.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Richardson's work will be useful to battery component developers and cell producers. The PI seems to see a low success likelihood, but he has shown good science in his approach. No optimism was shown, according to another reviewer, in improving the stability of the materials for future technology transfer or marketing. Another stated that while the rating here was "unlikely" the reviewer would still rate their work very best interims of understanding quantitatively the phase boundary behavior of $LiFePO_4$. Their particle engineering effort is important for the success of $LiFePO_4$. Their current research on studying the degradation mechanism of $LiMnPO_4$ is also very relevant for validating these kinds of high-energy cathodes for PHEV and next generation cells.

Too early to tell, but certainly the synthetic methods and morphology created will be interesting for companies synthesizing olivines. The correlation to performance is important in conjunction with this and will help companies optimize their processes.

The achieved results justify the actions of the project team to publish some results and patent others, stated a reviewer. The PI needs to make more of an effort to reach out to industry and support the U.S. battery industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

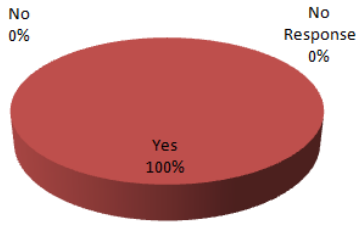
Adequate to one reviewer, to another funding for this work is insufficient based on the results obtained. Richardson's group should be funded at a higher level. In contrast, another reviewer said the work performed is inadequate for the funding obtained. A positive attitude of how to improve the material properties may have helped.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

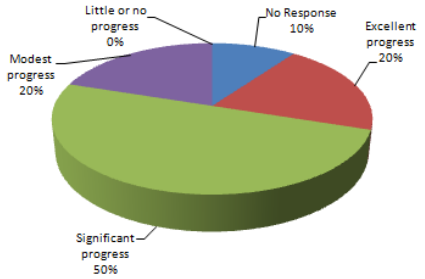
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Phase Behavior and Solid State Chemistry in Olivines

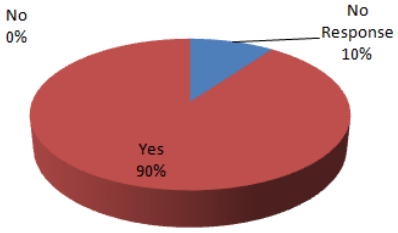
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



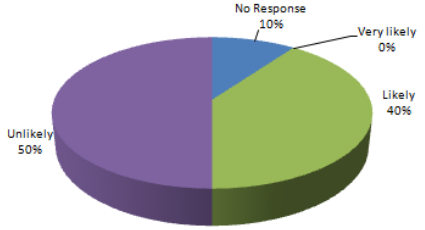
Question 3: Characterize the technical accomplishments and progress toward goals.



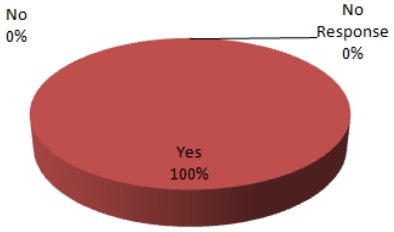
Question 2a: Are the goals of the project technically achievable?



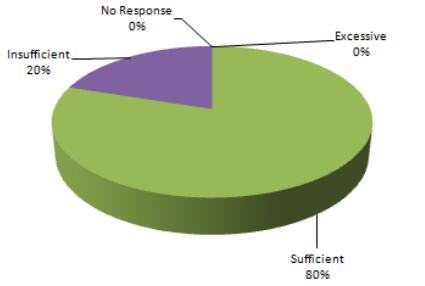
Question 4: How likely is the project team to move technologies into the marketplace?



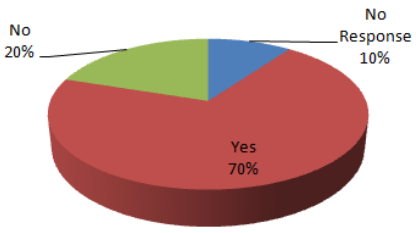
Question 2b: Have the technical barriers been identified and addressed?



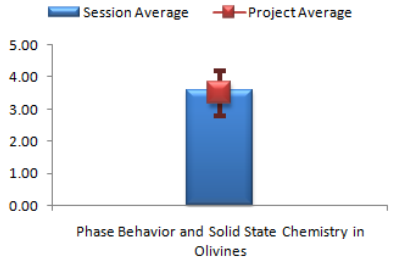
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Stabilization of Layered Metal Oxides (M. Thackeray, of Argonne National Laboratory)

Reviewer Sample Size

This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

One person remarked that absolutely, only through this kind of work can we make breakthroughs to reach the DOE goals. Another person agreed, stating that the project targets the key objectives of the DOE program: energy content, cost and stability. One person simply noted that this is a high level new material program. One reviewer mentioned that the program supports the development of materials for next generation energy/power batteries. Another person acknowledged that the project's goal is to obtain high energy materials at low-cost providing high cycle life and good abuse tolerance is a stated goal for the PHEV project and this program does that by looking at the new high power manganese based cathodes. One person noted that low-cost and high-capacity needed for PHEV. Another person commented that this project will lead to electrodes that will last longer which will enable suitable batteries for HEVs and PHEVs thereby reducing oil use. Another person had similar comments, stating that the material researched by the PI is very promising for a low-cost, high-performance positive electrode material for HEV and PHEV systems. The last person suggested that this work is valuable and should be continued and expanded.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One person felt that the work is excellent, noting that the researchers are already working very extensively with external partners. Another person indicated that the researchers are addressing the right materials problems that need to be overcome like stability of materials, their surfaces and capacity. One person thought that a good understanding is being established on the limitations, adding that the use of fluorination is a good way to go. One person commented that the strategy highlights the need for high-capacity cathode materials and possible means to obtain them, which is essential for PHEV program which must have higher energy cathode materials. Another person indicated that the goals are well defined with reasonable and convincing steps to achieve them. They added that the project must be significantly supported and possibly passed to more industrial phases: ATD and battery development for verifying cost and scale up. One person pointed out that the strategy or purpose of this work is to design and fabricate intermetallic anodes to replace graphite which this reviewer thought was a good approach to explore new and innovative ideas. A reviewer thought that the idea about stabilizing structural units, instead of working on dopants, is a nice strategy that obviously works. They added that the fluroniation of surfaces is also a sound approach (that has been proven in other systems) for improving performance further. They concluded by acknowledging that the researchers have developed a good deployment strategy. One person commented that the PI has demonstrated that his process leads to stabilization of layer oxides and that thus process may be used by battery developers to improve the life time of their cells. One reviewer commented that the project should characterize conductivity of the basic studied material(s), and should provide some observations of power capability in a typical electrode formulation configuration. The reviewer added that modeling of dissolution should be progressed as possible on from the initial studies of $LiCoO_2$ as a validation of the method towards more relevant materials which would hopefully include spinel/layered compound blends. The last reviewer would like the program to understand the excess capacity more; the uncertainty makes them a bit nervous. They asked whether the extra capacity is available at low-rate even after long open circuit stand in the charged state, or does this "bleed off" during standing by side reaction with the electrolyte.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One person simply stated that the project involves outstanding industry leading work. Another person commented that the results show a very promising high-performance material that is also embraced by community. Another person acknowledged the project involves very good scientific work, both in trying to develop new understanding and in being honest about what is not yet fully understood. Another person noted that the PI's results seem promising and may lead to a new material for cathodes in lithium ion cells. One reviewer noted that new results towards development of intermetallic anodes were shown; some of these materials could have good potential. Another person noted that numerous Sn substitute materials have been studied, but none has replaced graphite and made to any useable batteries as yet. Another reviewer mentioned that the investigators have added fluoride etching on the material surface to improve the previously developed materials, with improved cycle-life as a result. One person highlighted that the results show an excellent progress with breakthrough achievements, but that the specific energy requires to be better presented. They concluded by suggesting that scale up problems and cost implications should be analyzed. One person highlighted that the work has made excellent progress in advancing the specific energy of the cathode material. They noted that it is a very novel idea for stabilizing a structure, but asked whether this material will survive overcharge or thermal stability. The reviewer was not sure there are electrolytes which can survive such high voltages over the greater than ten-year timeframe we are looking for. They concluded by asking how to alleviate the first cycle in efficiency. The last reviewer commented that methods to improve the stabilization of the cathodes need to be pursued as it is well understood that there is an irreversible first cycle loss. The reviewer felt that fluorination is a good way to go, but it still does not seem to remove the first cycle loss, although it improves the cyclability of the cells after that first loss. Another issue they noticed is going to high voltages, such as 4.6V to 4.8 V. These voltages are never practically recommended for li-ion batteries; when one goes to higher charge voltages, one can obviously get higher capacities, but this will compromise the safety. The reviewer recommended some microcalorimeter work on the materials in small coin cells to understand the heat generation at these high voltages. The last person cautioned that they remain a little concerned about high irreversible capacity loss as this is far more than can be compensated for by the irreversible loss at most carbon anodes. They asked if these materials can be "formed" externally and then placed in a cell. If this is feasible, a program to do this could be useful, patentable, profitable, and a good fit for the synthetic skills of the PI and ANL. They note that industry might be a better developer of high-voltage electrolytes than ANL, suggesting that their partnering royalty agreements could potentially cover a cooperative agreement for technology exchange.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person simply noted that the next-generation materials are of great interest. Another mentioned that the material made by the PI may be useful for commercial cells. One person commented that if the initial loss is overcome and if the capacities can be improved with the lower end of charge voltages (4.0V to 4.2V), it is good technology for transfer and marketing. Another person simply stated that this is already underway, which says it all. Another person indicated that patents are already licensed. Another reviewer noted that the licensees are already in place and results can be only improved. Another person also acknowledged that this is already happening (they are receiving royalty income), so the team seems to have winner. One reviewer highlighted that this task has done an excellent job of publishing good scientific papers as well as working to commercializing the materials. Another reviewer commented that the project is developing materials which are of significant interest to the marketplace, and the modeling of dissolution, if applied to relevant materials, would be of great

interest and value to activities already underway in the marketplace. One person cautioned that, with the recent activities by 3M, there is risk that the patent portfolio is hindering commercialization if a clear path is not available to companies; this may have to be addressed and studied. The final reviewer cautioned that it is likely but more chemistry has to be studied like interaction with electrolytes, cathode pair. They highlighted that this is non-trivial as each set of these redox pairs has to be studied in detail.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

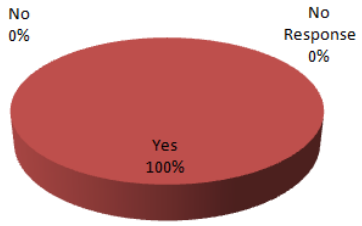
Reactions to this question were mixed. One person commented that they could not really comment on this question, but guessed the funding is sufficient to achieve their goals. They concluded by stating that the plan seems reasonable. One person thought that funding for this project is sufficient. Another person indicated that the resources should be increased, if anything, to further this work. Another person commented that actually, the project should be given whatever the PI's think they need. The reviewer could not tell if they have enough or not. They concluded by pointing out that the royalty path they are following may effectively move this forward to implementation without DOE support, so maybe what they have is actually sufficient. Another person commented that some more resources would be dedicated to abuse tolerance analysis and scale up work. One person pointed out that the project is approaching commercialization, but still some optimization is needed and for that funding should remain for at least another couple of years. They congratulated the great work in general and money well spent by DOE. The last person, however, felt that more work can be done for the funding received; a lot of this work is also being carried out as part of the applied research program. The reviewer acknowledged that some leverage exists, which either should help do more work or reduce the cost of the current work.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

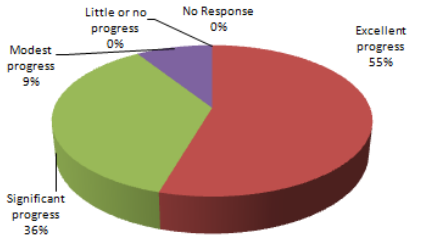
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Stabilization of Layered Metal Oxides

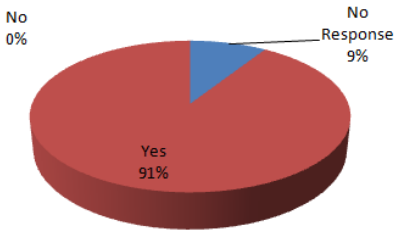
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



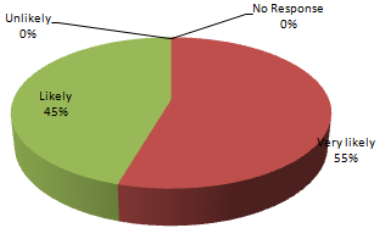
Question 3: Characterize the technical accomplishments and progress toward goals.



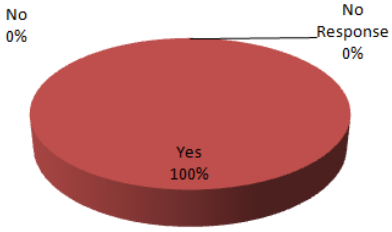
Question 2a: Are the goals of the project technically achievable?



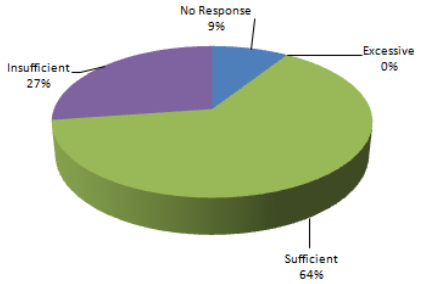
Question 4: How likely is the project team to move technologies into the marketplace?



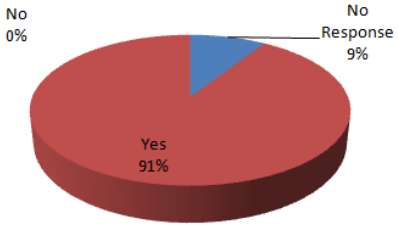
Question 2b: Have the technical barriers been identified and addressed?



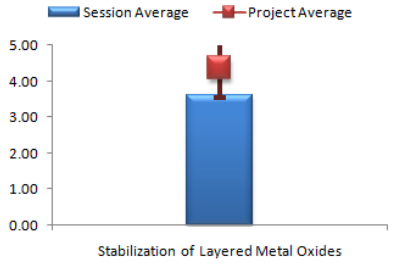
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Stabilized Spinels and Nano Olivines (A. Manthiram, of University of Texas at Austin)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive in this section. One reviewer stated that improved spinel materials are very promising low-cost materials for HEV and PHEV positive electrodes, while another added that high-power stabilized spinels and new forms of olivine are important for HEV goals. One other reviewer indicated that the work is very relevant, and a high performance cathode is the heart of a next-generation cell. One respondent noted that the group is working with low-cost materials, while another person commented that cathode cost and improved performances are key objectives relevant to DOE program. Similarly, one reviewer wrote that Manthiram's work may lead to higher energy density cathodes and consequently more rapid development of batteries for HEVs and PHEVs, which would lead to less oil consumption. Another person remarked that the goals of cost, cycle life, safety, rate capability, and energy density are in sync with the goals of the PHEV program. One final reviewer simply noted the work is aimed at synthesis and optimization of cathodes for Li-ion batteries.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that there are a lot of creative ideas to resolve the problems, while another respondent added that the approach is well justified, starting from the comprehension of the way various cathodes work and then proposing modifications to overcome barriers. One reviewer indicated that the use of stabilized high power spinels is a good approach, adding that the oxygen substitution limitations are well understood and the use of fluorine substitution is a good approach. Another respondent noted the team has a goal of pairing their spinel cathodes with novel anodes to achieve high power and capacity. They have also demonstrated mixed cathodes, which could be the way to go. Excellent progress has been made towards synthesis of nano-olivines. One other reviewer commented on the solids approach with doping and study, adding that there are good cyclability studies that differentiate. This reviewer adds that this is well done, and it appears that the investigators have control of how to make good cells for this purpose, which is unusual.

One reviewer felt that Manthiram's materials do not appear to have the required rate capability for batteries for HEVs and PHEVs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One respondent indicated the group has shown a promising synthesis approach and performance, while another reviewer stated they have done a good job at inventing new materials. One reviewer commented that the demonstration of a significant reduction in first-cycle loss in spinel-type cathodes is of value, and the demonstration of alternative first-cycle charging methods which improve cycle life are of value as well, and these aspects of this work should be expanded in future work. The polymer coating of $LiFePO_4$ appears promising and this work should be expanded. Another reviewer noted that this is excellent work carried out on the quick method of synthesis of the nano-iron phosphates. The mixed cathodes substituted oxides are also a good study, and the factors affecting the performance have also been well studied. Some work on safety can be pursued in cells made with the new cathode material- carbon electrode. The project may benefit from providing materials to labs such as Sandia to make larger cells and study the safety. One other person remarked that the proton insertion technique

for determining the lithium content in layered oxides is novel. As per the cyclability of their cathodes, their study of Mn dissolution is crucial for long cycle life and capacity loss. The authors have lot of valuable and pertinent data to conclude their results and it looks like their synthesis strategies are working. The reviewer suggested that the basic materials synthesis efforts must continue, especially synthesis and optimization of nano-olivines with directed shape and morphology.

One response stated that the results are very good with significant progress, even if the cathode capacity remains low (about 130 mAh/g) at high voltage. The analysis at 60°C seems questionable with spinel: more operating temperature should be analyzed including low temperature tests. The choice of materials in the new cathodes must follow some well defined criteria (cost, availability), as for Co, for example. Another person wrote that there are quite a few interesting and novel results. This work shows good promise for further fundamentally new results. This reviewer advised against Co-based olivine, adding that he or she thought we are trying to move away from this metal.

One reviewer noted that $LiFePO_4$ nanorods coated with a mixed ionically and electronically conducting polymer exhibit excellent rate capability in the lab but in the real world in scaled up situations the implication is not clear. Good rate capabilities are already shown by some manufacturers of the cells with $LiFePO_4$ cathodes. So what is the advantage of this study? Lots of good work, but how these findings can be used was not clear. Another reviewer commented that the stabilized spinel work for 4V materials seems to be at a point of diminishing returns – needs new ideas if work is to continue. 5V spinel work is very high risk in view of electrolyte instability over long use situations. Olivine nanorods look like a good possibility for implementation if economically viable methods of preparation can be devised. One other respondent indicated that Manthiram's work has produced material that may be useful because of the higher potential of his cathode material. Unfortunately, this reviewer noted that the rate capability of his material is low.

One final reviewer indicated that he or she thought that the Koreans had already shown that F-doping, oxide coating, and mixing with other cathodes were all effective ways to stabilize spinel many years ago. This reviewer is not sure how original this work is. Thus, this work seems to follow rather than lead. That said, this reviewer adds that the PI appears to be able to provide an important understanding to some of these effects. The level of control demonstrated in the synthesis work on $LiFePO_4$ is interesting.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first response indicated that the group's low-cost synthesis of olivine is of direct interest to developers. One reviewer commented that technology transfer to a start-up has been already realized. One respondent stated that the group is doing excellent work and detailed studies on the materials. This has a high likelihood for technology transfer and marketing. Another person stated that the high quality of this work will led to near-term commercialization. One reviewer wrote that success will be useful for both battery companies and materials manufacturers. Technology can easily be transferred, due to the richness of results from the PI and the clear information on synthetic conditions, crystal structure, and its correlation to performance.

One response stated that, in particular, the polymer coating process for $LiFePO_4$ appears to be directly transferable to the marketplace. Another person added this task has done a good job of inventing new materials, adding that the PI needs to partner with others (perhaps his new startup) to start exploring the practical issues involved with making and operating batteries from these materials, e.g., cost

constraints of coating phosphates with expensive mixed conducting polymers; achievable electrode densities with nanorod materials, and overcharge protection in the context of 5V cathode materials.

Other reviewer were less positive, with one commented that many of the ideas on the spinel have been developed by others in Asia. So, while implementation of this is likely, this reviewer is not sure that this work is the driver for that. Olivine work will have to compete with other methods – not sure it is any better than other materials. He or she did not see any comparison with other nano-materials. One final reviewer stated that Manthiram's material is unlikely to meet the needs of industry because of its low rate capability.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Responses to this prompt were generally positive. One reviewer stated that the resources seem adequate, while another wrote that the quantity of work performed is of high volume compared to the funding obtained. Several different aspects have been pursued with excellent results obtained, and the funding should be increased based on the quantity and quality of the work. The additional funding provided can be used for synthesizing more materials and providing them for larger cell manufacturing and testing. One other person commented that next year's focus for spinels is good. One reviewer indicated that he or she could not comment on this, but added that the PI and team are extremely capable and technically qualified in their area. One other respondent suggested that continued work to further examine rapid processing methods for $LiFePO_4$ may warrant additional resources, or more ideally a separate project.

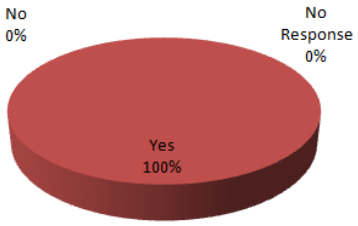
In contrast, one final reviewer felt that the funding for this project is excessive relative to the results obtained.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

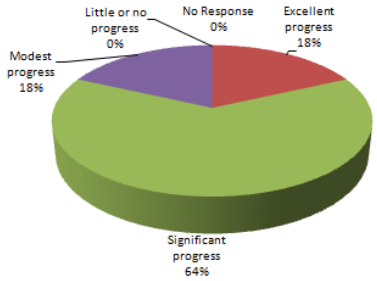
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Stabilized Spinels and Nano Olivines

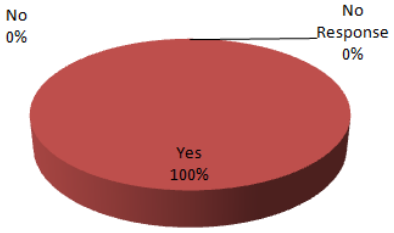
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



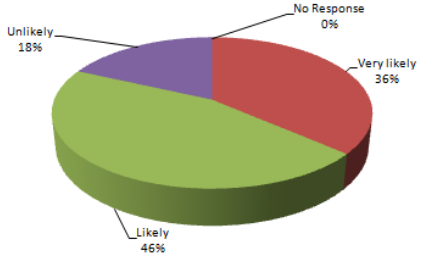
Question 3: Characterize the technical accomplishments and progress toward goals.



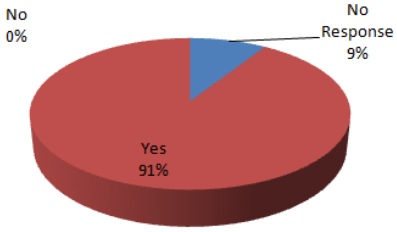
Question 2a: Are the goals of the project technically achievable?



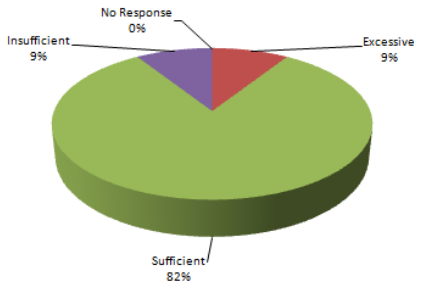
Question 4: How likely is the project team to move technologies into the marketplace?



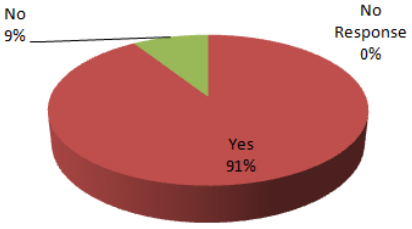
Question 2b: Have the technical barriers been identified and addressed?



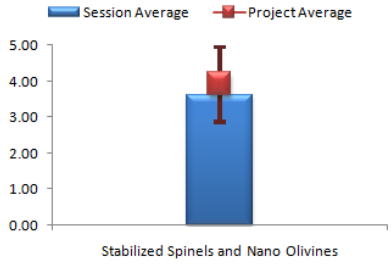
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Summary and Future Plans (V. Srinivasan, of Lawrence Berkeley National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that BATT is very relevant to meet DOE goals, while another added that the BATT program is ideal for developing the next generation of energy storage technology. One reviewer stated, yes, adding that the flowchart shows that all the good collaboration will help meet the goals of the program. Another reviewer stated that the group working on the key things and seems to be the only way to get at long-range PHEV and EV. One final reviewer wrote that the BATT program has led to useful results that may lead to better batteries for HEVs and PHEVs, which will lead to less oil consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that BATT has challenging targets with very good strategy based on cutting-edge fundamental research. Another respondent added that the BATT program addresses long-term research in most aspects of the Li-ion battery technology. This reviewer feels efforts should be extended beyond lithium-based systems. One other person stated there is good strategy with all the collaborations and interactions to meet the program goals. Another response noted the excellent balance and wide range of abilities in the program. The PI is generally of a very high quality and almost all of the staff is comprised of Tier 1 people. The management seems focused and holistic. One person noted the BATT program has helped develop a complete understanding of the barriers to better batteries and has funded projects that have contributed to overcoming these barriers.

One final reviewer suggested that some optimization with ATD and Battery Development programs should be looked at on modeling, final battery evaluation, and material development and testing. Some joint economical evaluations should be started to better estimate the potential cost reduction in material and component development.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the results have surely progressed in a timely fashion with some outstanding results on new materials, new electrodes, new electrolytes, and, in general, in a better comprehension of fundamental mechanisms. Some efforts should be dedicated to the extrapolation of basic results to final batteries. Another respondent noted that BATT has issued a RFP in the area of "Synthesis and Characterization of Novel Electrolytes and Additives for Use in High-energy Lithium-ion Batteries" and is always looking for new ideas that advance the mission of DOE/BATT. There is good coordination and good work.

One response indicated that it was nice to have an overview at the end for ranking purposes and also at the beginning for background/information purposes. Another stated that if the different groups can also keep up with some of the work performed by battery manufacturers and other researchers, it may accelerate the process of reaching the goals.

One reviewer commented that if they continue the momentum like last year this would make a lot of progress. One final reviewer noted that the BATT program has made significant contributions to the development of better batteries. However, this reviewer adds that some of the projects that have been

funded for several years have not borne fruit, such as the DesMarteau project. These projects should not continue to receive funding.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer commented that the BATT program has produced useful results that have been used in the battery industry. One other reviewer added that there are a large number of examples of different types of transfers.

One person indicated there is good collaboration and understanding of team strengths, but added that the group needs more acceleration in tasks to meet goals and have technology transfer. One final reviewer felt that while in general the group is working on the right things, some of the blue sky stuff (Li anodes) is frankly unlikely to make it to market, but it is important to have those coming along as well as long as the funding levels do not get too high and the projects are watched closely to make sure they still make sense (this does not mean we should not have patience with them – progress in these areas will take a lot of time). This reviewer understands that things like this are needed to address the energy needs of the longer-range PHEVs. It is always important to consider material costs associated with major efforts, as expensive materials are unlikely to ever make it to market unless the cost is associated with the production methods. This reviewer is skeptical whenever he or she sees Co mentioned.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the resources must be adequate to support program changes, while another reviewer noted that the university programs seem to have much less than the National Labs, which is understandable. The resources available at universities should be better utilized by providing more funding, as a lot of basic research can be and has been performed by those groups. Another respondent encourages more support to the BATT program to include more university researchers. Similarly, one reviewer thinks the BATT program should be funded at a higher level if the poor projects are pruned.

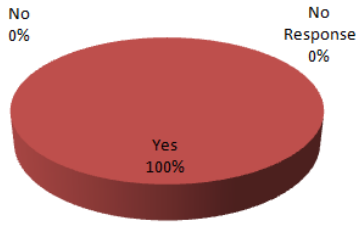
Specifically, one respondent thinks that activity involving Li-metal should be eliminated or significantly reduced. One final reviewer noted that there are a lot of expensive people in the group, but the tasks are daunting enough to match the expense. Looking forward, this reviewer expects this work to continue to advance the science and encourage implementation without doing the detailed development/optimization work that battery companies are better placed to do.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

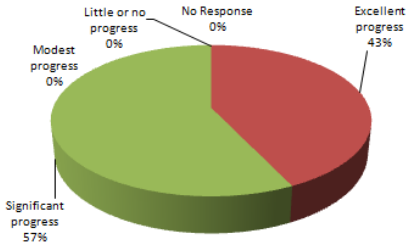
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Summary and Future Plans

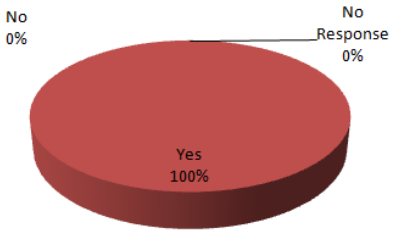
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



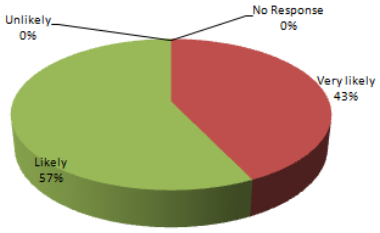
Question 3: Characterize the technical accomplishments and progress toward goals.



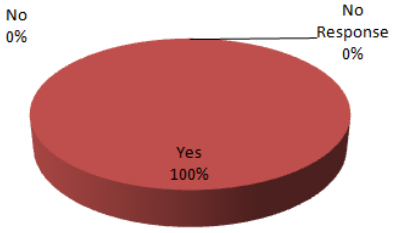
Question 2a: Are the goals of the project technically achievable?



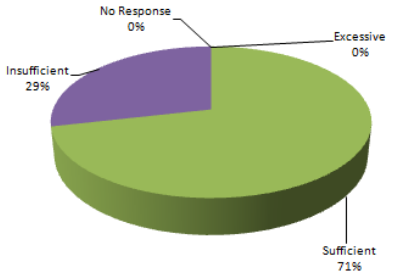
Question 4: How likely is the project team to move technologies into the marketplace?



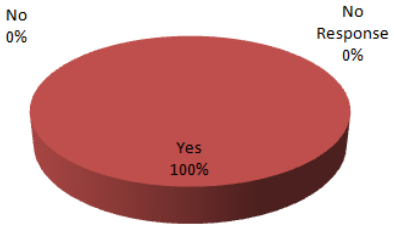
Question 2b: Have the technical barriers been identified and addressed?



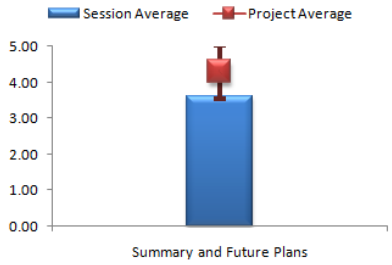
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides (S. Whittingham, of State University of New York-Binghamton)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person simply stated the project supports DOE very much so, as a better cathode will lead to a better cell. Another reviewer agreed, stating that cathode development is a key enabling technology relevant to DOE program. One reviewer indicated that the work is related to the development of high capacity cathodes for li-ion batteries. Another added that the goals include lower cost high capacity and high-rate batteries. One person observed that Whittingham's work may lead to better batteries for HEVs and PHEVs, which would lead to a reduction of oil consumption. Another mentioned that the materials under study have the possibility of increasing the energy of lithium ion batteries to help meet the PHEV goals. One person noted that the focus is on low-cost and environmentally friendly materials, which is in line with the PHEV goals. The use of high power materials with manganese and iron phosphates is also meeting the goals of the program. The last person commented that materials with high Mn content can prove to be cost effective high performance materials. These are yet not synthesized in a satisfactory way, which is in part what this program can do.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person noted that the barriers are clearly identified and the approach is clearly addressing actions to overcome them. Another commented that the authors are competent and the plan is feasible and have put up a good team to study the basics of electrode materials. Another person commented that the low-cost materials and processes are bound to attract industrial interest and should have a big pull from such companies. The reviewer also liked the practical approach of the PI in always looking at the production costs and scalability. They acknowledged the nice work with the $LiFePO_4$, but were glad to see them planning to move on to higher capacity phosphate materials. Another person stated that Whittingham's approach may lead to better cathodes that will last longer and be cheaper than currently used materials. One person commented that the studies on the different phosphates and the layered transition metal oxides does meet the goals identified by the PHEV program and will help overcome the technical barriers. Another person mentioned that hydrothermal methods are generally useful in exploring a broad range of new phosphate materials. They concluded by observing that the impact of reduced cobalt in layer material will have a beneficial economic effect. One reviewer commented that the study of where Ni resides, Li layer or not in Li layer, can help produce synthesis paths that leads to compounds with high Mn content and less Ni in the Li layer. This will likely help increase cycling stability of such a materials, as Ni^{2+} would be disruptive to the materials ability to perform. The last person mentioned the synthesis pathways for olivines with mixed metals are useful for optimizing higher performing compounds.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that progress has been made in upgrading of voltage on phosphate materials while increasing the conductivity and maintaining capacity. Methods of making low cobalt layered oxides are underway. Another reviewer stated that the authors have synthesized $LiFeO_4$ and optimized their synthetic parameters. They have extensively used detailed characterization technique

like X-ray, TEM, SEM, etc. They have also used magnetization studies to see the hysteresis effect in Ni-based cathodes to monitor Ni valency. One person indicated that the discovery of some new synthetic methods and how that affects the crystal structure of materials are all very important for the correlation to electronic and ionic behavior. One other respondent noted the increase in understanding of key synthesis conditions and the questioning of accepted theories, adding that this is good work on the right kinds of materials. One person added that Whittingham is working on reducing the expensive Co component of cathodes, and he is trying to reduce the amount of Ni in the cathode material. He is also trying to find the optimum conditions for the production of $LiFePO_4$.

Some reviewers offered suggestions. One response stated that the progress has been very good with interesting results in terms of increased capacity and preparation process development (hydrothermal for $LiFePO_4$). Some economical studies will be valuable to specify better cost aspects. Another reviewer wrote that the substitutions in the layered oxides and the cycle data showed are good. The studies on the different metal phosphates and the hydrothermal synthesis studies also provide excellent data. More work to study the safety and abuse characteristics of the materials can be carried out in the future to confirm the safe use of these materials.

One other respondent remarked that there has been very good progress in synthesizing new materials and understanding the structures, then asked: why use Ni and Co at all for making low-cost materials (unless you do for understanding purposes)? Another reviewer noted that some olivines and layered manganese oxides have made it into commercial batteries – the present study may confirm their usefulness, but does not add any added advantage of these compounds.

One reviewer commented that, regarding the Ni-Mn-Co work, there has been a lot of work done on these compositions by other groups around the world; what is the original contribution of this work? Regarding the $Ni_{0.5}Mn_{0.5}$ work, it is not clear what the goal of this work is and what work is being done in this task. PO_4 work: this project is showing creativity lacking in the above work. This is nice work thinking of novel phosphate compositions to investigate. One final reviewer noted the focus on: (1) determining optimum Ni/Mn/Co composition is valuable and should be continued and (2) capacity and conductivity of $LiFePO_4$ is valuable and should be continued. Work involving cost-related aspects of $LiFePO_4$ and related processing should be very limited and should only be at a very high level, if at all. Study involving determination of processing methods for $LiFePO_4$ and cost-related aspects of $LiFePO_4$ should basically be discontinued in this project. Greater focus to increase the conductivity or power capability of $LiFePO_4$ would be significantly more valuable than working to increase the storage capacity of Fe and Mn containing phosphates, and these should not be a focus of future work for this project.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that various actions have been in place for assuring technology transfer, while another commented that commercialization of some of these materials has already been done and is expected to continue in the future. One other reviewer felt that the cost drivers and practicality of synthetic methods are very attractive for commercialization. One respondent noted that Whittingham is producing several (perhaps cheaper) olivines, adding that his work may lead to a material that performs better and has a longer cycle life. His work on producing Mg olivines may be used by battery developers. Another response indicated that the researchers have already licensed their technology to Phostech, while one other reviewer remarked that hydrothermal methods are already transferred to lithium iron phosphate materials. One reviewer felt that, in particular, determination of an optimum Ni/Mn/Co ratio should be directly transferable or of value to the marketplace. Another respondent

added that materials companies can bring out the compounds in an effective way with this information. The information on control of morphology is particular important for companies trying to commercialize the materials. The hydrothermal process can be a very cost effective way of synthesize these compounds, which may lead to low-cost material for HEV and PHEV use.

One person wrote that the optimized $LiFePO_4$ or Nickelates have a commercialization path, but added that there are already several competitors in this area. So they need to come up with something different in terms of new attributes which distinguishes them from others. One final reviewer indicated that Ni-Mn-Co materials are already in commercial production in Asia; is the PI talking with any companies to license IP?

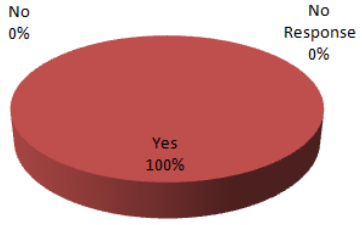
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Two reviewers indicated that the resources for this project seem adequate, while another reviewer felt that the group is doing good work for the funding obtained. One reviewer commented that the ability to tailor morphology is important and the PI can obviously do this. This may enhance conductive pathways and hence performance, all of which are desired for improved electrode materials. There is a good choice of activities for the next year, and optimizing the Mn content is particularly desired for cost reasons.

Another respondent stated that resources intended to be focused on detailed aspects of processing methods or cost aspects on this project should be re-directed towards the other goals of this project. One final reviewer commented that the researcher seems to have a lot on his plate, but added that he or she would like to see more support and even more collaborations.

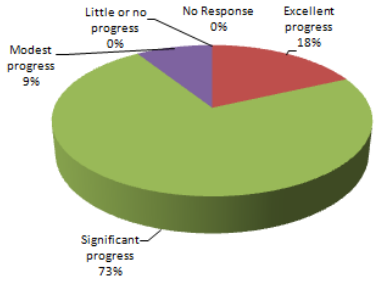
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides

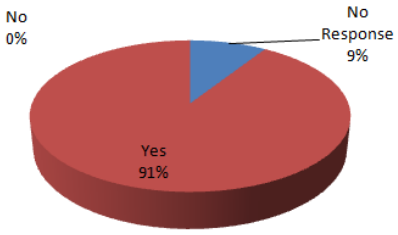
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



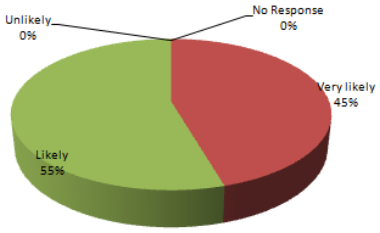
Question 3: Characterize the technical accomplishments and progress toward goals.



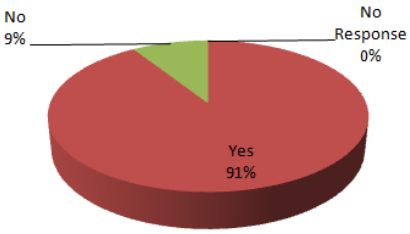
Question 2a: Are the goals of the project technically achievable?



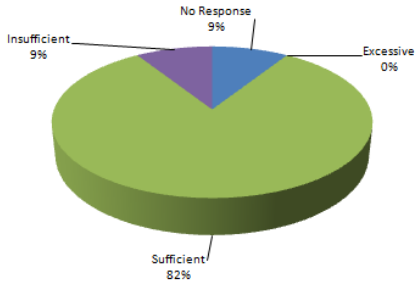
Question 4: How likely is the project team to move technologies into the marketplace?



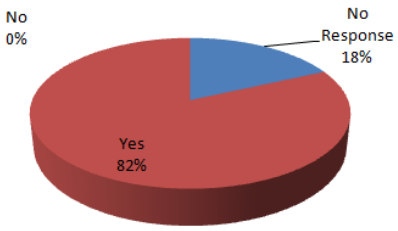
Question 2b: Have the technical barriers been identified and addressed?



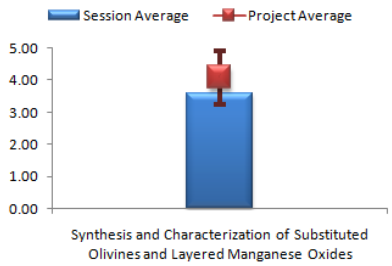
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



The Impact of Electrode Structure on the Processes that Limit Cathode Performance (D. Wheeler, of Brigham Young University)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Positive comments included that this was a basic study to improve comprehension of working mechanisms and is relevant to DOE objectives, and that it is gaining understanding of cathode material properties to improve materials that would meet the program goals for PHEV. Also noted were that the goal of this work is to optimize already existing anode and cathode materials for Li-Ion batteries. Furthermore, electrode design is important for keeping cell impedance down and maybe even in maintaining good cycle life and that Wheeler's work may lead to improved electrodes which may produce better batteries for HEVs and PHEVs which would lead to a reduction in oil use. The final reviewer said that in general, optimized electrodes are needed to fully evaluate new materials and study formulation dependencies. This program was not so successful in doing so.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer reflected positively on the work, stating that the strategy is clear and consistent with the scope to improve the fundamental knowledge and support material development. The work plan was also felt to be feasible, and Wheeler's work may lead to design rules to help optimize the design of electrodes by changing the composition and structure of the electrodes. Trades between the use of materials of lower impedance versus using more inert materials which in turn translates to increasing electronic transport properties have been carried out.

On the other hand, a reviewer said the work is important but was not sure the approach is novel enough. A reviewer said similarly that the project seems too superficial to be successful. The interaction with other participants was not clear to a reviewer, nor was the work on first principle modeling. A reviewer suggested that the PI needs to spend time looking at commercial electrodes and establish baseline. The results and any interpretations are suffering from lack of fundamental understanding of what constitutes a good electrode.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A number of comments were received on the technical aspects of the work. One statement was that a reviewer did not see any substantial results coming out of the program as yet. Another shared that the team needs to show clearly the changes needed in physical parameters to improve electrode operation. Furthermore, a reviewer felt the team had a lack of understanding in electrode fabrication. Formulation work (effect of conductive additives) was stated by one reviewer to be really not at all useful for a university to do - the approach is naive relative to what is done in industry. This reviewer said that we already have Srinivasan at LBNL and Dees at ANL doing similar work on optimizing loading and density; what new contribution does this work make to the program aside from training students? Finally, this reviewer said that much of the electrode design work is pretty obvious and it doesn't really explain fundamentally what's going on. The model seems to be a fitting system, not based on what's actually happening in the battery. Frankly, the Dees model seems to be a much better bet to this reviewer. The thickness impact on power and energy are very well known as are the

importance of calendaring the materials to attain good interparticle contact - basic electrode design work.

On the other hand, a reviewer stated that the results are good and in line with the project objectives. Additionally, the electrode analysis work is very important for the extrapolation of the results from material- or lab-cell results to equivalent vehicle battery system: the method should be extended to all the BATT similar results on cell materials. Further, the extension to other cell components and the study at low temperature should be of value. It was noted that the project may deliver alternative methods to achieve useful modeling of electrodes for the purposes of cell design and performance. This may be useful for other researches in other projects. Finally, effective transport properties in the porous electrode were felt to be useful - it would be good to have a more fundamental understanding of how tortuosity depends on electrode morphology and porosity. This reviewer encouraged the PI to do more work in this area. New models are a good start - the work should be done in collaboration with others in the BATT program to help them understand their materials.

A reviewer commented that studies on cell level performance with changes made to loading, porosity, etc. of the electrode materials, especially the olivine cathode have been carried out to determine the energy and power densities. The correlation between peak performance and loading was explained well. Bulk electrode properties were shown to have impact on cell high rate performance. The development of a battery model helps extend intrinsic properties like electronic conductivity to the performance of a complete cell. The simulation for the thin cell has good correlation with experimental data only at the highest and lowest rate. Same is seen for the thick cell simulation too. No explanations were provided for that. That area of discrepancy may have to be focused on to determine what the limiting factors at those intermediate rates are.

A reviewer noted that the team has optimized the electrode fabrication performance for both energy and power. The parameters like thickness and porosity, carbon weight percent were varied and the corresponding capacity and rate was compared. Subsequently these parameters were modeled. This reviewer suggested that the team carry out these optimizing parameters for a few important cathode and anode materials that have potential for PHEV (energy) cell and tie up with industry if the results are promising. Argonne has already done work in this area and author should choose materials that are rather complementary/not done.

Wheeler's work shows clearly that the thickness and other design parameters of the electrodes must be optimized based on the desired performance. For example, the electrodes for a PHEV10 battery must be different from those for a PHEV40 battery.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

On the positive side, the technology transfer is related to the collaborations and publications and the use of the electrode analysis work may improve the transfer. The project is working on the tech transfer and has a good likelihood for tech transfer as it is being extended to completed cells. Additionally, the electrode optimization and design knowledge gained is important for industry. Finally, Wheeler's work will help battery manufacturers optimize their cell designs to meet the criteria for the HEV or PHEV application.

On the negative side, a reviewer characterized these as poor results. Another said that much of the work presented is naive and not state-of-the-art; we hope that the PI will stay in close contact with others in the BATT program to increase the relevance of his work. A third did not see how the work

really pushes the program forward. Lastly a reviewer offered that it is possible that the model might influence cell or electrode design elsewhere in the future.

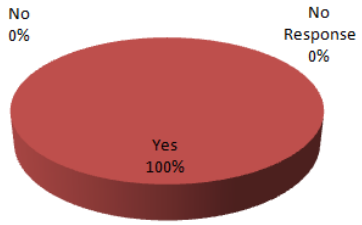
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
To one, the resources seem adequate to the work done: to another, funding was sufficient. A reviewer offered more comments, stating this was very good work for the funding received. The project could benefit from increased funding. Universities are a good resource for both scientific work and high-tech equipment. The cost of labor is also less. Hence more funds can be provided to fund more basic research at the Universities, especially for groups like this that do quality work. Another comment was that training should take place for electrode manufacturing, so better experimental data can be available for the coated electrodes. This will make the PI more effective and then he can apply his core skillset in modeling in a successful way.

One reviewer could not comment on the funding level. The final reviewer recommended cutting funding for this program, stating that others in the program do better electrode design work (ANL) and far better and more relevant modeling work (Dees/Sastry).

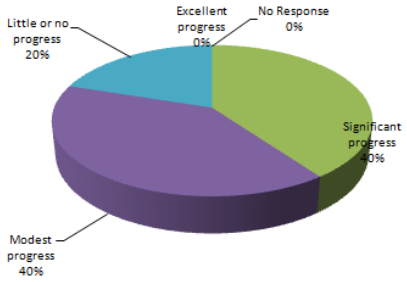
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: The Impact of Electrode Structure on the Processes that Limit Cathode Performance

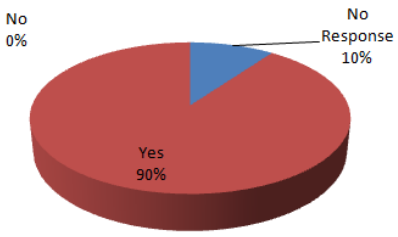
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



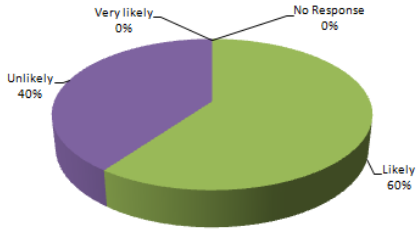
Question 3: Characterize the technical accomplishments and progress toward goals.



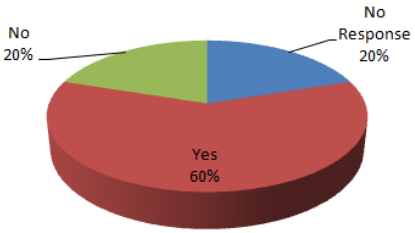
Question 2a: Are the goals of the project technically achievable?



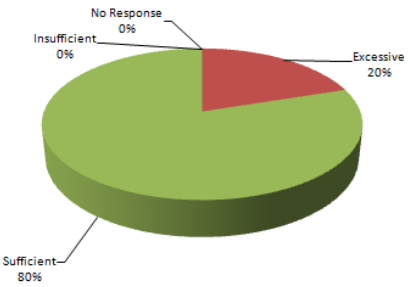
Question 4: How likely is the project team to move technologies into the marketplace?



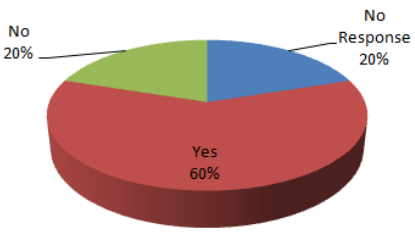
Question 2b: Have the technical barriers been identified and addressed?



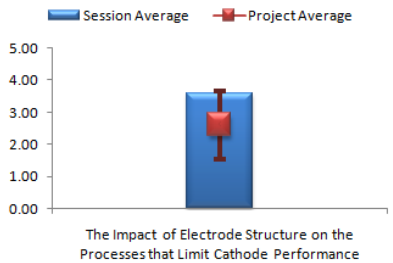
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



5. Advanced Power Electronics

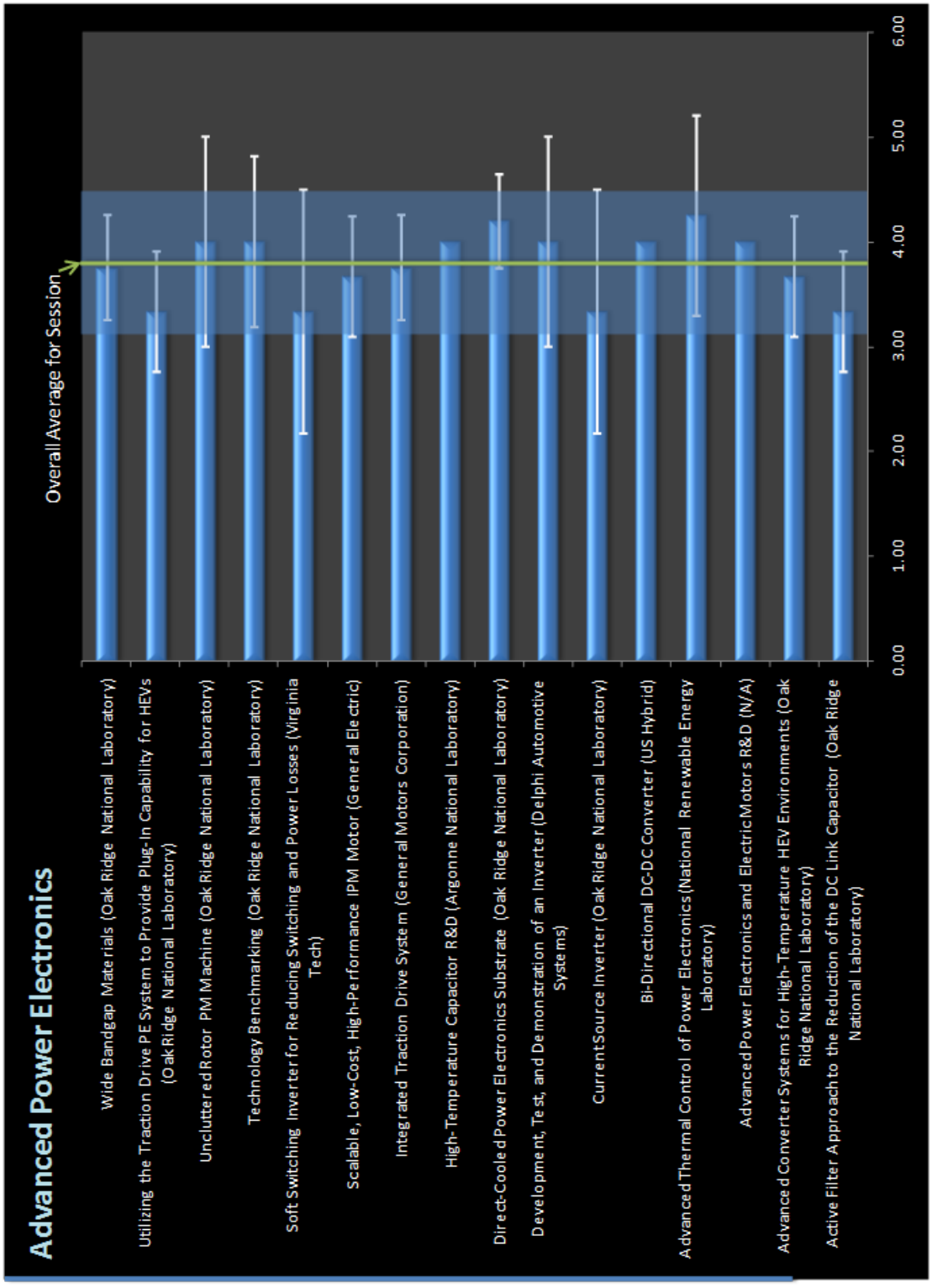
Introduction

Achieving the power electronics and electrical machines goals will require the development of new technologies. These new technologies must be compatible with high-volume manufacturing; must ensure high reliability, efficiency, and ruggedness; and must simultaneously reduce cost, weight, and volume. Of these challenges, cost is the greatest. Key components for hybrid vehicles (with either fuel cell advanced combustion engines as the prime mover) include motors, inverters/converters, sensors, control systems, and other interface electronics. Power electronics and electrical machines research is a collaboration among government, national laboratories, academia, and industry partners. These partners work together to ensure that technical attributes, vehicle-scale manufacturing, and cost sensitivities are addressed in a timely fashion and that the resulting technologies can be adopted by companies willing and able to supply products to automakers.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
5-4	Active Filter Approach to the Reduction of the DC Link Capacitor (Ozpineci, Burak, Oak Ridge National Laboratory)	3.33	0.58
5-6	Advanced Converter Systems for High-Temperature HEV Environments (Ozpineci, Burak, Oak Ridge National Laboratory)	3.67	0.58
5-8	Advanced Power Electronics and Electric Motors R&D (N/A, N/A)	4.00	
5-10	Advanced Thermal Control of Power Electronics (Kelly, Ken, National Renewable Energy Laboratory)	4.25	0.96
5-13	Bi-Directional DC-DC Converter (Goodarzi, Abas, US Hybrid)	4.00	0.00
5-15	Current Source Inverter (Marlino, Laura, Oak Ridge National Laboratory)	3.33	1.15
5-17	Development, Test, and Demonstration of an Inverter (Taylor, Ralph, Delphi Automotive Systems)	4.00	1.00
5-19	Direct-Cooled Power Electronics Substrate (Olszewski, Mitch, Oak Ridge National Laboratory)	4.20	0.45
5-22	High-Temperature Capacitor R&D (Balachandran, Uthamalingam, Argonne National Laboratory, and Dirk, Shawn, Sandia National Laboratories)	4.00	0.00
5-25	Integrated Traction Drive System (Smith, Greg, General Motors Corporation)	3.75	0.50

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
5-27	Scalable, Low-Cost, High-Performance IPM Motor (Salasoo, Lembit, General Electric)	3.67	0.58
5-29	Soft Switching Inverter for Reducing Switching and Power Losses (Lai, Jason, Virginia Tech)	3.33	1.15
5-32	Technology Benchmarking (Olszewski, Mitch, Oak Ridge National Laboratory)	4.00	0.82
5-34	Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors (Marlino, Laura, Oak Ridge National Laboratory and Anderson, Iver, Ames National Laboratory)	4.00	1.00
5-37	Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs (Marlino, Laura, Oak Ridge National Laboratory)	3.33	0.58
5-39	Wide Bandgap Materials (Ozpineci, Burak, Oak Ridge National Laboratory)	3.75	0.50
	Overall Session Average and Standard Deviation	**3.81**	**0.68**


Advanced Power Electronics
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Wide Bandgap Materials (Oak Ridge National Laboratory)
Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs (Oak Ridge National Laboratory)
Uncluttered Rotor PM Machine (Oak Ridge National Laboratory)
Technology Benchmarking (Oak Ridge National Laboratory)
Soft Switching Inverter for Reducing Switching and Power Losses (Virginia Tech)
Scalable, Low-Cost, High-Performance IPM Motor (General Electric)
Integrated Traction Drive System (General Motors Corporation)
High-Temperature Capacitor R&D (Argonne National Laboratory)
Direct-Cooled Power Electronics Substrate (Oak Ridge National Laboratory)
Development, Test, and Demonstration of an Inverter (Delphi Automotive Systems)
CurrentSource Inverter (Oak Ridge National Laboratory)
Bi-Directional DC-DC Converter (US Hybrid)
Advanced Thermal Control of Power Electronics (National Renewable Energy Laboratory)
Advanced Power Electronics and Electric Motors R&D (N/A)
Advanced Converter Systems for High-Temperature HEV Environments (Oak Ridge National Laboratory)
Active Filter Approach to the Reduction of the DC Link Capacitor (Oak Ridge National Laboratory)

Active Filter Approach to the Reduction of the DC Link Capacitor (Burak Ozpineci, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer noted that limiting capacitors limits the need to find high-power-density, high-temperature ones, which is normally a very difficult technical challenge. This is a nice way to solve the problem by avoiding it. Another person commented that reducing the total cost of power electronics systems will be of importance in HEV and PHEV applications. One person added that the work could lead to some cost savings.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses to this prompt were mixed. One person indicated that it should be possible to achieve the goals with clever electrical design. Another stated that an active filter is a nice concept, but no technical details or designs have been identified in this project. The team needs to develop a detailed approach that can work at this high frequency and still be cost effective. One other reviewer stated that no real deployment plan had been presented.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that no detailed technical approach has been proposed, while the other reviewer said it seems to be early on and has not moved beyond the simulation stage.

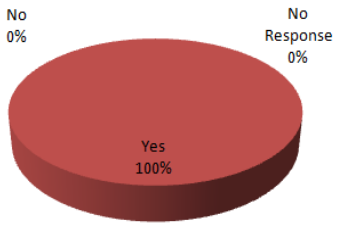
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that the reduction in the size of the capacitor may be offset by the complexity of the design. This reviewer would expect the reliability of the system to be worse, since the capacitor is not eliminated and the design adds more switches. One other person commented that it is not about knowing how the active filter is designed, but rather about whether it is fast enough to perform the required filtering task.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that resources are sufficient to perform this task.

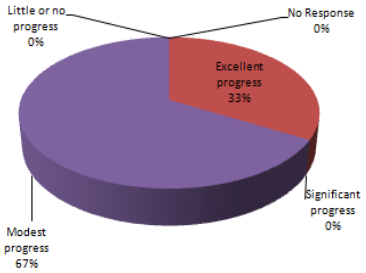
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Active Filter Approach to the Reduction of the DC Link Capacitor

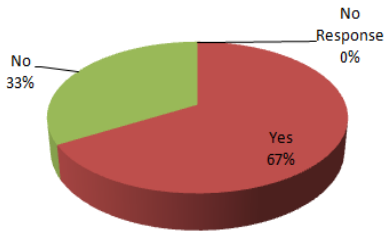
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



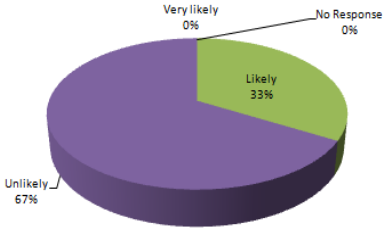
Question 3: Characterize the technical accomplishments and progress toward goals.



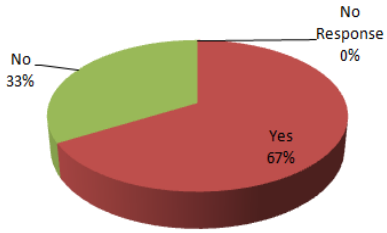
Question 2a: Are the goals of the project technically achievable?



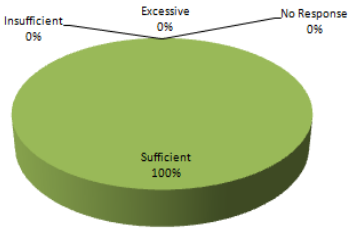
Question 4: How likely is the project team to move technologies into the marketplace?



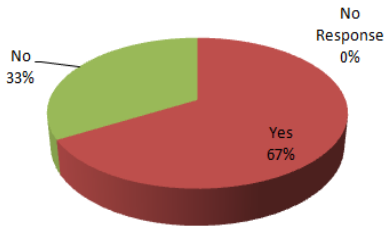
Question 2b: Have the technical barriers been identified and addressed?



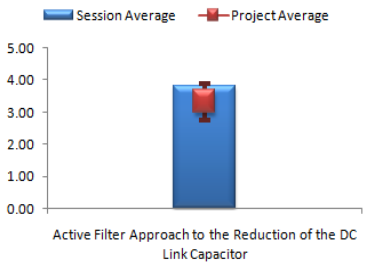
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Converter Systems for High-Temperature HEV Environments (Burak Ozpineci, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this is a critical component in future vehicles, while another commented, similarly, that converter systems, especially ones designed and packaged for high temperature environments, are very important for achieving DOE's vehicle goals. One other respondent stated that an SiC converter is one potential candidate for high temperature applications, adding that there are many challenges and barriers in applying this technology. A 55kW DC-DC converter is very ambitious if SiC is used. If Si is used, then there is limited potential to achieve the desired high temperature capabilities.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent indicated that widespread use of this design depends greatly on the cost of the SiC devices, adding that they will likely find uses in the military and aerospace markets. Another reviewer commented that, if SiC is used, then at a lower power rating it is possible for deployment. The reviewer adds that the available SiC JFET and MOSFET may not be available for the application. When parallel-connecting the devices to achieve the power rating of 55kW, parasitic stray inductance and capacitance will have a large impact on the current and voltage (reverse recovery current, etc.).

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the technical approach and plan is reasonable to achieve the goal, while another said that the project has made progress in using Si for high temperature capability. This person also noted that SiC has not been investigated yet.

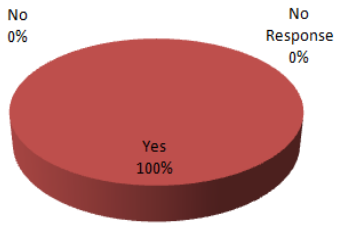
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that DC-DC converters at much higher powers have been developed (5.5KW). Even though these are working at a high temperature, this reviewer feels that they may not be of interest to the industry. One person suggested considering the military and aerospace or other niche applications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that resources are sufficient.

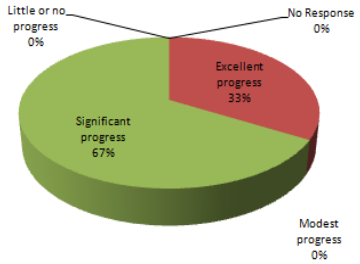
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Converter Systems for High-Temperature HEV Environments

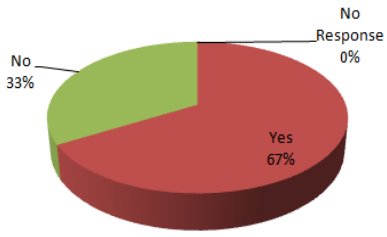
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



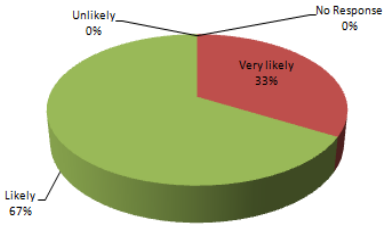
Question 3: Characterize the technical accomplishments and progress toward goals.



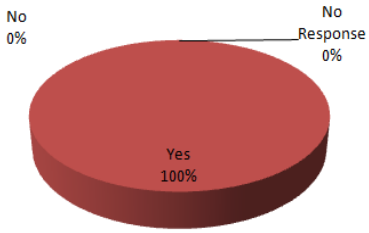
Question 2a: Are the goals of the project technically achievable?



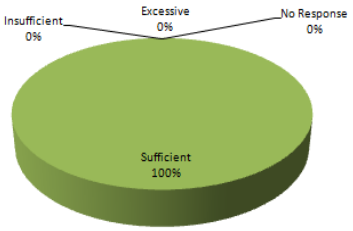
Question 4: How likely is the project team to move technologies into the marketplace?



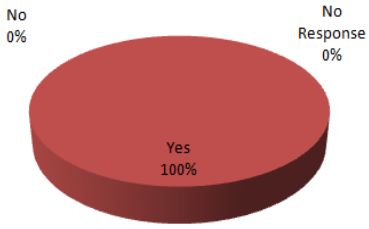
Question 2b: Have the technical barriers been identified and addressed?



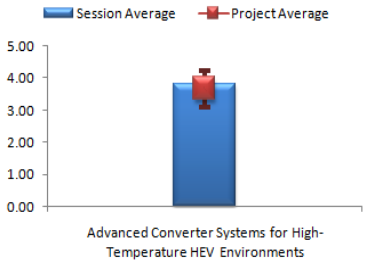
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Power Electronics and Electric Motors R&D

Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent stated that this project summarizes efforts for APEEM for a better assessment of future research directions to meet DOE goals.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent stated that this was not really applicable to a summary poster.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent commented that the projects as a whole have shown good progress.

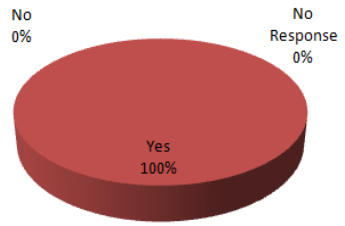
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
There were no responses to this prompt.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

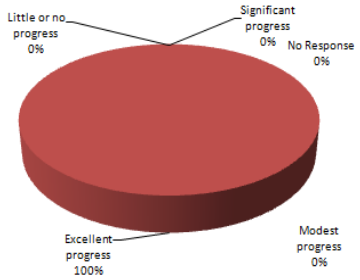
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Power Electronics and Electric Motors R&D

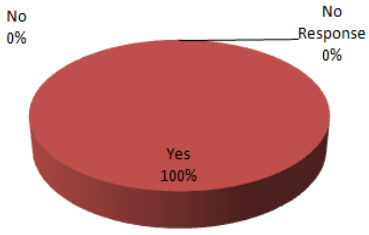
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



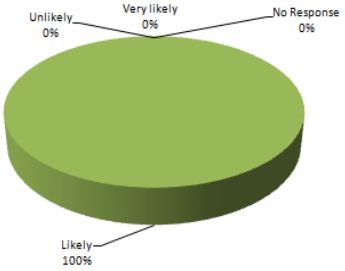
Question 3: Characterize the technical accomplishments and progress toward goals.



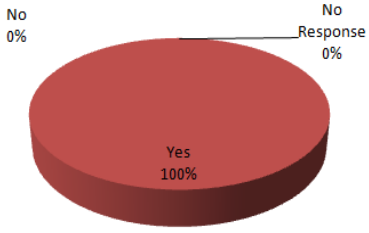
Question 2a: Are the goals of the project technically achievable?



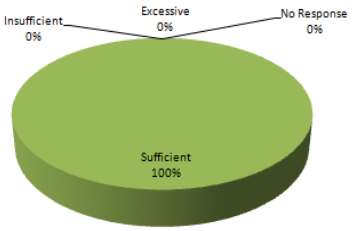
Question 4: How likely is the project team to move technologies into the marketplace?



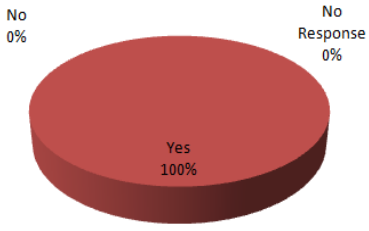
Question 2b: Have the technical barriers been identified and addressed?



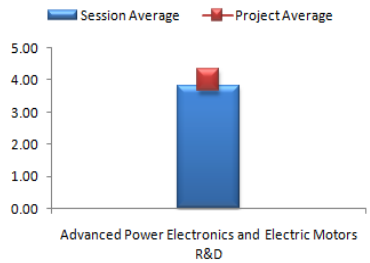
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Thermal Control of Power Electronics (Ken Kelly, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that thermal management is of particular interest in advanced vehicle (HEV, PHEV) applications, and it is essential to reduce size, volume, cost, and increase reliability, and efficiency. Another individual commented that the cooling of the power electronics is critical to having a reliable power electronics design for the HEV. Similarly, another reviewer indicated that thermal management is critical to enabling the electronic systems to ensure reliable, efficient performance of HEVs. APEEM program goals for a 105°C coolant require advances in the areas addressed by this effort. One final reviewer stated that advanced thermal control technologies are critical to enabling higher power densities and the associated reduction in the need for fuel without producing such high temperature levels that performance, life, and reliability of power electronic components are significantly degraded, especially at the desired coolant temperature of 105°C.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the goals of the project are clearly defined: reach \$12/kW, 400W/cm^2, and 105°C inlet temperature. The group has examined Prius, Camry, and Lexus designs in cooling. The barriers are correctly identified with regards to heat flux density capability, and three types of solutions were compared to reduce costs. There are currently five projects in thermal / cooling from NREL. One person added that, by looking at a broad range of cooling materials and technologies, this will allow for one of the best solutions to be brought forward.

One reviewer stated that they recognize the need to improve measurements in all areas. The TIM goal is ambitious given how much effort industry has been put into this area. While using air to cool power electronics is desirable, it seems impractical to meet the required 200+ W/cm^2. Important barriers to implementing modeling tools for reliability are identified, but path to addressing them is not clear. This reviewer adds that standards for reliability are important.

One final reviewer commented that many advanced cooling projects were discussed concurrently. Most of the research seems to be focused on modeling and assessing existing materials and technologies, and not on identifying and overcoming technical barriers that are standing in the way of HEV development. A good example of this is in the area of thermal interface materials, where most work characterizes existing TIMs and there is no clear path to the "BREAKTHROUGH" material desired as the final output.

The reviewer was also not clear what new technology is being developed in air-cooled microchannel heat exchangers. Finally, the goal in the thermal stress and reliability program of having a quantitative method to evaluate the 15-year-life target of new technologies is being achieved right now at leading universities, companies, and government agencies that are already working on this. Major players in this area need to be brought onboard in more than an interviewee role to ensure timely and cost-effective success. For example, the reviewer adds, Daimler/Ford/GM have been working in this area for at least a decade.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that the program is on track with its scheduled milestones and suggested that they work closely with power electronics experts (universities, etc.) to quantify the loss and effectiveness of the cooling methodology based on driving profiles (when the heat is not uniformly distributed nor constant function of time).

Another person stated that there has been good progress in improving characterization techniques. The integration of experimentation and modeling is good. The TIM program incorporating materials other than CNT is key to cost/risk reduction. Direct backside cooling represents a high-risk approach to cooling, and this may lead to mechanical fatigue problems in the electronic module. The reviewer added that more work needs to be done to address reliability and cost. There is currently insufficient data regarding thermal stress and reliability to validate models. The uncertainty in each step of approach is unknown, so how this uncertainty propagates through multiple modeling steps significantly impacts the predictions of the system model (robust design).

One final reviewer noted that, in the area of thermal interface materials, significant effort has been devoted to reproducing the ASTM standard set up with its significant limitations and using it to characterize off-the-shelf TIMs instead of pursuing and validating promising new approaches in testing or materials development. Also, most of the accomplishments appear to be conference papers, not actual hardware or technology improvements demonstrating progress toward overcoming barriers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent stated that some of the technologies being looked at will move into the final package design, while another individual stated that the group is working closely with industry partners on methodologies, materials, and modeling. One reviewer added that there is potential for the method and material to be used by industry. The CRADA with Semikron is a good indication of implementation in the marketplace.

To contrast, one response stated that there is no clear pathway for the development, let alone the marketing of new TIM materials, heat exchangers, or reliability tools.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the resources are sufficient in the study, while another noted that funding should be ongoing into 2009. Another person added that this is an important component of the APEEM program and sustained funding is justified.

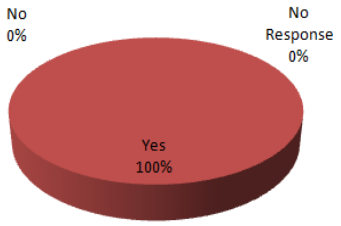
One final reviewer said that too many resources are being spent rebuilding existing test method setups and re-evaluating and assessing existing materials, existing technologies, and existing reliability models already developed and characterized by the power electronics community. If kept at the current level of funding, NREL needs to distribute more of the funding through partnerships with leading research institutions to actually move the technology forward.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

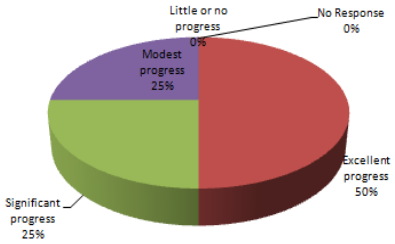
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Thermal Control of Power Electronics

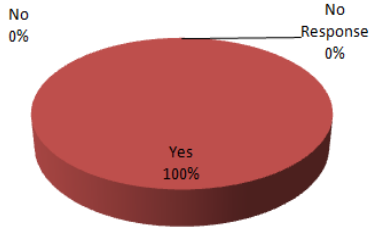
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



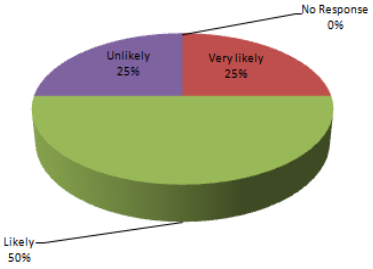
Question 3: Characterize the technical accomplishments and progress toward goals.



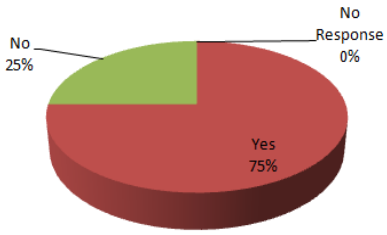
Question 2a: Are the goals of the project technically achievable?



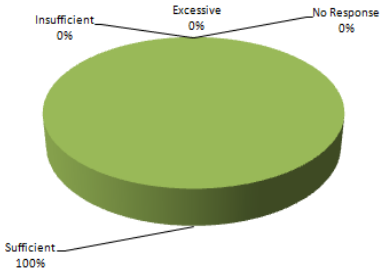
Question 4: How likely is the project team to move technologies into the marketplace?



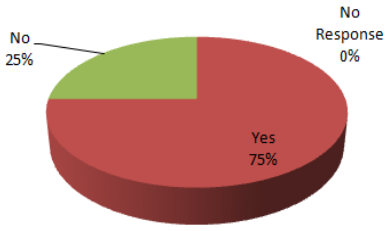
Question 2b: Have the technical barriers been identified and addressed?



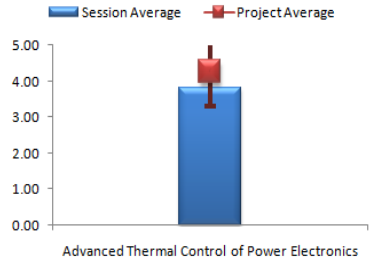
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Bi-Directional DC-DC Converter (Abas Goodarzi, of US Hybrid)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first response stated that a DC-DC converter is an important component in HEVs to manage batteries and increase battery life, as well as matching the voltage with the DC bus and battery terminal. Another reviewer commented that the use of a bi-directional DC-DC converter allows the use of multiple energy storage units, and the flexible DC-link voltages can enhance the performance of the electronics. Similarly, one other person stated that HEVs/PHEVs will have multiple DC voltage levels, and that makes the DC/DC converter important. The product can be more significant in the FCV.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that efficiency is critical, noting the DC link voltage optimization to combine a high energy battery and a high power battery (ultracap?). Another reviewer commented that higher motor efficiency is achieved by increasing the DC bus voltage. The dual energy storage system – one for energy density and one for power density with a DC-DC converter and DC link volt regulator – allows for a SOC-versus-time curve that is flat, as opposed to decreasing as the battery is drained. One other person stated that they did not see a plan to deploy the product.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer indicated that some testing has been done, but more detailed research at the system level (packaging and parallel connection of SiC chips, etc.) should be explored. The other respondent stated that the effort completed so far covers the concept study and design. This progress is significant and headed in the right direction.

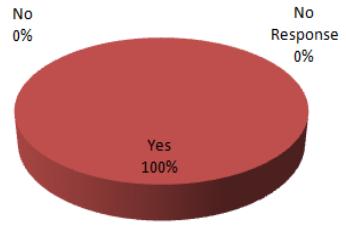
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented that all SiC DC-DC converters may have a cost concern in terms of marketing them for general use in vehicles. The other respondent stated that DC/DC is a significant component and a Si converter can readily transfer to market. The SiC solution will depend entirely on the ability to meet cost targets and reliability performance.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the funding level is sufficient to complete the tasks, while another felt that the project seems underfunded ($293k) for the goals stated.

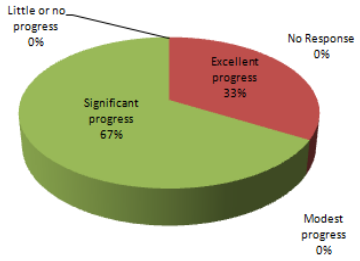
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Bi-Directional DC-DC Converter

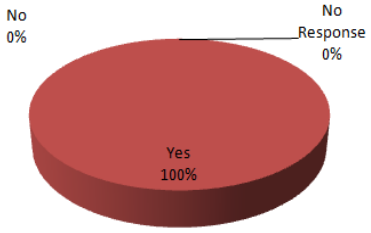
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



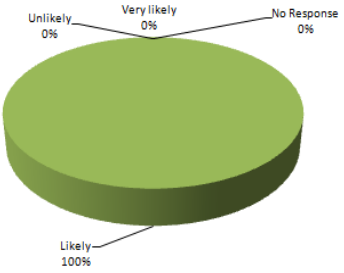
Question 3: Characterize the technical accomplishments and progress toward goals.



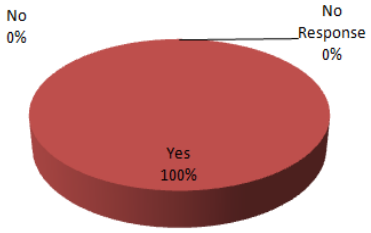
Question 2a: Are the goals of the project technically achievable?



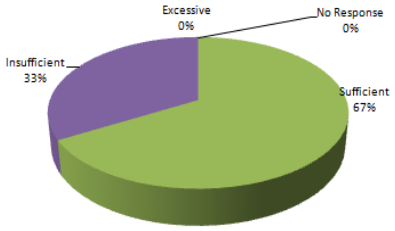
Question 4: How likely is the project team to move technologies into the marketplace?



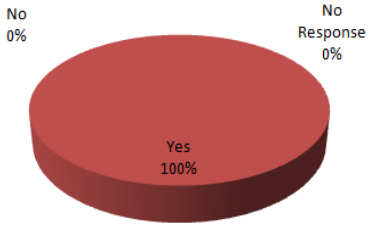
Question 2b: Have the technical barriers been identified and addressed?



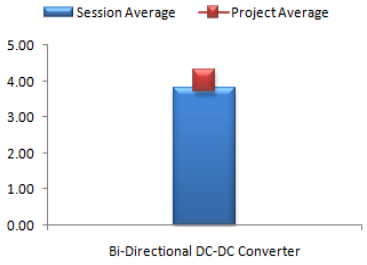
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Current Source Inverter (Laura Marlino, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that inverters are critical elements in HEV electronic propulsion systems. Another person stated that, even though advanced power electronics are critical for the successful implementation and commercialization of HEVs, in general the US is way behind Japanese automotive companies. Personally, this reviewer does not think that a current source inverter is a good choice for HEV applications.

One other reviewer stated that the concept is worth investigating to achieve the stated goals of the program, but this may be a case of simply replacing the issues of the voltage source inverter with the new issues in the CSI, which is of equal difficulty. This reviewer felt that there are significant packaging issues, but the end reward of significantly reducing the capacitance justifies the effort.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the barriers are likely to be overcome but still need serious work and innovative ideas. The other respondent did not hear a deployment strategy.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent stated that it is too early in the project to give this project a higher rating.

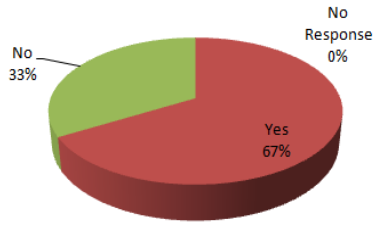
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent stated that he or she could not be sure until they see more information and test results.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

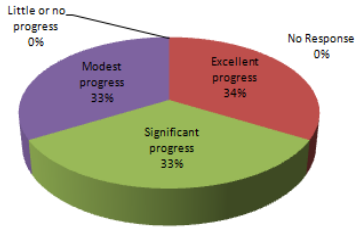
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Current Source Inverter

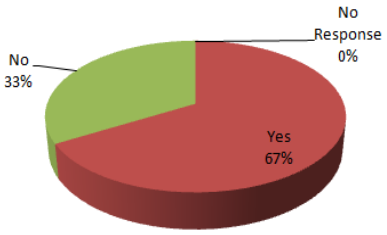
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



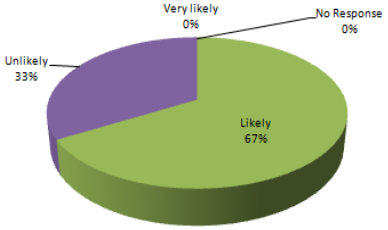
Question 3: Characterize the technical accomplishments and progress toward goals.



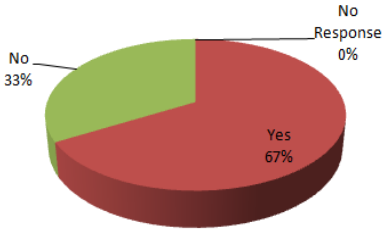
Question 2a: Are the goals of the project technically achievable?



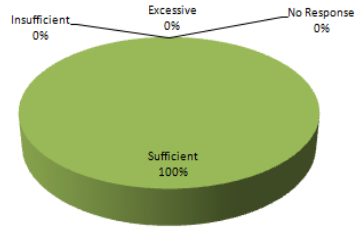
Question 4: How likely is the project team to move technologies into the marketplace?



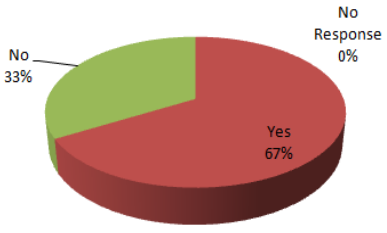
Question 2b: Have the technical barriers been identified and addressed?



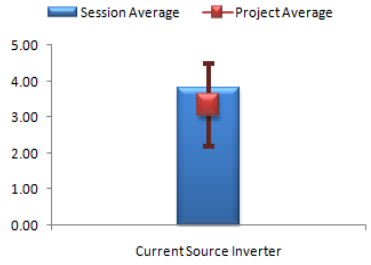
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Development, Test, and Demonstration of an Inverter (Ralph Taylor, of Delphi Automotive Systems)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated that high temperature inverter technology is critical to the development of HEVs, while another added that high temperature inverters will reduce future vehicle system costs and improve reliability. One other reviewer commented that the inverter is an important part of HEVs and PHEVs, and it must be investigated in terms of operation efficiency, temperature, cost, and reliability.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer indicated that there is good work being done in the comparison of different technologies, while another stated that there is a very good plan and partners selected to be able to bring the technology to market quickly if successful. One other individual noted that the project requires the integration of a number of new developmental technologies for success, and so is high risk. However, this reviewer adds that the technologies chosen are promising and seem to be ready for such an integration.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Results were similar in this section. One reviewer commented that this is a new project and so there are not many results yet. The results shown were promising. Another person added that some preliminary investigation has been performed. One other reviewer stated that the only progress shown to date was the creation of the project team.

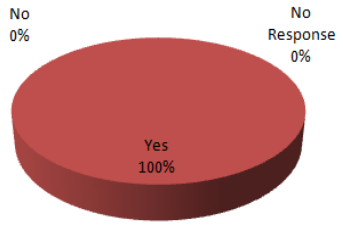
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer noted that Delphi itself is a Tier 1 supplier, and therefore it will be easy to implement if the research is successful. Another stated that, if not all the technologies, some of the technologies that come from this project will most likely make it to a successful product.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the funding is sufficient for the project, and probably more than what it needs.

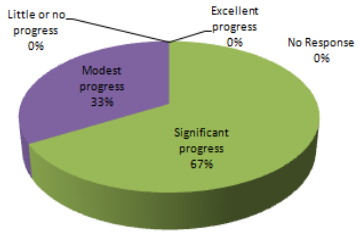
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development, Test, and Demonstration of an Inverter

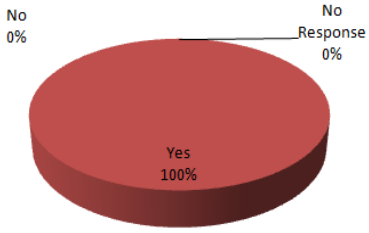
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



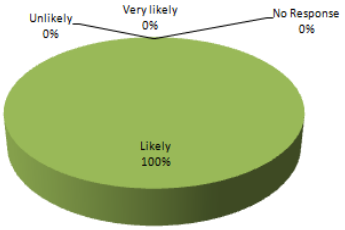
Question 3: Characterize the technical accomplishments and progress toward goals.



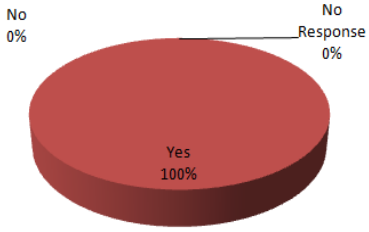
Question 2a: Are the goals of the project technically achievable?



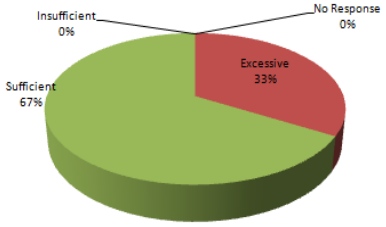
Question 4: How likely is the project team to move technologies into the marketplace?



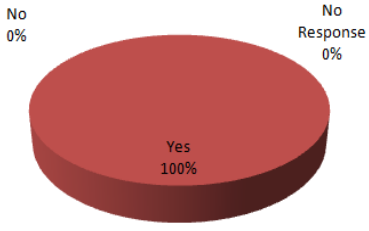
Question 2b: Have the technical barriers been identified and addressed?



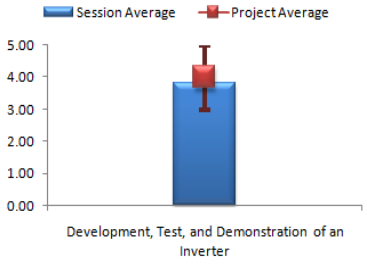
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Direct-Cooled Power Electronics Substrate (Mitch Olszewski, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that cooling technologies are essential for next generation power electronics and for fuel use reduction, while another added that the project's impact on cooling the power semiconductors could be very significant for power electronics. One reviewer stated that developing a novel thermal management methodology is critical for HEV and PHEV power electronics, while another person similarly wrote that thermal management is critical to enabling the electronic systems to ensure reliable, efficient performance of HEVs. One final reviewer stated that this is a novel approach to improving cooling by eliminating the heat sink. If successful, this reviewer adds, the results could be ground-breaking in terms of packaging power modules.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses to this prompt were generally mixed. One reviewer called this a well-defined and scoped project, while another indicated that the barriers are identified and a technical approach is proposed, with a potential density of 15kW/L with 105°C coolant using Si devices. One other person stated that, from a cooling standpoint, the project could have a major impact on the power semiconductor operating temperature/heat flux density and the size of the power electronics. The impact on EMC should be evaluated, as this approach may have a negative impact on EMC.

In contrast, one reviewer stated that the presenter identified the technical barriers well, but did not present any information to lead this reviewer to think that the barriers could be overcome. One other individual also noted that there are significant barriers to developing these technologies. Many have been identified. Thermal stressing due to CTE mismatch is a significant problem. They have a methodology to address it, but no path has been identified. Manifolding will also be an important issue.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that progress has been made on the shapes of the coolant path in the ceramic substrate.

Another person indicated that the project is still at a starting stage: the reviewer would like to see early experiments on the approaches proposed. Similarly, one reviewer stated that it is a new project, so they may need more time to show progress. One final reviewer also noted the newness of the project, adding that this is why all the barriers have not yet been addressed. This reviewer added that stress analysis results are not yet available, and alternative designs were alluded to, but not shown.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that the technology should be transferrable to a wide range of inverter/converter technology. Another person commented that the basic concept has high potential to make a significant impact on cooling the power semiconductors. If coolants are compatible with

the device materials and costs to manufacture are inline, the likelihood that the technology will move forward is high.

In contrast, one individual stated that it is too early to know the feasibility of the approach, and added that it may face serious technical barriers in implementation of the approach. Another review indicated that, since at this stage it is only a concept and no information was presented with regards to overcoming the very significant technical barriers and cost issues, one would have to say at this time it looks unlikely to make it to market.

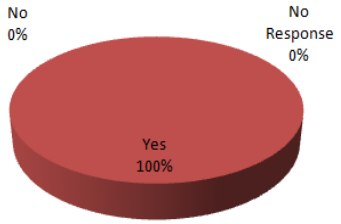
One final reviewer noted that this is a high-risk approach. Industrial adoption will be difficult and manufacturing cost is likely to be greater than estimated.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the funding level is appropriate, while another commented that resources are consistent with the effort described. One individual stated that, because of the high risk involved and high-payoff nature of this project, more should be spent on the feasibility phase of the project. Another reviewer indicated that funding for this year is sufficient, but future years' funding will be required to advance the technology. Funding should be ongoing into 2009 depending on 2008 results.

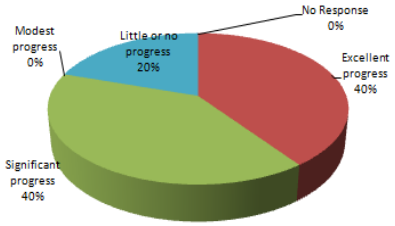
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Direct-Cooled Power Electronics Substrate

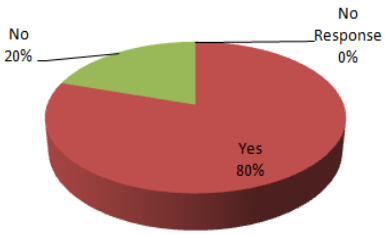
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



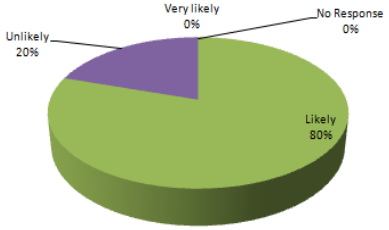
Question 3: Characterize the technical accomplishments and progress toward goals.



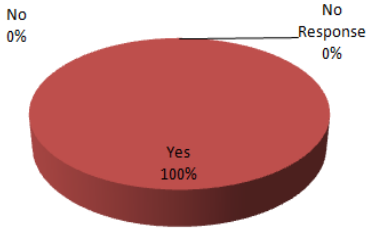
Question 2a: Are the goals of the project technically achievable?



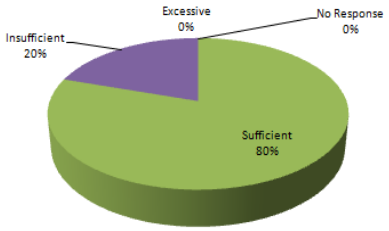
Question 4: How likely is the project team to move technologies into the marketplace?



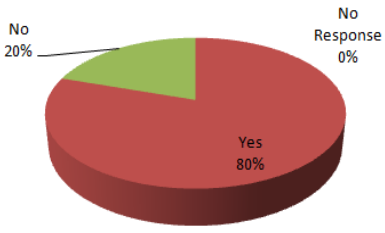
Question 2b: Have the technical barriers been identified and addressed?



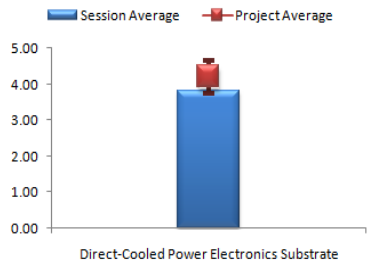
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Temperature Capacitor R&D (Uthamalingam Balachandran, of Argonne National Laboratory and Shawn Dirk, Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that capacitors are the limiting factors for high temperature applications, and are therefore worthwhile to investigate. Another person commented that, at the moment, the capacitor component in the inverter for HEV / EV and FCV vehicles is the weakest link in terms of moving to higher operating temperatures. One reviewer stated that higher temperature and fail-safe capacitors are needed for the power electronics in the HEV. One final commenter wrote that capacitor development can lead to size and weight reductions in one of the largest, heaviest, and least reliable elements of the motor drive: the DC bus capacitor. Smaller, higher power density capacitors with higher performance and reliability will reduce the electronics' weight and improve the ability of these systems to store and process energy, leading to increases in fuel efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person commented that the current three-pronged approach provides redundant paths for success and the ability to choose from several successful solutions for the optimum path for future deployment. One reviewer also commented on these different approaches, while a third person stated that these parallel technology approaches should continue.

Another reviewer stated that the group seemed to have selected the right partners to commercialize the technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that certain progress has been made, while another wrote that good progress has been shown on all the different technical approaches. One final reviewer stated that the project has demonstrated good performance and reliability of film-on-foil dielectric capacitors, along with a graceful failure mode. This reviewer adds that TRS has demonstrated a high energy density capacitor made from LCD glass plate, and a polymer film capacitor from Sandia has been demonstrated in lab-scale production with good levels of performance.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer commented that one of the technologies could reach the market, while another response stated that, since higher temperature and high density capacitors are desperately needed, it is highly likely that one of the technologies under development (polymer, glass, etc.) will make it to market. This reviewer adds that the polymer solution seems most likely to succeed.

One other respondent stated that, if successful, it has potential to significantly reduce size, volume, and increase operational temperature of power electronic systems. One final reviewer commented that a U.S. patent has been granted for film-on-foil capacitors. Penn State is collaborating with Corning and Schott Glass to adapt LCD-display manufacturing to capacitors. This reviewer adds that

TRS, Inc., a small business, is committed to the development and marketing of the LCD glass capacitor.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that this is making good progress on the current level of resources. Efforts are now focused on prototyping, development/improvement, and marketing activities, and are unlikely to require an increase in resources over the current level. One other response suggested that funding should continue on all three technologies into 2009.

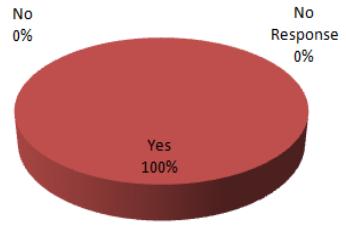
One other person recommended putting more resources into this effort to speed up the development and bring the technology to market sooner.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

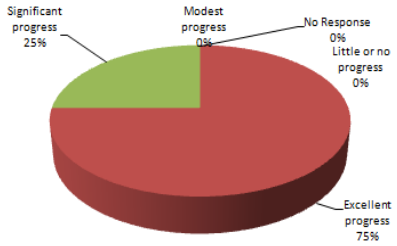
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Temperature Capacitor R&D

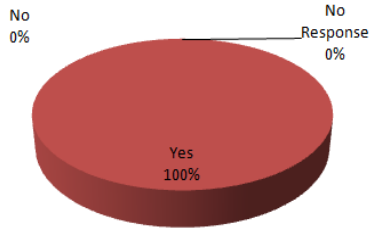
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



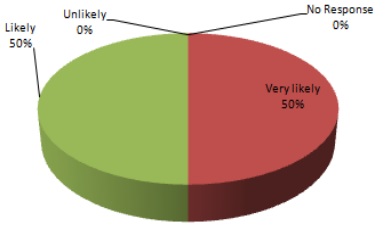
Question 3: Characterize the technical accomplishments and progress toward goals.



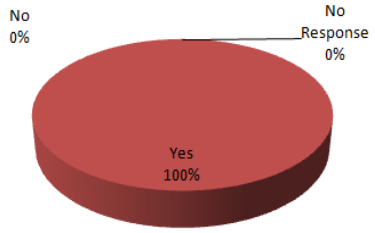
Question 2a: Are the goals of the project technically achievable?



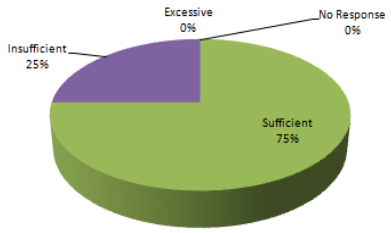
Question 4: How likely is the project team to move technologies into the marketplace?



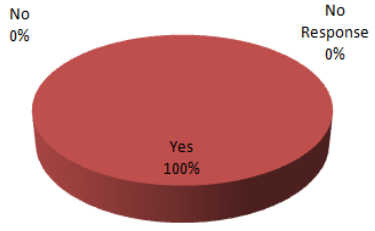
Question 2b: Have the technical barriers been identified and addressed?



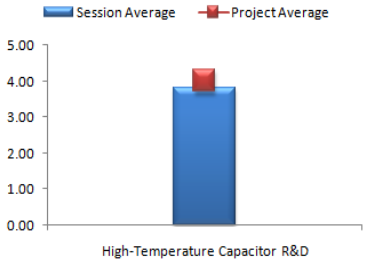
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Integrated Traction Drive System (Greg Smith, of General Motors Corporation)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person noted that this project is to develop an inverter for the HEV, which would tie directly to the HEV fuel savings. Another reviewer commented that the US is very late in HEV and PHEV development and commercialization, and the hope is that this will add to the efforts of the auto companies. One other reviewer stated that system level integration presents its own set of problems and should be investigated to reduce the cost of the hybrid drive train.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the barriers were correctly identified, including thermal, switching frequency, cost, capacitor, motor, etc. Another person stated that the concepts for cooling the power electronics and the packaging of the power semiconductors appear likely to be deployed.

One other respondent stated that this is a new project, and thus it is too early to make any significant comments regarding deployment. However, this reviewer noted that GM is large enough to deploy the technology, should it prove to be viable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that there were no technical details to help them to come to a meaningful conclusion. Another commented that, since it is too early in the project, no significant progress has been made to overcome the technical barriers. This reviewer added that a good plan was presented to achieve success. One final reviewer noted that this was a new start to the program and that the basic concepts appear likely to work.

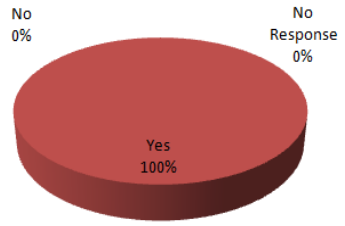
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the basic concepts appear likely to work, while another indicated that, if the project meets its goals, then it is highly likely that the technology will make its way to GM vehicles. One reviewer stated that GM is the OEM but they may never make electric powertrain components. This reviewer hopes it will work out well with a supplier.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that they would like to see the funds spread out to a few companies or universities to support more projects, adding that it seems that the grantee is just doing system integration, not developing any of the system components. One other reviewer stated that the project will require addition funding for future years, adding that funding should be ongoing into 2009.

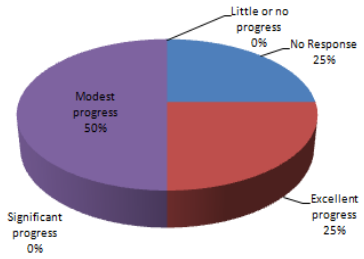
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Integrated Traction Drive System

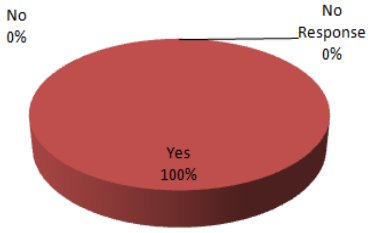
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



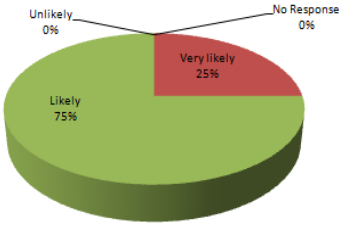
Question 3: Characterize the technical accomplishments and progress toward goals.



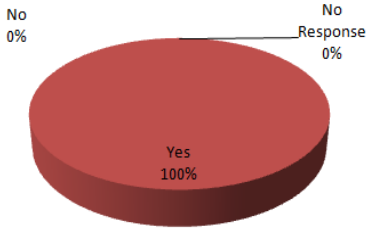
Question 2a: Are the goals of the project technically achievable?



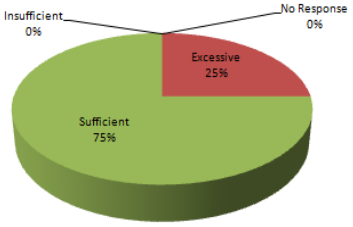
Question 4: How likely is the project team to move technologies into the marketplace?



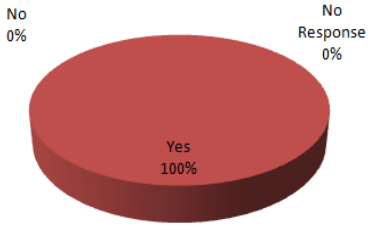
Question 2b: Have the technical barriers been identified and addressed?



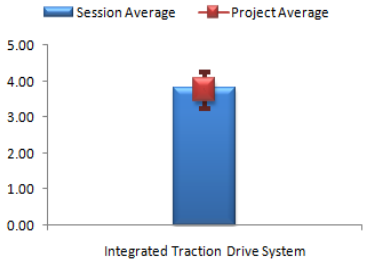
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Scalable, Low-Cost, High-Performance IPM Motor (Lembit Salasoo, of General Electric)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer indicated that this is one of the areas that can improve the efficiency of HEV motors. The other respondent stated that, since the electric motor is expected to be the prime mover in all future vehicles, work on new motors is very much justified.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response stated that this is an interesting new motor development. Another stated that the nanostructured material to reduce iron loss is good. This reviewer asked, are there any technical breakthroughs? There is no or little information on the technology for the reviewers to understand.

One reviewer felt that the project is unlikely to achieve 95% efficiency over the entire operating range of the motor.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that it was still an early phase of the project, while another respondent said there were few technical details provided for review, as it started in October 2007.

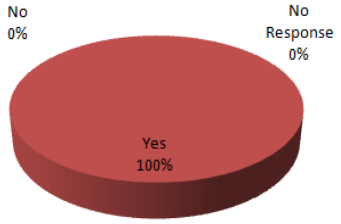
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that GE has the capability to commercialize the results if successful. Another person commented that, if the project can achieve its goals, then the motor technology will certainly make it to the market through GE's consumer division.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent would like to see DOE spread the funds to more projects.

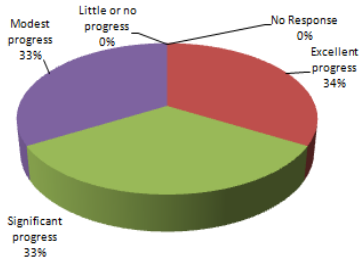
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Scalable, Low-Cost, High-Performance IPM Motor

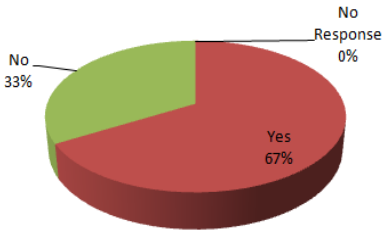
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



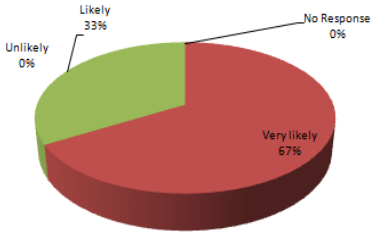
Question 3: Characterize the technical accomplishments and progress toward goals.



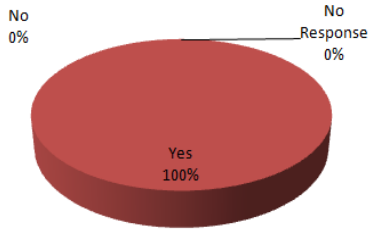
Question 2a: Are the goals of the project technically achievable?



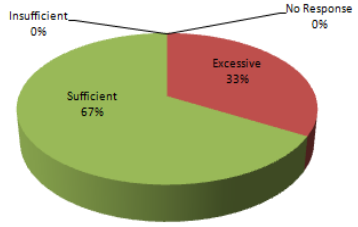
Question 4: How likely is the project team to move technologies into the marketplace?



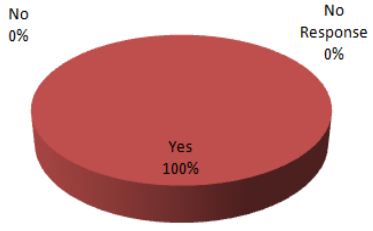
Question 2b: Have the technical barriers been identified and addressed?



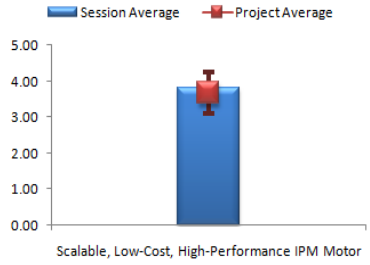
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Soft Switching Inverter for Reducing Switching and Power Losses (Jason Lai, of Virginia Tech)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that reduced switching and power losses contribute to improved fuel efficiency in the HEV, while another added that power loss reduction of power devices is of paramount importance to the further efficiency increase of HEV systems. One other reviewer, to contrast, stated that the complexity in design, (likely) lower operational reliability, and packaging complexities of a soft-switching inverter will most likely outweigh any benefits gained from inverter efficiency in a vehicle traction application.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer indicated that advanced soft-switching is a cost-effective way to permit a single 105°C loop to be used instead of a dual loop without requiring the use of SiC or loss reduction techniques that can result in poorer EMI and drive efficiency. The barriers of needing an ultra-low thermal impedance package, high temperature capacitors, and high temperature circuit components have been identified. Another reviewer commented that the 125°C operating temperature and 98% efficiency target are set for the project. The issues have been identified; for single-loop cooling, component level cost will be a major barrier, including the use of SiC, bulk cap, etc. High temperature operation and system cost are together the major barriers overall. This reviewer is not sure how soft switching is used in fulfill these goals, noting that soft switching is usually implemented in DC-DC converters; using it for an inverter could be cumbersome. One reviewer did not see a clear plan or industry partners to deploy the technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that some progress has been made (papers, patent preparations, etc.), though hardware experiments are not extensive yet. More experiments are needed to show how the actual soft switching can be implemented in motor drive applications at high switching frequencies.

Another person noted this was a new project – just funded and mostly in the planning stage, so there is not currently much in the way of accomplishments. However, the results shown so far were excellent. One other reviewer commented that the presenter did not present any significant new information.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Responses were mixed in this section. One reviewer commented that there was no reason to believe that it cannot be transitioned to the marketplace. Since it is still early in the program, there is no marketing program at this time. Another person stated that is it possible unless is it infeasible to implement at a reasonable cost.

To contrast, one response stated that the concept of soft-switching inverters has been around for a number of years and thoroughly researched. This reviewer thinks that the increased system

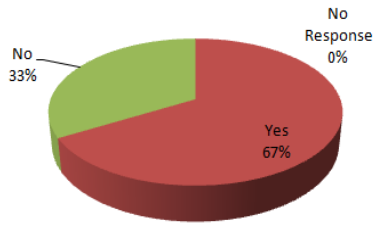
complexity, cost, and the likely reduction in operational reliability will lead to an unfavorable cost-benefit outcome.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the project has sufficient funds and human resources.

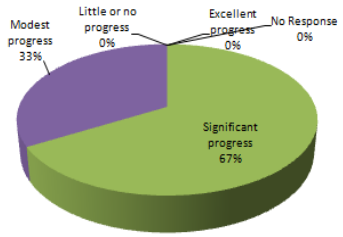
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Soft Switching Inverter for Reducing Switching and Power Losses

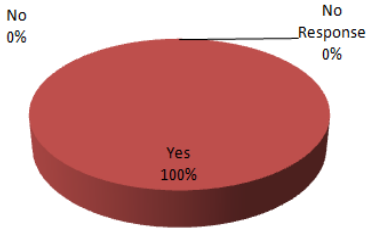
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



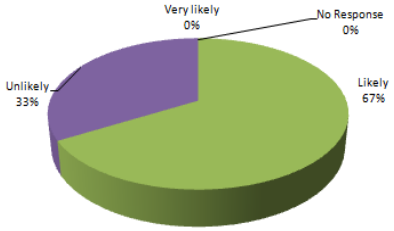
Question 3: Characterize the technical accomplishments and progress toward goals.



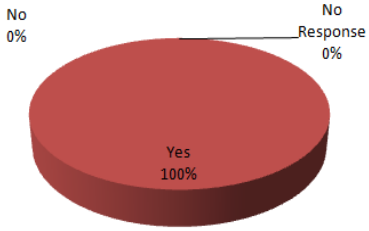
Question 2a: Are the goals of the project technically achievable?



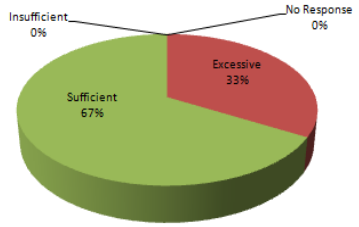
Question 4: How likely is the project team to move technologies into the marketplace?



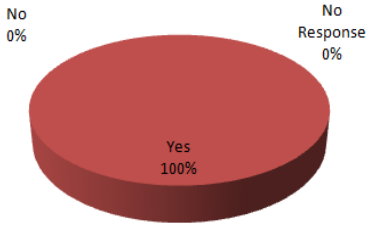
Question 2b: Have the technical barriers been identified and addressed?



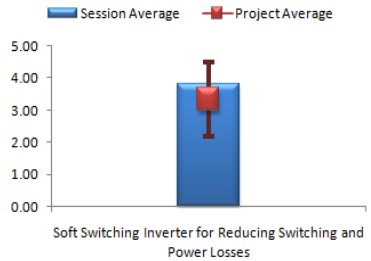
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Technology Benchmarking (Mitch Olszewski, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this was a great service to the US industry, while another commented that the benchmarking activity is required to keep abreast of technology from other key suppliers of HEV's. To contrast, one other reviewer did not agree that DOE should spend this much effort to investigate the Japanese rivals' technology. They need to work on advancing the technology and commercializing their technology.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that there was a good approach to benchmarking technologies for incorporation into FreedomCAR activities. The other respondent stated that the data generated from the benchmarking is valuable to any player in the automotive industry.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first respondent noted that they were still at the start of the project. One other reviewer was not sure whether there were any technical barriers to overcome, as this is a benchmarking service of products in the market.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that there was a good selection of technologies, while another person commented that benchmarking can guide in the development of improved systems that are already in the market place. Another reviewer indicated that the information gathered from the benchmarking service is readily used by the industry. This reviewer asked whether component-level data was available as well. For example, it would be nice to see what kind of current sensor is used and what the performance is of the sensor, etc.

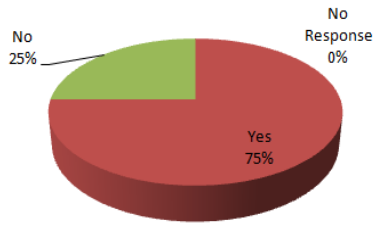
One other person asked how you can commercialize someone else's technology.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer suggested that they may need additional resources to gather component-level data. Another commented that funding should be ongoing into 2009.

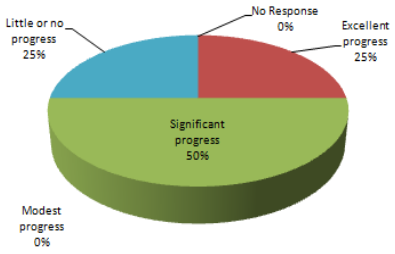
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Technology Benchmarking

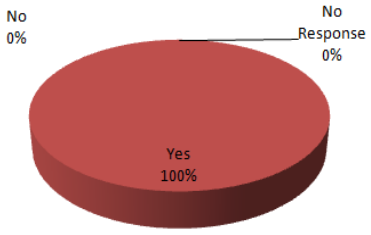
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



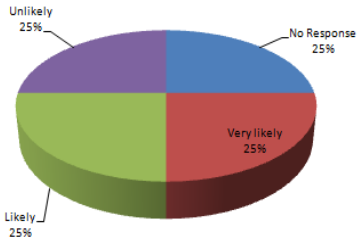
Question 3: Characterize the technical accomplishments and progress toward goals.



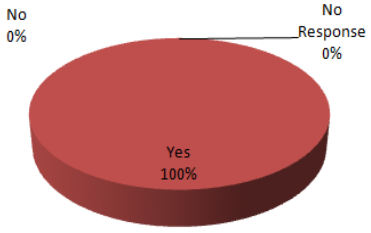
Question 2a: Are the goals of the project technically achievable?



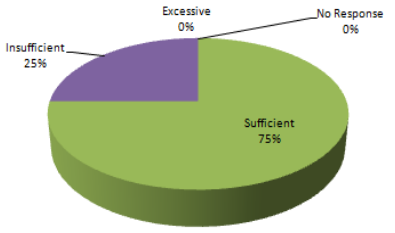
Question 4: How likely is the project team to move technologies into the marketplace?



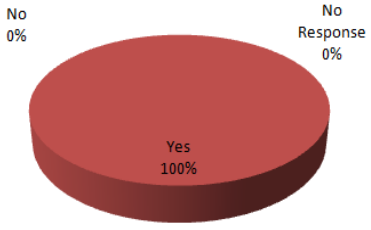
Question 2b: Have the technical barriers been identified and addressed?



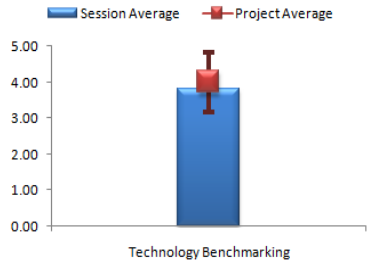
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors (Laura Marlino, of Oak Ridge National Laboratory and Iver Anderson, of Ames National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that advanced motor concepts are important for HEVs and PHEVs, and this project therefore is in line with DOE goals. Another person stated that the uncluttered rotor concept offers increased integration in HEV and PHEV drivetrains and possible cost savings. This is good to have as an alternative to PM material.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response cited the good combination of motor technologies and materials technologies (magnetic permanent motor materials) to enhance performance and reliability. Another reviewer commented that the plan for the uncluttered rotor seems to be to build the prototype and then convince potential users of its benefits. This reviewer thinks it is important to get buy-in from at least one industry partner.

One final respondent notes that some of this concept was originated in 2001. This reviewer would like to see earlier prototypes and demonstrations. It seems that some of the prototyping was slow. Also, they need to work closely with automotive suppliers to investigate the feasibility of their technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that it appears there is still no prototype uncluttered rotor unit available for testing. The other respondent would like to see a prototype demonstration earlier than the scheduled 2009. This presentation covers five projects, and some of these are on track while others have just started with little progress.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first response indicated that there was good buy-in from key players in the materials, motors, and user communities.

In contrast, another reviewer stated that, unless demonstrated feasibility and cost benefits are shown by prototype, the uncluttered motor cannot be used in real life. One reviewer added that it is hard to understand the benefits of the uncluttered rotor concept when compared to the simple motor and generator configuration used in most mild-hybrid drivetrains.

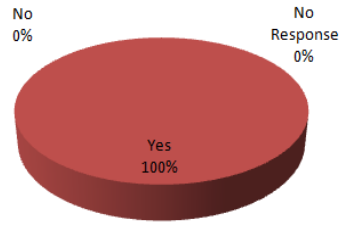
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the funds are sufficient, while the other respondent recommended allocating more resources to the concentrated windings motor.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

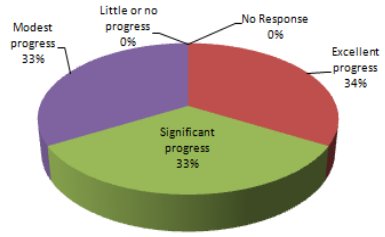
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Uncluttered Rotor PM Machine

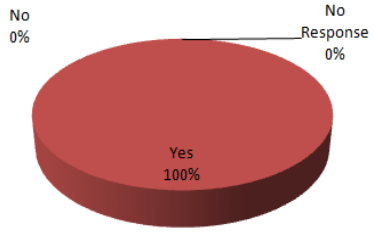
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



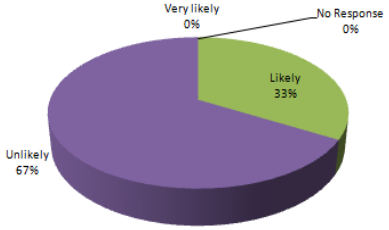
Question 3: Characterize the technical accomplishments and progress toward goals.



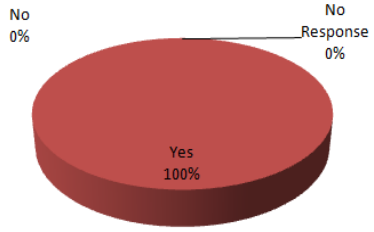
Question 2a: Are the goals of the project technically achievable?



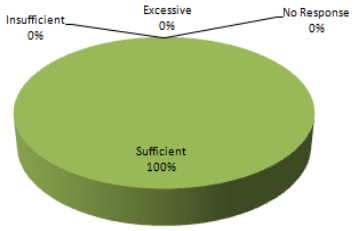
Question 4: How likely is the project team to move technologies into the marketplace?



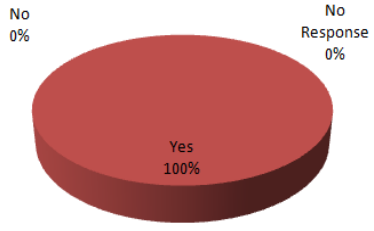
Question 2b: Have the technical barriers been identified and addressed?



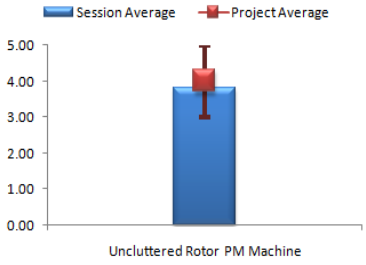
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs (Laura Marlino, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that this is excellent and creative work in support of PHEVs, while another commented that PHEV charging technology is behind and therefore DOE needs to look into this area. One other response stated that PHEVs will be available in the market over the next 2-3 years, so this work is significant and should have started earlier.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer had a number of questions and was not sure about the technology proposed. Why is the motor winding in the loop of the circuit? Is it being used as an inductor? Would the resistance consume power? Would it cause heating problems for the motor? How is the cooling done while the vehicle is parked? The other respondent stated that it was not really clear what the solution was, and this makes it difficult to comment.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that there has been some limited progress on the project, while another said that the level of progress achieved was not clear.

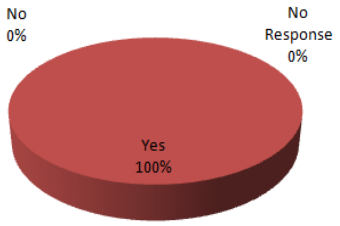
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented that, if the stated objectives are met, then this technology should transfer to the market. Another person noted that, without understanding the technology, he or she did not think the proposed approach is legitimate.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

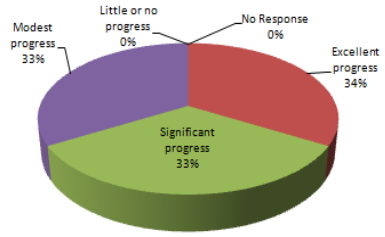
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs

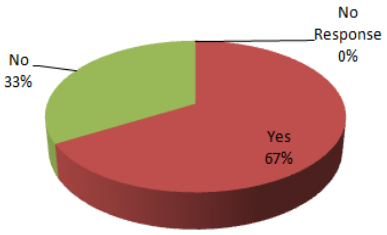
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



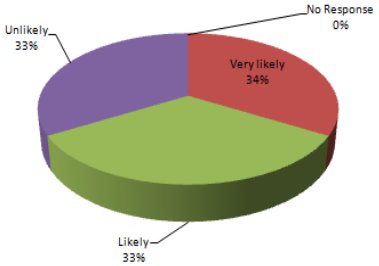
Question 3: Characterize the technical accomplishments and progress toward goals.



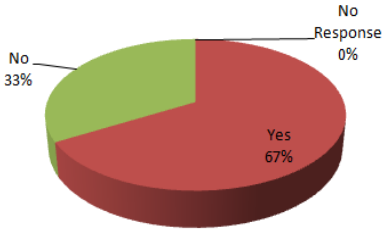
Question 2a: Are the goals of the project technically achievable?



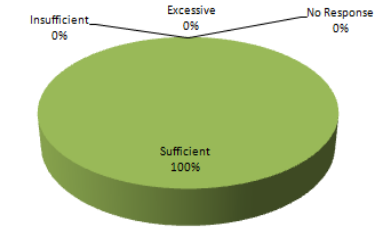
Question 4: How likely is the project team to move technologies into the marketplace?



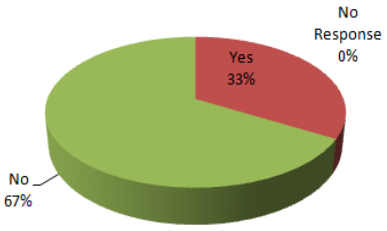
Question 2b: Have the technical barriers been identified and addressed?



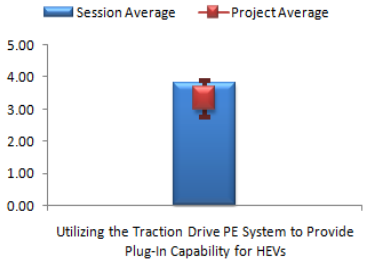
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Wide Bandgap Materials (Burak Ozpineci, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the development of power electronics based on wide bandgap semiconductors is necessary to provide intelligent power management at under-hood temperatures in hybrid electric vehicles. This intelligent power management is necessary both to maximize fuel efficiency and to provide effective control of the hybrid electric propulsion system. Another reviewer stated that tests can be a good source to determine the feasibility of the various WBG devices coming out of the R&D labs.

One other person indicated that SiC has the potential to operate at high temperatures for use in special applications, as well as increasing switching frequency, adding efficiency, and reducing size. Similarly, one individual wrote that the SiC technology has the potential to become the power semiconductor switching technology in the drives if the costs come in line and the devices are readily available.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer noted that this project is making the data available to the industry, while another stated that keeping abreast of the technology and evaluating the present states of device technology is needed. One final reviewer commented that the team has developed a hybrid package with heat barriers for Si gate drivers and high temperature SiC modules, and developed a PSAT loss model. The SiC converters are potential candidates for high temperature applications. The reviewer notes that there are many challenges and barriers in apply this technology and a 55kW DC-DC converter is very ambitious, but at a lower power rating it is possible. But the available SiC JFET and MOSFET may not be available for the application. By parallel-connecting the devices to achieve the desired power rating of 55kW, the reviewer indicated that parasitic stray inductance and capacitance will have a big impact on the current and voltage (reverse recovery current, etc.).

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer felt that the group was making good progress in solving packaging issues when testing high temperature devices, while another stated that the program is keeping abreast of the technology as it develops. To contrast, one person wanted to see more activities regarding system packaging.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer indicated that military applications are probably the first ones to emerge in SiC converter/inverters. Another person stated that some of the solutions developed in testing the high temperature devices, like gate drives, can readily transfer to industry. One other reviewer indicated that, with time, it is likely that the technology will be used in the power electronic systems.

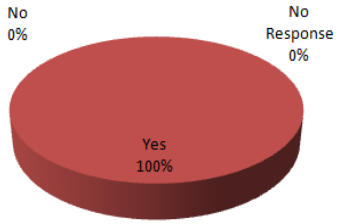
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the resources are sufficient for the project, while another noted that they are probably sufficient for the moment, due to the relative immaturity of WBG devices available in the market today. One other reviewer commented that funding should be ongoing into 2009.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

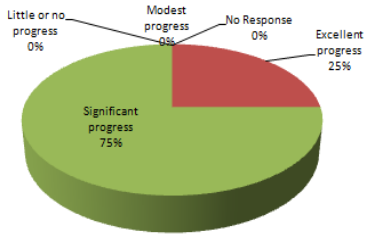
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Wide Bandgap Materials

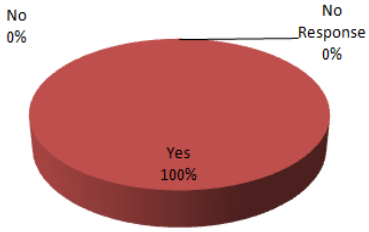
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



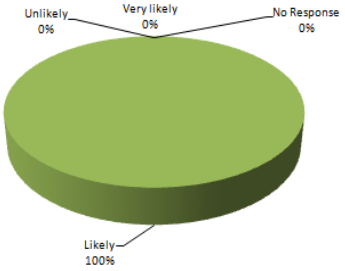
Question 3: Characterize the technical accomplishments and progress toward goals.



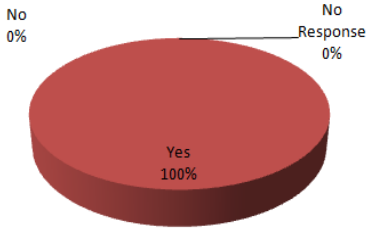
Question 2a: Are the goals of the project technically achievable?



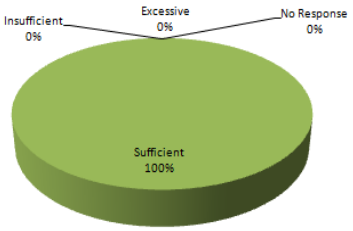
Question 4: How likely is the project team to move technologies into the marketplace?



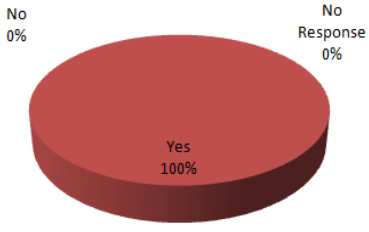
Question 2b: Have the technical barriers been identified and addressed?



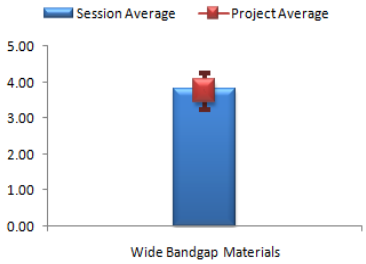
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



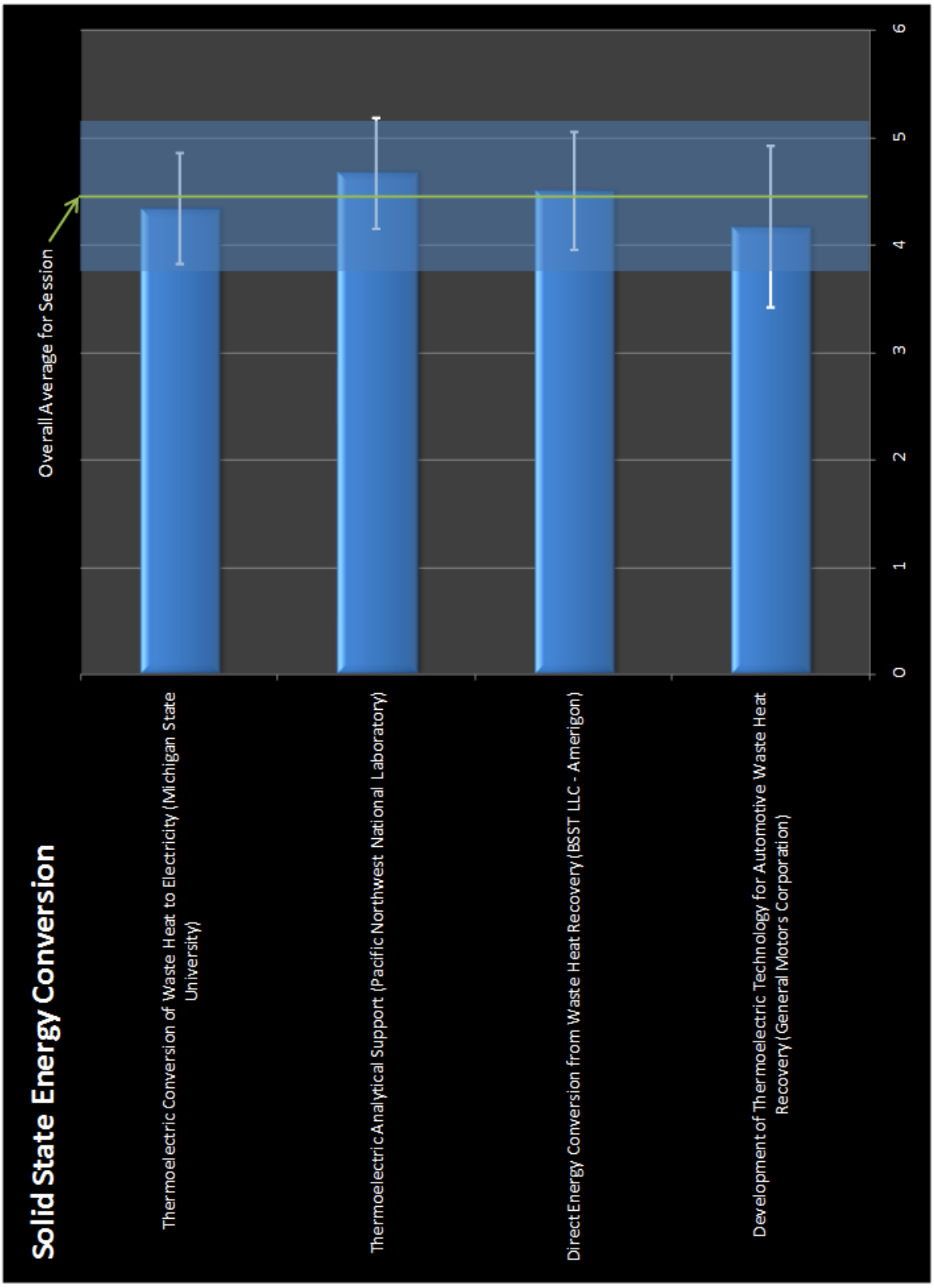
6. Solid State Energy Conversion

Introduction

The Solid State Energy Conversion activity focuses on developing advanced thermoelectrics for converting waste heat from engines into useful energy (e.g., electrical energy) to improve overall vehicle energy efficiency and reduce emissions. Effective use of waste heat from combustion engines would significantly increase vehicle fuel economy. In current production passenger vehicles, roughly over 70 percent of the fuel energy is lost as waste heat from an engine operating at full power. About 35 to 40 percent is lost in the exhaust gases and another 30 to 35 percent is lost to the engine coolant. There is an opportunity to recover some of the engine's waste heat using thermoelectric materials that will convert it directly to electricity for operating vehicle auxiliaries and accessories. The goal of this activity is to develop advanced thermoelectric technologies for recovering engine waste heat and converting it to useful energy that will improve overall engine thermal efficiency to 55 percent for Class 7 and 8 trucks, and 45 percent for passenger vehicles while reducing emissions to near-zero levels.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
6-3	Development of Thermoelectric Technology for Automotive Waste Heat Recovery (Jihui Yang, General Motors Corporation)	4.17	0.75
6-7	Direct Energy Conversion from Waste Heat Recovery (Lon Bell, BSST LLC - Amerigon)	4.50	0.55
6-11	Thermoelectric Analytical Support (Terry Hendricks, Pacific Northwest National Laboratory)	4.67	0.52
6-14	Thermoelectric Conversion of Waste Heat to Electricity (Harold Schock, Michigan State University)	4.33	0.52
	Overall Session Average and Standard Deviation	**4.42**	**0.58**


Solid State Energy Conversion
Overall Average for Session
Thermoelectric Conversion of Waste Heat to Electricity (Michigan State University)
Thermoelectric Analytical Support (Pacific Northwest National Laboratory)
Direct Energy Conversion from Waste Heat Recovery (BSST LLC - Amerigon)
Development of Thermoelectric Technology for Automotive Waste Heat Recovery (General Motors Corporation)
0
1
2
3
4
5
6

Development of Thermoelectric Technology for Automotive Waste Heat Recovery (Jihui Yang of General Motors Corporation)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The reviewers had some disagreements regarding the program's goals. One reviewer commented that waste heat recovery in general is a good approach to increase fuel economy of vehicles. Another person stated that the objectives of this project (finalizing material selection, completing the initial design for the exhaust waste heat recovery, and identifying manufacturing processes for thermoelectric modules) are realistic, right on the mark, and well-aligned with DOE's objectives of petroleum displacement. One reviewer simply indicated that this activity does comply with DOE's goal of 10% improvement in fuel efficiency with regard to waste heat recovery for vehicle applications.

Others were less enthusiastic. One responder noted that the goal of the SSEC program is to reduce petroleum consumption by 10% through state power generation, but the goal of this activity is only a 3% improvement. The person adds that the vehicle platform chosen somewhat limits their ability to meet program goals. Another person noted that a reduction in parasitic loads on a vehicle can reduce cycle-average and real-world fuel consumption, adding that no requirement for the total amount of fuel savings is requested and there will certainly be some savings. The person adds that it is highly unlikely that this approach can save 10% fuel economy in any reasonable real-world cycle-averaged scenario. One final commenter stated the objective of a 10% increase in fuel economy on a designated vehicle platform is understood. The group believes they can deliver at least a 3-4% increase using a FTP cycle and more in a real world driving cycle. The reviewer adds that the overall system cost of $1 per watt is a target and seems to be well-accepted. This person was also unsure about the vehicle platform, noting that GM's program is targeting a large SUV as the platform vehicle of choice. GM stated that space requirements and heat loss are advantageous in this vehicle for an everyday non-commercial vehicle. A large truck platform could also be investigated in tandem with the SUV platform.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Respondents had mixed reviews regarding the project's strategy. One person indicated that the group recognizes the technical hurdles (uncertainty of materials performance, difficulties in module design and integration) and systematically addressed and overcame them with an excellent plan. Another person felt that there was a good strategy in place to accomplish the task. Similarly, another indicated that the barriers are correctly identified and goals are achievable, adding that, with 37 presentations and publications, it seems that the team has made progress. They should investigate recent work by Honda and Toyota in the same area, as these groups have claimed about 5% fuel economy increase (or 500W recovery of electricity), while this project has 350W or 3% gain.

Another respondent felt that specific project goals were not defined in the presentation. They felt that the group had done a good job identifying manufacturing barriers, but other barriers (mechanical, thermal etc) were not discussed in any detail. Further, one person added that the project goal of 10% increase in fuel efficiency is not likely, but significant progress can be made. The barriers have been identified and a lot of work on performance and mechanical testing of the materials and modules is in progress. The PI's have a strong team in place to address these barriers, and they understand the

overall goals of the program very well. There has been a lot of emphasis on new materials development at about a 50% level in the program according to the PI. They have down-selected a material about which they were unwilling to disclose the details. It is recommended that they focus their efforts much less on the materials and more on the device development and implementation in the next phase. They have stated that this is their goal with a significant shift towards this end in Phase II. They should keep a small effort going in new materials development of already very promising materials. Module design should not be a problem for GM. They have a very good chance of having a prototype device on a vehicle very soon. At no point in the review did the PI discuss GE's role in this project and they were not very specific on the details of what they have done or were planning.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer noted that the team spends a majority of their efforts on advanced materials development. Most of this program appears to be focused on achieving a breakthrough in ZT for power generating materials. They still have not discussed in enough detail how to overcome the other engineering, manufacturing, and market issues with the technology. Similarly, one person added that the project is on track with the proposal goals; however, without knowing the details of the approach (which are proprietary), it is hard to justify the exact progress. Another respondent felt the same way, stating progress of this program is difficult to gauge based on limited details in presentation. The group claims to have made significant materials advances and finalized system design, but no evidence given.

One person stated that the team has developed and down-selected the materials, decided on a vehicle platform, performed a cost analysis, and is now in the process of developing a prototype TE generator. Another stated GM has demonstrated a willingness to work on the task as well as collaborate with other organizations, such as Oak Ridge National Lab.

One final reviewer commented that the group had shown impressive accomplishments overall, particularly the following: (1) selection of low $/W materials with reasonably high ZT; (2) establishing high-temperature thermo-mechanical property data; (3) completion of testing facility; (4) completion of excellent design for exhaust waste heat recovery (350W, 3% urban/highway fuel economy improvement), which could yield 4% heat conversion efficiency after integration; (5) excellent team effort and coordination (strongest team); and (6) an impressive number of publications, talks and patent applications. This final reviewer added that this project has shown the highest overall output.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Results for technology transfer were, in general, positive. One reviewer stated that the team already has a large OEM and this team has applied for several patents, adding that it should be easier for them to transition this technology than any of the other teams. In the same respect, one person commented that GM also recognizes all the barriers and therefore will be able to carry the project successfully. Another response stated that, with their first-rate output this year and their plans to finalize TE waste heat recovery subsystem design and subsystem prototype construction next fiscal year, the schedule for technology transfer and market transformation should be on target.

Others were less sure, with one reviewer stating that, without knowing the detailed technology, it is hard to know whether the technology will be marketable. Another person stated that some form of this technology could migrate into production if the cost and packaging targets in the program are met, adding that it is unclear right now if the team has an approach that will allow commercialization. Lastly, one person (similar to comments above) felt that leadership by GM makes it likely that any technological advances will be commercialized, but added there weren't enough details available to assess its potential.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

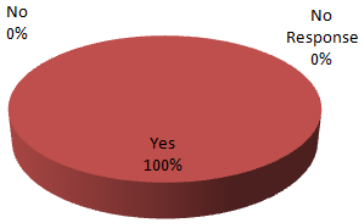
Multiple reviewers felt that the available resources seem to be sufficient, with one person adding that the team may consider reallocation to other aspects of engineering the TE module and vehicle systems. Another person noted that the team also has access to Michigan state university and DOE laboratories, while someone else commented that collaboration with ORNL is an excellent way to achieve milestones in a timely manner. Another person stated that the team has sufficient resources available in terms of materials synthesis and characterization as well as device modeling and development, adding that they also have access to all of GM's capabilities in design and manufacturing. One final person stated that they have received large amounts of funding, but added that milestones were not clearly defined, making this difficult to assess.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

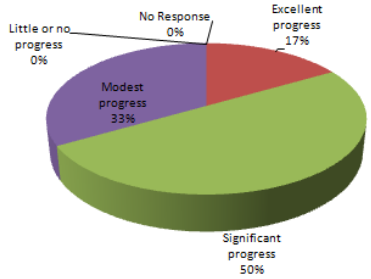
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development of Thermoelectric Technology for Automotive Waste Heat Recovery

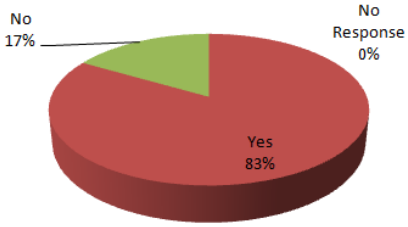
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



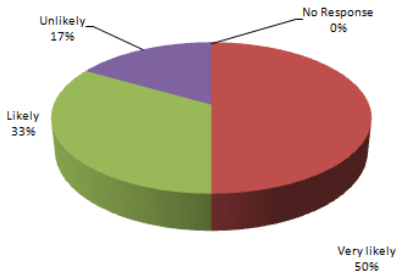
Question 3: Characterize the technical accomplishments and progress toward goals.



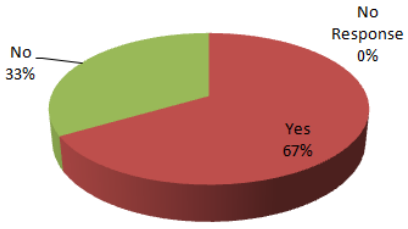
Question 2a: Are the goals of the project technically achievable?



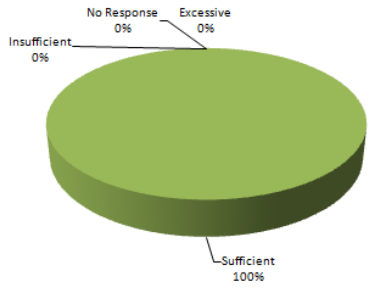
Question 4: How likely is the project team to move technologies into the marketplace?



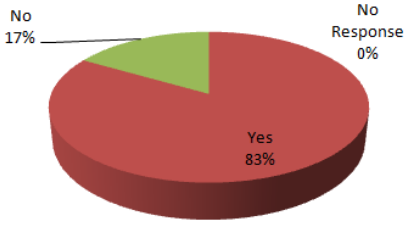
Question 2b: Have the technical barriers been identified and addressed?



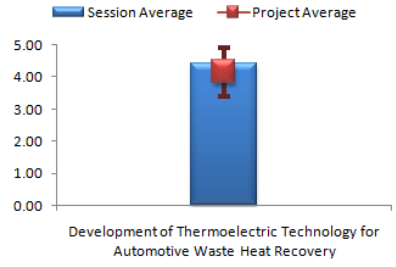
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Direct Energy Conversion from Waste Heat Recovery (Lon Bell of BSST LLC - Amerigon)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
There was some disagreement among the reviewers here. One person began by stating that the reduction in parasitic loads in vehicles can reduce cycle-average and real-world fuel consumption. There is no requirement for the total amount of fuel savings is requested, and there will certainly be some savings. The person added, however, that it is highly unlikely that this approach can save 10% fuel economy in any reasonable real-world cycle-averaged scenario. Somewhat more positively, another reviewer noted that the goal of the SSEC program is to reduce petroleum consumption by 10% through state power generation. The goal of this activity is consistent with DOE objectives. Modeling has shown up to 8% efficiency improvements, but this was under very favorable conditions; most conditions only showed 2-3% gains.

One response stated that the objective of a 10% increase in fuel economy on a designated vehicle platform is understood. The group did not actually state their overall increase in fuel efficiency to the best of the reviewer's recollection.

Others were more positive, with one person stating that waste heat recovery in general can increase the fuel economy of vehicles, and therefore it is in line with DOE's overall goals. Another added that BSST's TE power generator will be used to improve fuel efficiency of the vehicle, while a final person commented that the group's objectives of improving fuel efficiency by 10% and creating a path to commercialization exactly align with DOE's objectives of petroleum displacement. There is some discrepancy amongst the responses.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person commented that BSST has a good approach in developing their TE generator, but felt that a more detailed description of how to monitor and control the hot side of the TE generator is needed. Another reviewer stated that it is really unclear that the economic requirements of a light-duty application will be viable in the North American marketplace, adding that the team has started with a good approach to assessing performance against the durability requirements of the light-duty vehicle cycle. However, it is unclear if these barriers can be overcome in the time period that the program predicts, and, longer term, it may be more practical to overcome the engineering and technical barriers. One other person felt that the project team showed a sound strategy to overcome various technical barriers by developing new system architecture and using system modeling approach.

Another reviewer noted this was the only program to specifically address using segmented TE's, and that this seems to be the only feasible approach to achieving program metrics using materials available today. Thermal issues have been identified and well addressed, mechanical issues less so. More mechanical modeling of segmented devices is required.

Lastly, one reviewer provided the following points: a.) A project goal of 10% increase in fuel efficiency is not likely, but significant progress can be made. b.) The barriers have been identified. A lot of work is in progress on development of the materials, the modules and heat exchangers. c.) The PI's have a strong team in place to address these barriers. d.) The PI's understand the overall goals of the program very well. This is a very strong team. They have partnered with Visteon for development of

the power electronics and with several universities to continue to develop higher efficiency materials. However, this is not infringing on the progress of a prototype development. The reviewer added that there is a tremendous amount of expertise in the heat exchanger and thermal management aspects of this project, but there is not a lot of effort on investigating and modeling the effects of mechanical properties. They also are imposing non-rigid constraints. This is a good idea, especially for the initial prototype. They have a very good chance of having a prototype device on a vehicle very soon. It would have been advantageous to understand BMW's role and contributions to the project in more depth.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Feedback was generally positive here, with one reviewer noting that their presentation showed that BSST has been making significant progress in a timely fashion. Another said that this team has adapted well to changes required by an economically feasible system. They have been very open about their program, technical requirements, and modifications that the team has had to make during the program to meet their assumptions. One other person noted that the team has developed and down-selected the initial materials, and they have decided on a vehicle platform. They have a lot of expertise in incorporating their devices into vehicles. This person added that the group is in the process of developing a prototype TE generator and appear to be further along than the other teams.

One reviewer commented that the barriers are identified, and some work has been done to overcome these barriers. The group has worked with Visteon to design power electronics for maximum power tracking. Another noted good progress on thermal design through new system architecture. Heat exchanger designs are crucial to system level performance and BSST has developed architectures to address this. Performance of hot gas heat exchange still needs to be verified. Thermal cycling work using BiTe was good, but is just a start toward determining reliability of this concept. There is a strong system-level thermal model based on realistic (average) ZT, but still need system-level demonstration of segmented devices.

A final reviewer remarked that the group's overall achievements are impressive, including: a.) New architect to enable high efficiency power conversion and reduce TE material usage; the module size appears to be in good progress and on schedule, b.) Encouraging model results for optimization of system performance, and c.) Good team effort.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Comments from the reviewers, in general, were very positive. One commented that it is possible to move to the market, adding that the 500W of power generated are a good scale of power generation. Another person felt that some form of this system can be migrated into the marketplace based on the data presented, and this team seems to have the best chance of implementing some form of this technology into the marketplace. Adding to this, one reviewer indicated that technology development shows good progress, and that the team has shown a good FY 2008 work plan, which includes the testing of a full scale system by year-end. Technology transfer should be possible and within reach.

Others commented on industry partners, with one person stating that partnership with BMW and Visteon increases the likelihood that advances will be commercialized, but added that the use of segmented TE's may drive cost to prohibitive levels. Another noted that BSST has been working on their design for several years, and its technology has been actively tested by BMW. One final reviewer stated that the team has already done this with the BSST climate-controlled seat and should have no

issue with moving the TE generator forward. They have partnered with BMW and selected a vehicle platform for installation. They may be the furthest along in terms of integrating a TE generator on a vehicle platform than any of the other teams.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

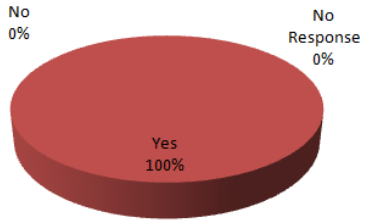
Most reviewers stated that the current resources and allocation seem to be sufficient for the team to meet its objectives / proposed activities, with one person noting the collaborations with Virginia Tech and Ohio State, along with various patents and publications. Another reviewer stated that these collaborations with BMW, Visteon, and universities will provide sufficient resources for the project. One final reviewer indicated that the team has sufficient resources available in terms of materials development into devices with elaborate configurations for the heat exchangers, and they are well equipped with respect to device modeling and development. They have partnered with several other institutions for new materials development and with companies for power electronics development.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

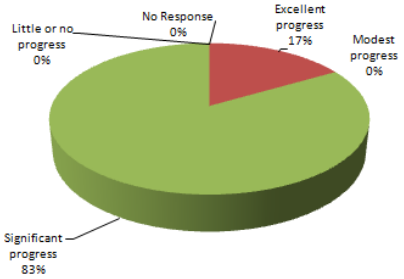
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Direct Energy Conversion from Waste Heat Recovery

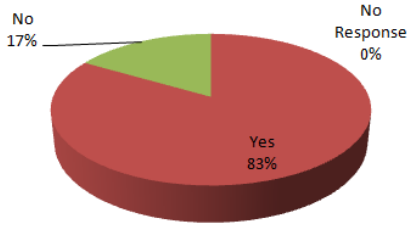
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



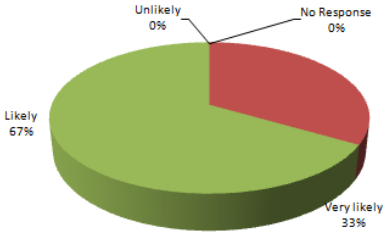
Question 3: Characterize the technical accomplishments and progress toward goals.



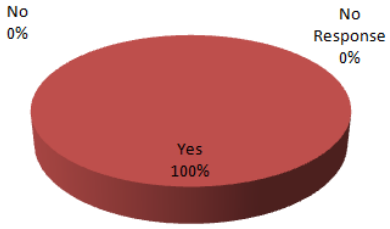
Question 2a: Are the goals of the project technically achievable?



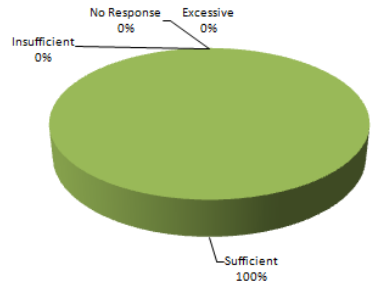
Question 4: How likely is the project team to move technologies into the marketplace?



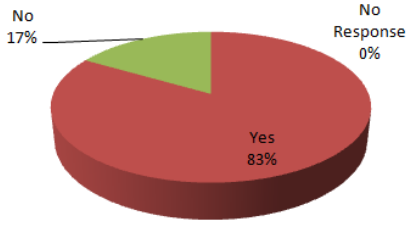
Question 2b: Have the technical barriers been identified and addressed?



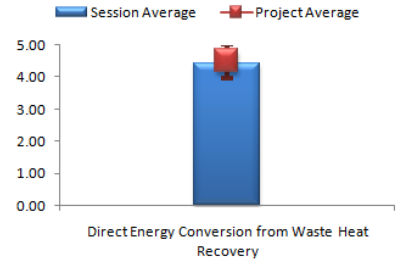
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermoelectric Analytical Support (Terry Hendricks of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive in this section, with multiple reviewers noting that the project objective (technology that increases vehicle fuel economy by up to 10%) supports the DOE's petroleum displacement objective. One person stated that the validation of advanced low-dimensional TE materials is critical to determining their commercial viability, while another commented that it is necessary to have this type of Thermoelectric Analytical Support. One final respondent added that this team is acting in an Advisory role and understands the goals of the project completely.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Multiple reviewers voiced support for this aspect of the program, with one person stating that this activity will certainly be needed to ensure that DOE projects are monitored and evaluated properly. Another indicated that the group addressed the previous reviewer's comments and that all technical details are on track. One person commented that, in terms of the advisor and "watchdog" role that PNNL plays, they are performing a vital service to this DOE program. Another reviewer indicated that validating materials claims is important, so developing standard experimental techniques is important for the success of this program.

One response expressed some skepticism, stating that it is optimistic to assume that the required TE will be met in the near-term. Some of the measurements and models proposed will require extensive development work. The person added that it is unclear whether the resources exist to meet these goals. One final reviewer commented on the sound technical approach in integrating TE system-analysis with materials & testing R&D, and that it was important to promote industry/government agency collaboration and interactions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Multiple reviewers commented on the strengths of the program. One person commented that the PNNL team works with all other PI's in order to coordinate the overall goals of the program, while another stated that great flexibility has been shown in the ability to support all aspects of this work. Another reviewer stated that PNNL provides support to WHR&U in terms of project evaluations, thermal electric analysis, testing, and new initiatives. One response added that Terry brings a strong benefit to the team by providing technical guidance and validating performance, while another commented that the presented graphs and analysis suggest that the program is on the right path to achieve the goals.

One final reviewer stated that the group: (1) Did a great job as the project leader of coordinating and developing advanced technologies to reduce fuel consumption and improve vehicle fuel economy, (2) Did excellent analysis to help both power generation and cooling systems (including integrated TE system analysis, device specific analysis, project-specific analyses, etc), (3) Showed great coordination for the important task of Si/SiGe thin film material/properties validation, and (4) Demonstrated encouraging research results in collaboration with ONAMI.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Many reviewers indicated that this question was not applicable for this type of support and that no demonstrated ability for advanced materials was available. Two reviewers added that the PNNL activity provides crucial guidance and tremendous expertise to assist the PI's in this endeavor, if tech transfer were to occur. One final person agreed, adding that, because of various successful collaborations (with PNNL/industry/university, and also government/industry) on materials, devices, and systems and testing, technology transfer into the market place will be highly possible.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

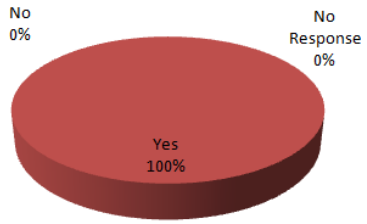
Multiple reviewers felt that the stated objectives seem to have enough resources, with one person adding that many questions raised in this work will require additional funding and investigation. Access to the PNNL database would help others in the US industry to develop internal studies, and mechanisms to obtain this work should be put in place. Other reviewers indicated that higher funding to PNNL to address cost and system analysis would improve the program, and that the current funding for these types of collaborations and support might not be sufficient. Another person added that the group gets a small amount of resources, but produces a lot of output. One other response stated that the team has sufficient resources available in terms of the requirements of the program. However, in the reviewer's opinion they are under-funded for their efforts and the role they play in the overall potential success of this program. More resources should be provided to the group, especially in the area of materials evaluation and validation. This seems to be an ever-occurring problem in many programs. However, the claims of the Si-SiGe quantum wells have to be resolved once and for all. Overall, this effort seems under-funded.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

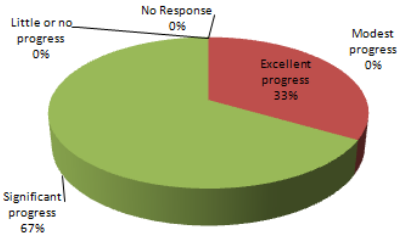
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermoelectric Analytical Support

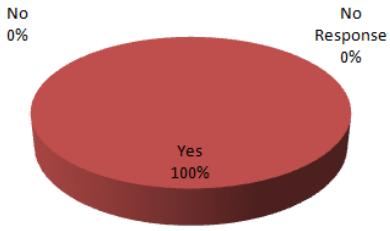
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



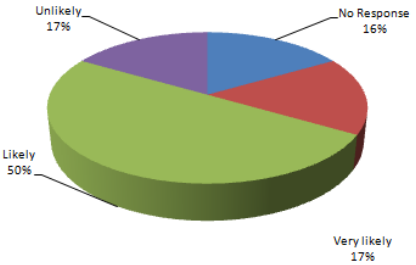
Question 3: Characterize the technical accomplishments and progress toward goals.



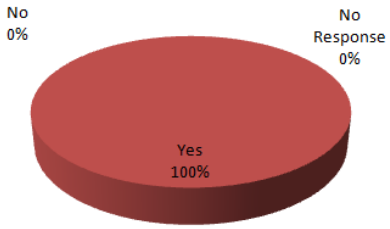
Question 2a: Are the goals of the project technically achievable?



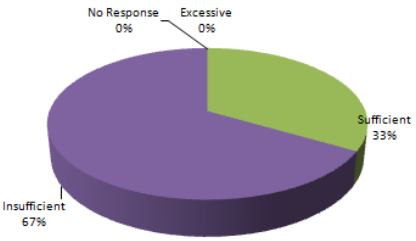
Question 4: How likely is the project team to move technologies into the marketplace?



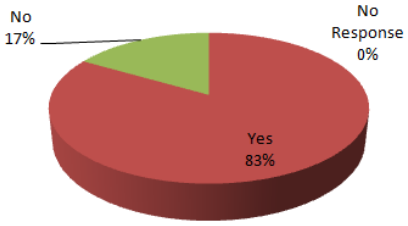
Question 2b: Have the technical barriers been identified and addressed?



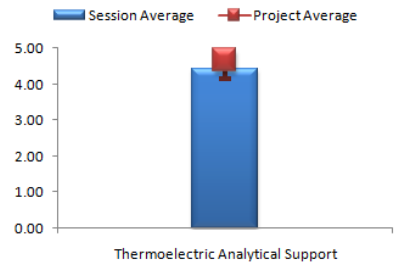
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermoelectric Conversion of Waste Heat to Electricity (Harold Schock of Michigan State University)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Multiple reviewers noted that it is unlikely that the team's approach can save 10% fuel economy (the SSEC goal) in any reasonable real-world cycle-averaged scenario, adding that the team noted that only 5% improvement was likely for Class-8 vehicle platforms. Another person stated that the group realizes the practical objective of perhaps a 5% fuel economy instead of 10%, which is a more realistic view at this point. This objective still aligns with the DOE petroleum displacement goal. Similarly, one person wrote that waste heat recovery in general can increase the fuel economy of vehicles; therefore this project is in line with the DOE goals. Another person commented that reduction in parasitic loads in vehicles can reduce cycle average and real-world fuel consumption. No requirement for the total amount of fuel savings is requested, and there will certainly be some savings.

One response noted that the group plans to target a large truck platform and develop a 1-kW prototype, which they hope they hope to scale-up to a 10 KW system. One other respondent, concentrating on a different aspect, commented that MSU spent their efforts in looking at new thermoelectric materials as well as design of power electronics to help integrate TE modules into vehicle waste heat recovery system.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the multiple approaches to materials improves the likelihood that goals will be achieved, adding that the group has done a good job identifying the technical barriers associated with mechanical stresses and head transfer. However, the path to overcoming the mechanical limits of the materials is not clear. Similarly, another person stated that it is unclear if they can overcome the heat transfer and durability requirements inherent to an automotive/heavy truck application. Team acknowledges and is well aware of the challenges inherent in this technology and has made a reasonable assessment of the potential for this technology. Technology goals may be met in the longer-term, but it is unlikely that the major barriers can be addressed in the timeframe of this program.

Another person approved of how the team addressed questions from the last review: material properties; power electronics was included in the system study, which showed improvement to the power output; mechanical properties (work with ORNL); modules were made with different sizes, and tested; FEA model of the 16-leg module. The person added that the team now needs to think about packaging issues.

One reviewer commented that using CFD for heat transfer and fluid flow calculation is appropriate for designing and predicting the performance of TEG.

Overall, one response noted that: (a) A project goal of 10% increase in fuel efficiency in not likely, but significant progress can be made. The group believes that 5% is achievable. (B) The barriers have been identified. A lot of work on mechanical testing of the materials and modules is in progress. (C) The PI's have a strong team in place to address these barriers. (D) The PI's understand the overall

goals of the program. There were several comments about the LAST materials not performing as originally expected. However, they did show results of LAST materials performing at about a ZT ≈ 1.2 level. It would be very beneficial to show time temperature performance curves of these materials. There was also mention of investigating new PbTe / PbS materials with an expected ZT ≈ 1.6, but they did not show any of these results or discuss them in any depth. They also made predictions of ZT values of materials that had not been synthesized. This should be avoided and ignored programmatically. This reviewer added that the addition of the large hot press is very positive, allowing the group to test "non-laboratory" samples to be able to identify what the "real world" ZT values of new materials might be in a scale-up fashion. This is very positive in evaluating the materials and eventually device performance. In a closing comment, the person noted that the group did not perform an economic feasibility study, and that the role of Cummins was not at all clear from the presentation.

In a similar format, one reviewer commented that there was (1) good strategy on materials development (on alternate material systems in addition to LASTS) and that collaboration with Northwestern team was excellent, (2) good approach to solving problems of heat transfer issues, (3) excellent plan for characterization – particularly mechanical properties (is there any plan to improve the mechanical properties of the brittle materials?), and (4) good approach to use finite element analysis. Overall, generally positive comments were offered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One person stated that the project has made reasonable progress in the technical analysis and prototype development, including incorporating power electronics, mechanical stress analysis and module design, heat transfer issues, and performance calculations. The person added that the team now needs to work on packaging issues of the system. Another review states that a reassessment of the system viability is very reasonable with modified goals, noting that reevaluation of the materials, heat transfer equipment, and approaches towards eliminating minor losses in the system may yield small efficiency gains. New materials are being evaluated, but, again, the time horizon for commercializable products seems to be further off. The reviewer adds that it would be useful to compare the Cummins Rankine Recovery system to the Cummins thermoelectric recovery system in terms of fuel economy improvement, cost, weight, volume, manufacturability, payback time, and potential for further efficiency gains under the same operating conditions.

One respondent stated that the work on PbTe-PbS materials shows an alternative path to meeting the program goals. This person is still concerned about the scale-up and reproducibility of LAST materials, but adds that there is good progress toward integrating power electronics to improve power output. There was talk about enhanced heat transfer on the hot side through gas jets, but little on the cold side, which is just as crucial.

One person simply stated that MSU has a good strategy for accomplishing the task.

Another reviewer noted that the team has developed and down-selected several materials. They really need to decide on a material and proceed. Last year it was LAST, now PbTe and all have been quoted as a ZT > 1.3. Have these been validated? They decided on a vehicle platform, which is a good one, and a large engine platform may be much better at achieving the DOE goals. However, Cummins' role is unclear from the presentation. The reviewer asks: how will they get the TE generator designed without a lot of input from Cummins? They have not performed a cost analysis, and they appear to be further behind the other two teams in actually developing a prototype TE generator.

One final reviewer commented that, in general, the progress is excellent and each objective is pretty much fulfilled. This person adds that it was an excellent idea to use the finite element analysis to evaluate stress distribution in order to improve module design, and there were very encouraging results shown in their performance calculations (two TEGs can give 3-6% improvement in brake-specific fuel consumption).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reviewers generally had mixed reactions to this question. One individual stated that it is likely that many of the individual technologies can be migrated into the marketplace, but it is hard to assess whether there will be a viable market for them at this early stage. Another added that the team is still in the process of a lot of testing and needs to move forward with the prototype device. This person added that working out materials issues and mechanical problems seems to be taking too long.

One person stated the partnership with Cummins improves the likelihood of transition, adding there are still significant materials challenges needed to meet the goals. Similarly, another person added that, since the team works with a company to produce the module, it is only natural for the research to be commercialized if the cost-output ratio is feasible.

One response commented that the group has shown good progress towards technology transfer -- excellent improvement in module fabrication and performance, and also because they are already working with Tellurex in making preproduction prototype modules for cost estimation. Similarly, another person felt that it was a good idea to work with a TE manufacturer such as Tellurex for TE modules fabrication and final product testing.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Multiple reviewers felt that the current resources were reasonable and appropriate, and that the team seems to have covered the major aspects required to deliver the requirements of this program. One person specifically stated the team has sufficient resources available in terms of materials synthesis and characterization as well as mechanical properties modeling and characterization, but the question will actually be developing a prototype model and installing it on a Cummins engine. How will Cummins facilitate this?

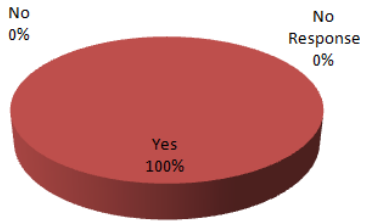
Another reviewer added that there is still significant technical work to be done, noting that the group plans to build a 1 kW generator in the next year, but only have about $400K left. One final response added that the collaborations with JPL as well as Tellurex are the most efficient way to carry out the task in a timely fashion.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

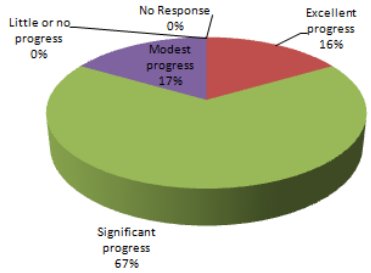
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermoelectric Conversion of Waste Heat to Electricity

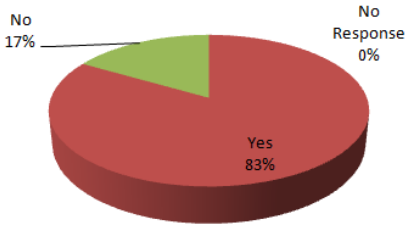
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



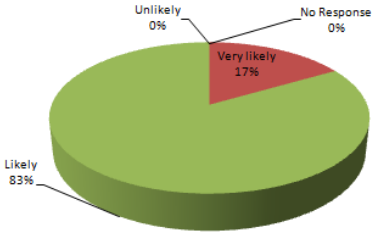
Question 3: Characterize the technical accomplishments and progress toward goals.



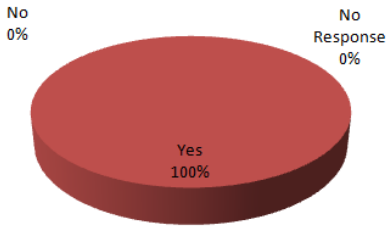
Question 2a: Are the goals of the project technically achievable?



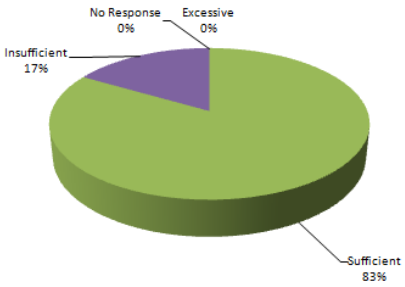
Question 4: How likely is the project team to move technologies into the marketplace?



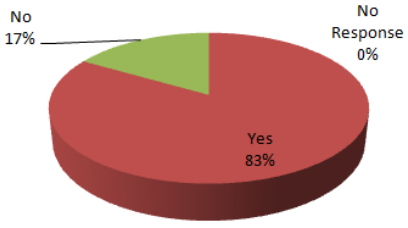
Question 2b: Have the technical barriers been identified and addressed?



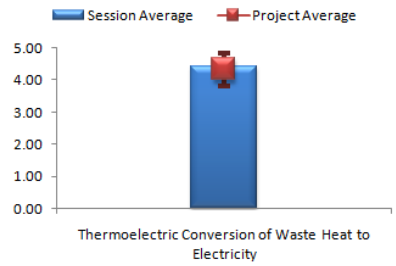
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



7. Combustion Research

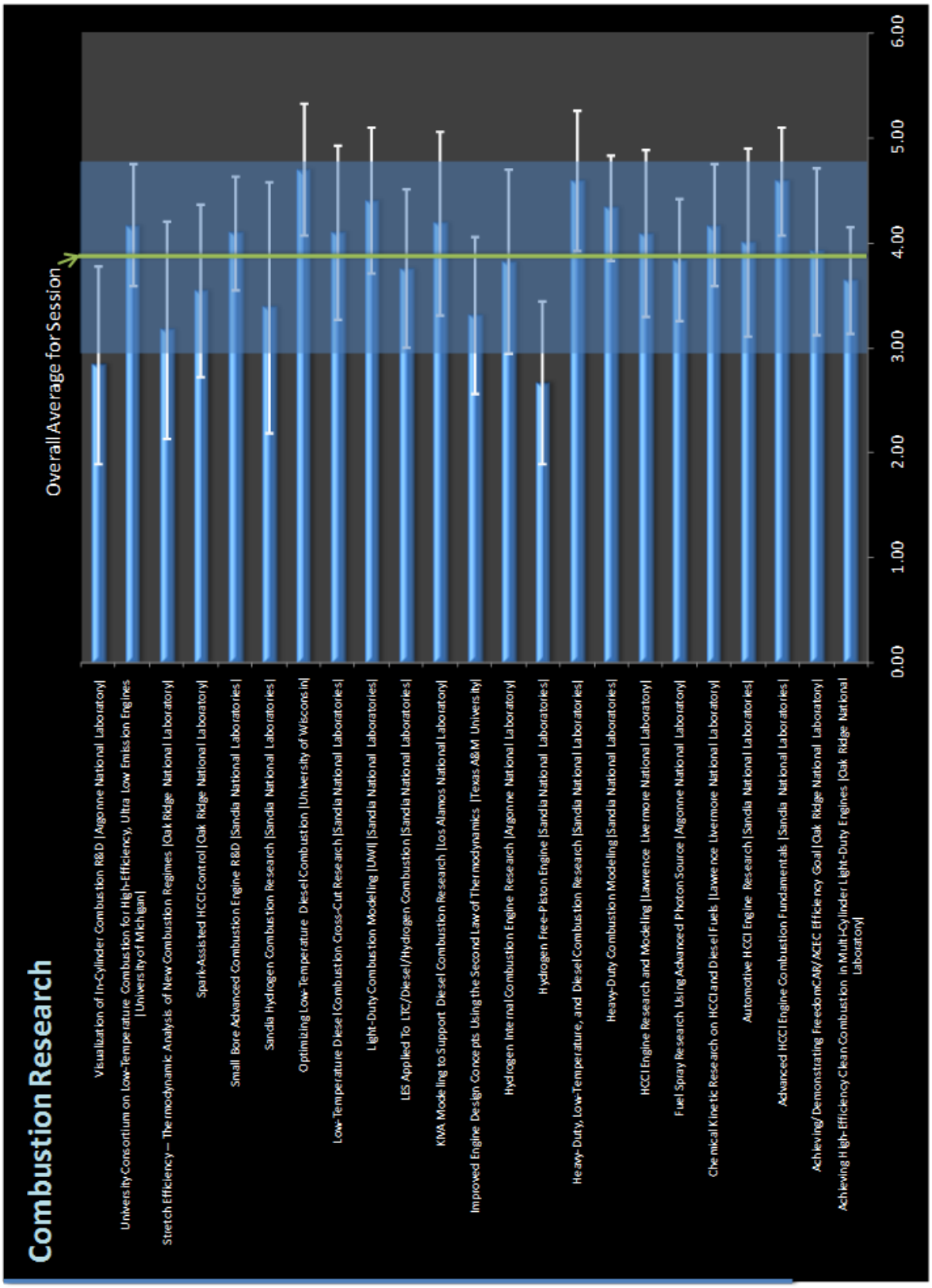
Introduction

The U.S. Department of Energy's Advanced Combustion Engine research addresses critical technical barriers to the commercialization of more efficient advanced internal combustion engines in light-, medium-, and heavy-duty vehicles. Specific goals are to improve, by 2012, the efficiency of internal combustion engines for (1) light-duty applications from 30% to 45% and (2) for heavy-duty applications from 40% to 55% – while meeting cost, durability, and emissions constraints. The research seeks to advance fundamental combustion understanding to enable design of engines with inherently lower emissions, and eventually advanced engines operating predominantly in low-temperature or HCCI combustion regimes. The resulting technological advances will reduce the size and complexity of emission control devices and minimize any impact these devices have on vehicle fuel efficiency. A fuel-neutral approach is being taken, with research addressing gasoline-based LTC engines as well as diesel-based advanced engines. In addition, the work seeks to increase overall engine efficiency through fundamental improvements such as advanced combustion processes, reduction of parasitic losses, and recovery of waste heat.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
7-4	Achieving High-Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines (Robert Wagner, Oak Ridge National Laboratory)	3.64	0.50
7-7	Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal (Robert Wagner, Oak Ridge National Laboratory)	3.92	0.79
7-11	Advanced HCCI Engine Combustion Fundamentals (John Dec, Sandia National Laboratories)	4.58	0.51
7-14	Automotive HCCI Engine Research (Richard Steeper, Sandia National Laboratories)	4.00	0.89
7-17	Chemical Kinetic Research on HCCI and Diesel Fuels (Bill Pitz, Lawrence Livermore National Laboratory)	4.17	0.58
7-20	Fuel Spray Research Using Advanced Photon Source (Christopher Powell, Argonne National Laboratory)	3.83	0.58
7-24	HCCI Engine Research and Modeling (Dan Flowers, Lawrence Livermore National Laboratory)	4.08	0.79
7-27	Heavy-Duty Combustion Modeling (Mark Musculus, Sandia National Laboratories)	4.33	0.50
7-30	Heavy-Duty, Low-Temperature, and Diesel Combustion Research (Mark Musculus, Sandia National Laboratories)	4.58	0.67

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
7-33	Hydrogen Free-Piston Engine (Peter Van Blarigan, Sandia National Laboratories)	2.67	0.78
7-36	Hydrogen Internal Combustion Engine Research (Thomas Wallner, Argonne National Laboratory)	3.82	0.87
7-39	Improved Engine Design Concepts Using the Second Law of Thermodynamics (Jerry Caton, Texas A&M University)	3.31	0.75
7-42	KIVA Modeling to Support Diesel Combustion Research (David Torres, Los Alamos National Laboratory)	4.18	0.87
7-45	LES Applied To LTC/Diesel/Hydrogen Combustion (Joe Oefelein, Sandia National Laboratories)	3.75	0.75
7-48	Light-Duty Combustion Modeling (UWI) (Paul Miles, Sandia National Laboratories)	4.40	0.70
7-51	Low-Temperature Diesel Combustion Cross-Cut Research (Lyle Pickett, Sandia National Laboratories)	4.09	0.83
7-54	Optimizing Low-Temperature Diesel Combustion (Rolf Reitz, University of Wisconsin)	4.69	0.63
7-57	Sandia Hydrogen Combustion Research (Sebastian Kaiser, Sandia National Laboratories)	3.38	1.19
7-61	Small Bore Advanced Combustion Engine R&D (Paul Miles, Sandia National Laboratories)	4.09	0.54
7-65	Spark-Assisted HCCI Control (Dean Edwards, Oak Ridge National Laboratory)	3.55	0.82
7-68	Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes (Josh Pihl, Oak Ridge National Laboratory)	3.17	1.03
7-72	University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines (Dennis Assanis, University of Michigan)	4.17	0.58
7-75	Visualization of In-Cylinder Combustion R&D (Steve Ciatti, Argonne National Laboratory)	2.83	0.94
	Overall Session Average and Standard Deviation	**3.87**	**0.91**


Combustion Research
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Visualization of In-Cylinder Combustion R&D |Argonne National Laboratory|
University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines |University of Michigan|
Stretch Efficiency – Thermodynamic Analysis of New Combustion Regimes |Oak Ridge National Laboratory|
Spark-Assisted HCCI Control |Oak Ridge National Laboratory|
Small Bore Advanced Combustion Engine R&D |Sandia National Laboratories|
Sandia Hydrogen Combustion Research |Sandia National Laboratories|
Optimizing Low-Temperature Diesel Combustion |University of Wisconsin|
Low-Temperature Diesel Combustion Cross-Cut Research |Sandia National Laboratories|
Light-Duty Combustion Modeling |UW|| Sandia National Laboratories|
LES Applied To LTC/Diesel/Hydrogen Combustion |Sandia National Laboratories|
KIVA Modeling to Support Diesel Combustion Research |Los Alamos National Laboratory|
Improved Engine Design Concepts Using the Second Law of Thermodynamics |Texas A&M University|
Hydrogen Internal Combustion Engine Research |Argonne National Laboratory|
Hydrogen Free-Piston Engine |Sandia National Laboratories|
Heavy-Duty, Low-Temperature, and Diesel Combustion Research |Sandia National Laboratories|
Heavy-Duty Combustion Modeling |Sandia National Laboratories|
HCCI Engine Research and Modeling |Lawrence Livermore National Laboratory|
Fuel Spray Research Using Advanced Photon Source |Argonne National Laboratory|
Chemical Kinetic Research on HCCI and Diesel Fuels |Lawrence Livermore National Laboratory|
Automotive HCCI Engine Research |Sandia National Laboratories|
Advanced HCCI Engine Combustion Fundamentals |Sandia National Laboratories|
Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal |Oak Ridge National Laboratory|
Achieving High-Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines |Oak Ridge National Laboratory|

Achieving High-Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines (Robert Wagner, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Light-duty low temperature combustion was seen, by one reviewer, as an important area of study for fuel economy improvement. Another reviewer felt that HECC will enhance the performance / emissions tradeoff of the engine. Another reviewer saw the project as supporting light-duty diesel with understanding and implementing LTC. Another reviewer viewed the project working toward improving fuel economy and reducing emissions.

Another reviewer was concerned that the program needed to be careful that engine testing doesn't lose focus on fundamental combustion issues. Much time can be spent diagnosing engine design specific issues (such as EGR cycle-to-cycle distribution due to a sub-par intake manifold) rather than addressing the fundamental combustion questions. Also, separating the impact of strategy and calibration robustness from fundamental combustion is difficult.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer saw the program as taking a laundry list approach to LTC in LD diesel and was concerned how much of the project is merely a "voyage of discovery" for ORNL rather than getting the job done. Another reviewer found the general subject matter as good, but was unclear what the actual objective of the project is. The same reviewer felt the team should pick an aspect of LTC and focus on it, for example, expanding the LTC operating range. Another reviewer did not feel that a good explanation was provided for what the barriers are and how they are addressing them. The reviewer also wondered is noise a primary focus?

A reviewer found that the program goals are well-defined in terms of objectives, task interactions and collaborations. The key goal is to enable and expand HECC boundaries in a multi-cylinder light-duty diesel engine. Another reviewer spoke of collaboration with industry partners.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt that progress was slow due to the large list of areas of interest being studied. Another reviewer felt the tools were now in place to move forward and wondered how well is modeling integrated with this project?

Another reviewer saw the program as making steady progress toward goals. The reviewer saw good interaction with industry partners and expressed the key accomplishments as characterizing performance (including noise) with mixed-source EGR and controls strategies. One reviewer viewed the project as looking at a systematic characterization of several different efficiency improvement techniques. The reviewer also commented that the project had done a good job combining modeling and experimental work. The project was seen, by a reviewer, as having shown some good results comparing low-pressure and high-pressure EGR as well as combined EGR systems, but did not provide any insight about why low-pressure EGR appears to have benefits. A reviewer felt it was a good idea to run FACE diesel fuels on the GM engine to look at cetane and other fuel property effects,

especially at low load conditions. The reviewer also felt that it would be very interesting to also run the FACE fuels on the Mercedes engine before shutting down work on that engine.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer saw good collaboration with industry and academics, but wondered how much if this was technology transfer from other organizations to Oak Ridge National Lab instead of the other way around. A reviewer felt the project needed to communicate with industry partners to make sure they (ORNL) are looking at practical methods for implementing the various HECC technologies.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

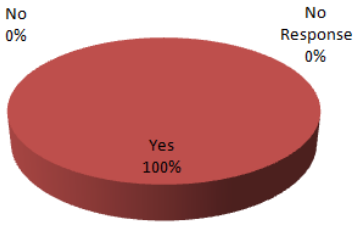
A reviewer felt that progress seems to match the budget, but a much larger budget could be consumed to fully explore these areas. Another reviewer felt that resources appear to be adequate. One reviewer felt closer industry ties were the key to support access to more state of the art hardware.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

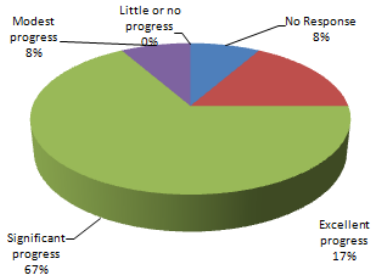
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Achieving High-Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines

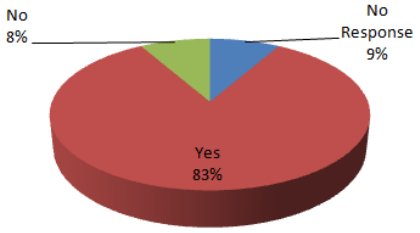
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



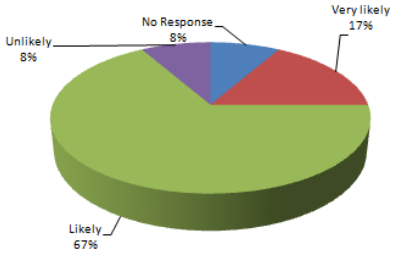
Question 3: Characterize the technical accomplishments and progress toward goals.



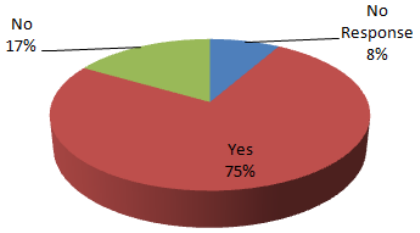
Question 2a: Are the goals of the project technically achievable?



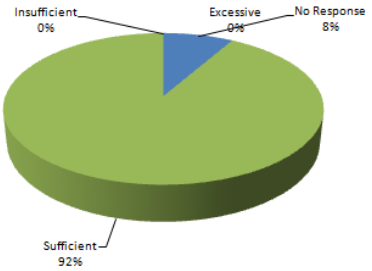
Question 4: How likely is the project team to move technologies into the marketplace?



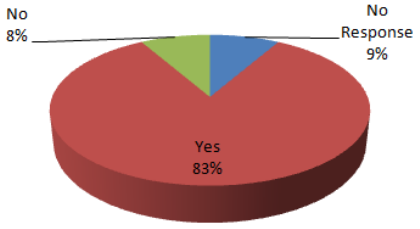
Question 2b: Have the technical barriers been identified and addressed?



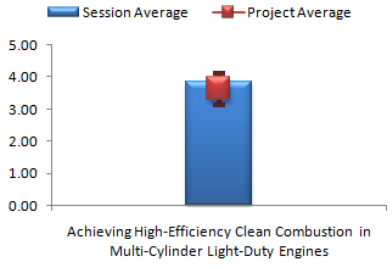
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal (Robert Wagner, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented that improving light-duty diesel fuel economy is an important step along the way to further improve the fuel cost benefit of dieselization. Another commented that the program supports DOE goals because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. Another saw the program as sharing the same goal for brake thermal efficiency as defined in the DOE objectives. Another reviewer saw the project as intended to bring technology together to demonstrate efficiency and emissions improvements on a light-duty diesel engine. Other reviewers saw the project as aiming at improved engine and fuel efficiency.

Another reviewer stated that integration of controls into a systems approach to LTC is needed for a timely implementation of this technology, but added that they would have liked to see more of the interaction between engine research and after treatment.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A number of reviewers questioned if waste heat recovery was practical for light duty vehicles. One reviewer was not sure if using the organic Rankine cycle to capture available exhaust energy would be likely to yield a significant amount in light duty applications where exhaust energy is relatively low. The reviewer felt it was important to balance energy recovery with aftertreatment function, which is difficult given the low exhaust temperature in light-duty, and hoped the transferability of what is done to achieve efficiency and/or emissions on this engine to other engines would be addressed.

A reviewer would have like to known the emissions levels at 42% BTE, but the reviewer realizes that this target is set elsewhere. The reviewer asked if anything would be gained by focusing on the areas of the engine map where the duty cycles spend the most time. The reviewer also wondered how waste heat recovery fits with aftertreatment, especially with light-duty off-road trucks. Another reviewer commented that availability, analysis and advanced combustion and waste heat recovery are being evaluated, but felt there should be more effort focused on improving part-load efficiency and emissions.

A few reviewers commented on the project as having good connections with several industry partners. A reviewer thought it was smart to use availability analysis to identify areas to go after energy. Another reviewer saw the project as having a good systematic approach to the problem, but waste heat recovery especially is a very large potential area of investigation, and it needs to be approached in a goal-based fashion. Another reviewer saw baseline measurements of performance on two light-duty diesel engines and studies of opportunities for improved efficiency as a key accomplishment. A reviewer commented that the slide showing exhaust energy over engine map was good for focus on where the most “bang for the buck” is to improve BTE.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer's belief that waste heat recovery is not feasible for light duty vehicles was reiterated. Another reviewer felt the program needed to progress beyond using available engines with varying calibrations. Another reviewer stated that the program needs to show how the 42.2% efficiency was accomplished, adding it is more important to learn the path then the numbers. One reviewer felt there should be a focus on an operating point for efficiency: the reviewer also wondered about emissions and cycle efficiencies. Yet another reviewer felt there should be a focus on part loads, stating that modest gains had been made at peak or near-peak loads. A reviewer found the project very interesting to assess the practicality of an organic Rankine cycle on a light duty engine. The reviewer added that the investigators also need to look at efficiency improvements over a real drive cycle and not just at the peak BTE point. The reviewer realized the DOE objective is 45% BTE at the peak efficiency point, but felt they should also report a drive cycle efficiency improvement too. The reviewer also commented that it was a good job working with Bosch to try and overcome the controller problems they have had.

Another reviewer felt the program is making steady progress towards goals. The reviewer saw interaction with industry partners as good. The reviewer saw baseline measurements of performance on two light-duty diesel engines and studies of opportunities for improved efficiency as key accomplishments.

A reviewer also noted this was one of the few DOE projects on light duty waste heat recovery, and hence an important project. The reviewer also noted that progress has been slow.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

It was reiterated, by a reviewer, that waste heat recovery is not economically feasible for LD vehicles. Another reviewer was concerned that it was not clear that anything new has been done yet. How was the 42% achieved? Advancing the timing? What other things can be done? Close analysis of where improvements can be made will be some of the key contribution, but how does this overlap with some other projects?

Another reviewer found waste heat recovery as a very attractive approach for fuel efficiency improvement, but wondered if ultimately the low grade of the energy available reduces the benefit to only a couple of percentage points at best. Another reviewer found that the program is yielding valuable insights into performance of light duty diesel engines. The team was able to demonstrate 42% thermal efficiency with two modified OEM engines, but the reviewer felt they did not state if these changes compromised consumer acceptance (life, operability, noise, etc)

A reviewer saw the question as whether an organic Rankine cycle is practical. The reviewer expect that if this project does an excellent job of characterizing and quantifying an organic Rankine cycle (which the reviewer believed it will), then the project was worthwhile even if the technology doesn't make it to the marketplace. Another reviewer stated that work is being performed on a relevant light-duty engine is so is easily relevant and transferable.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

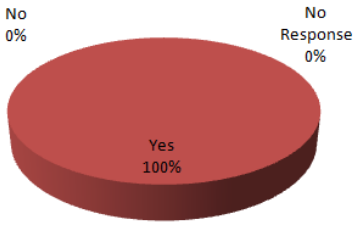
One reviewer felt that progress is slow but steady on the project. One reviewer found resources to be adequate. Another reviewer wondered if additional funding would allow the work to be expanded to looking at energy recovery from coolers.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

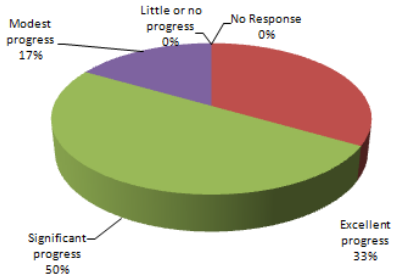
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal

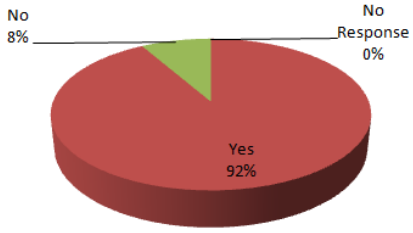
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



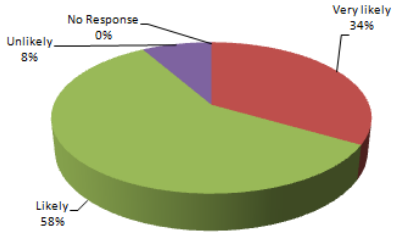
Question 3: Characterize the technical accomplishments and progress toward goals.



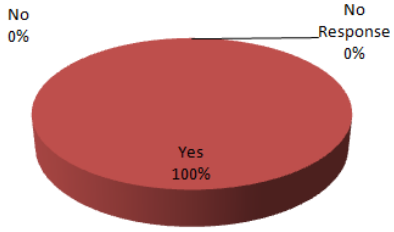
Question 2a: Are the goals of the project technically achievable?



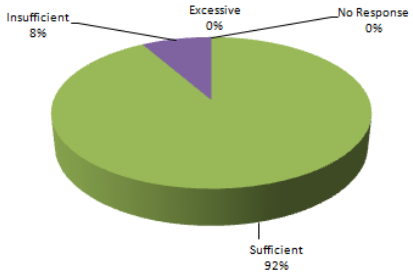
Question 4: How likely is the project team to move technologies into the marketplace?



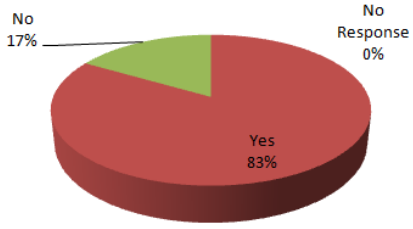
Question 2b: Have the technical barriers been identified and addressed?



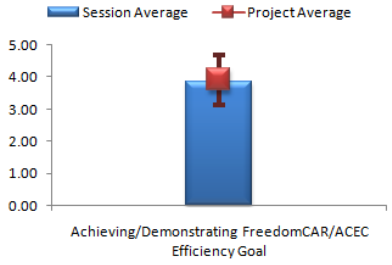
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced HCCI Engine Combustion Fundamentals (John Dec, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many reviewers felt that HCCI study will lead to real fuel savings, and is important because HCCI is already being implemented in test vehicles. The current study was also seen, by a reviewer, as being important to future engine design, and another reviewer said that extending the limits of HCCI would enable efficiency at part load on gasoline engines. The research was also seen as addressing fundamental barriers to implanting low temperature combustion, as expanding the LTC/HCCI operating regions.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The program's goals were seen as well-defined and the approach as good. Improvement was seen in chemical kinetics and CFD models, based on increased understanding obtained from the program. One reviewer saw the program's key accomplishments as the studies of fuel types, EGR levels, and valve actuation systems. The program goals are well-defined in terms of objectives, task interactions and collaborations. Key accomplishment is investigation of HCCI including fuel type, EGR levels and valve actuation schemes. A good connection was seen with industry and working group partners. One reviewer wondered if cooled EGR would lead to different results.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The work was seen as having an excellent approach with systematic progress. The program's plan was viewed as good, and the program was seen as achieving its goals. One reviewer went on to state that the work is having an impact on a number of programs at national labs, with good interaction among partners. One reviewer noted that the work showed a correct understanding of the issues, and that progress was being made in understanding the relative merits of injection retard versus EGR on IMEP, NOx and efficiency is important information. The reviewer added that going forward, studies in thermal stratification (TS) will be important in extending the high-load limit of HCCI and should continue to be pursued. The installation and operation of the VVA system is a key step. It will make this work more relevant to practical implementation of HCCI by the auto industries. Going forward, VVA strategies should be the grid upon which understanding of SOI, EGR and other parameters should be developed. Investigating boosted conditions to extend high-load limits will also be interesting. The information on the impact of EGR and thermal efficiency was viewed as good, by a reviewer, but the reviewer would have liked to hear more about the exhaust gas speciation and how that information will help better understand advanced combustion fundamentals. A reviewer felt that the mechanism of low temperature combustion still needed to be analyzed.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The program was seen as yielding valuable information towards making HCCI combustion material. The work was seen as the early stage basic science approach, which is important to the ultimate commercialization of the technologies. The plan was seen as being good to date, and another reviewer

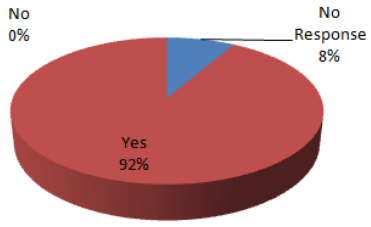
added that industry needs a high efficiency and low emission engine and the study shows it can fit the solicitation.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Responding reviewers felt that there was a need to consider additional funding for the program.

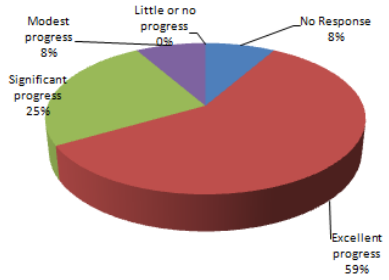
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced HCCI Engine Combustion Fundamentals

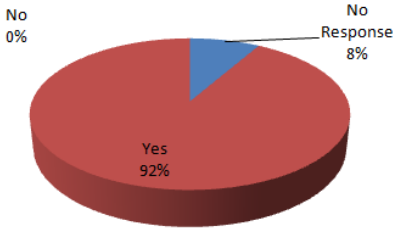
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



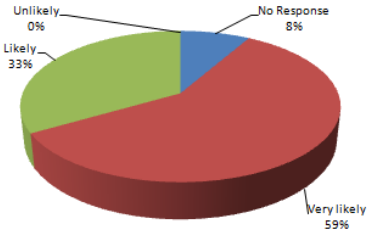
Question 3: Characterize the technical accomplishments and progress toward goals.



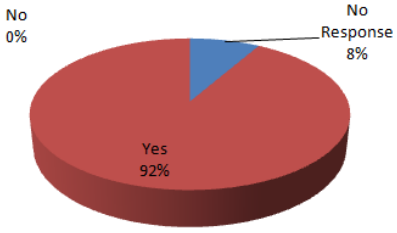
Question 2a: Are the goals of the project technically achievable?



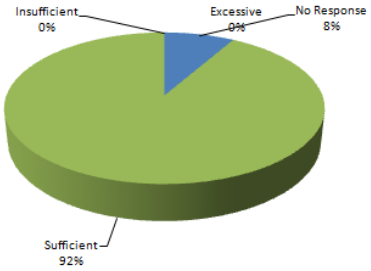
Question 4: How likely is the project team to move technologies into the marketplace?



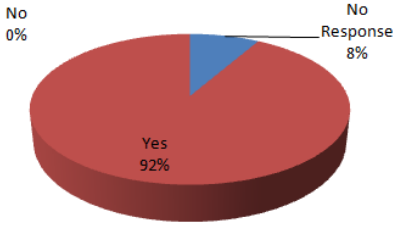
Question 2b: Have the technical barriers been identified and addressed?



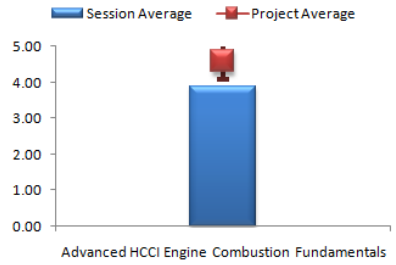
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Automotive HCCI Engine Research (Richard Steeper, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Most reviewers who responded found that automotive research was important for fuel efficiency improvement. One saw the program as understanding HCCI combustion using advanced optical diagnostic techniques.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A number of reviewers found the project goals as good and well defined. One reviewer saw the key accomplishments as the investigation of negative valve overlap applied to gasoline engine and PLIF diagnostic applied to optical engine.

Collaboration with industry partners was also observed by a reviewer. Another reviewer saw that there had been collaboration on chemical kinetic and CFD modeling work. One reviewer noted that understanding is being transferred to numerical models at UW and LLNL and industry. There was also a comment by a reviewer that the technique of looking at equivalent ratio and temperature simultaneously will provide incredibly useful data.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the program had saved a lot of time by using fixed cams for the NVO study instead of trying to implement a VVA system, which has allowed focus on doing work instead of implementing a VVA system. The program's systematic approach to try and understand the effects of temperature and EGR concentration throughout the cylinder was seen as positive. Another reviewer did not understand why VVA systems (which the reviewer saw as readily available) had not been incorporated.

A key accomplishment was viewed, by a reviewer, as the investigation of negative valve overlap applied to gasoline engine and PLIF diagnostic applied to optical engine. A reviewer also saw the development of experimental/analytical tools for HCCI investigation as interesting and to be encouraged. The prove-out of the technique was seen as a great accomplishment by another reviewer, while one reviewer found mixing observations as a key to successful development of LTC and HCCI.

The 2-wavelength PLIF diagnostic to simultaneously measure EGR concentrations and temperature was seen as exciting by a reviewer. The reviewer added this diagnostic should now be brought to bear on negative valve overlap and fuel injection parametric studies aimed at understanding the HCCI combustion process.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The program was seen by a reviewer as yielding valuable insights. Another reviewer noted that the program was seeking to improve collaboration. One also felt that the development of the Stanford technique was useful. Another reviewer expressed concern that the program continued to be too

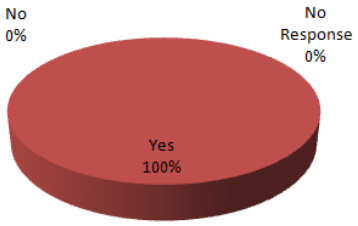
focused on GM, while another reviewer did not see how the program's results will help to develop engines with better efficiency.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All reviewers who responded found resources to be sufficient.

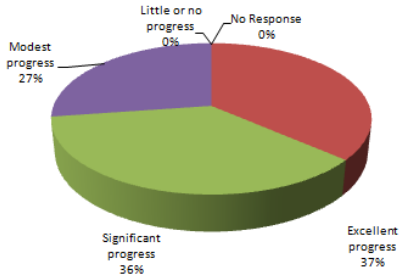
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Automotive HCCI Engine Research

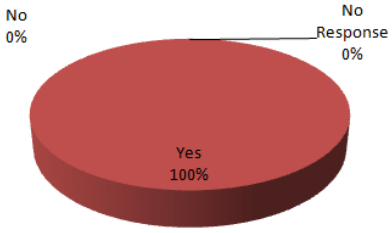
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



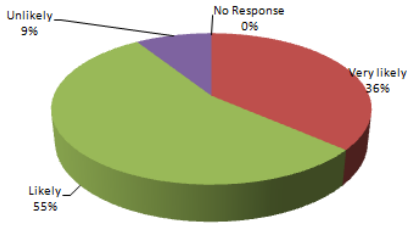
Question 3: Characterize the technical accomplishments and progress toward goals.



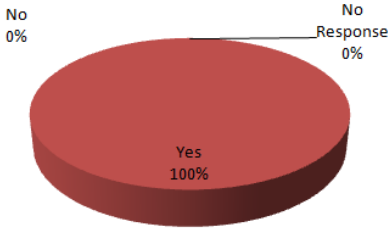
Question 2a: Are the goals of the project technically achievable?



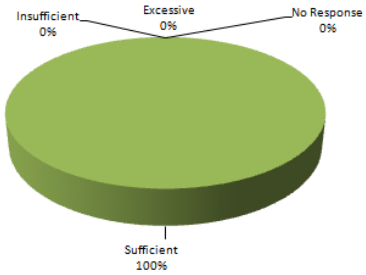
Question 4: How likely is the project team to move technologies into the marketplace?



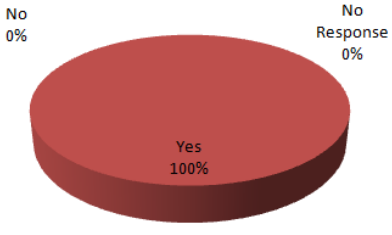
Question 2b: Have the technical barriers been identified and addressed?



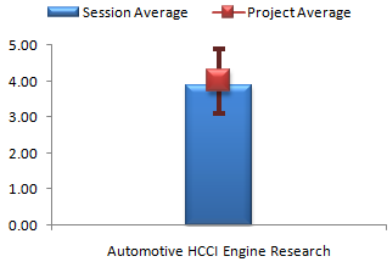
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Chemical Kinetic Research on HCCI and Diesel Fuels (Bill Pitz, of Lawrence Livermore National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers stated that better chemical kinetic models are critical for improved modeling and ultimately engine design, especially for low temperature combustion. Other reviewers commented on generating surrogate fuels and alternative fuels which will lead towards bio-based fuels and alternative fuels with petroleum use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
It was commented by a reviewer that this project is well connected to industry, universities and other labs through the distribution of mechanisms. Another reviewer stated that the modeling was vital for advancing combustion technology, and found the modeling of RME as new and valuable. One reviewer stated that simplified models, as discussed, are important in that they will allow a broader group of researchers to use the techniques in a broader range of projects. The reviewer added that simplification is not a substitute for complete understanding of detailed kinetics. A reviewer mentioned that LLNL has a unique capability, which is being used wisely in the project.

A reviewer said that the strategy seemed good overall and solid. The reviewer added that it was good to see modeling backed up with experiments. It was said, by another reviewer, that the focus on biodiesel, while understandable from a DOE perspective, seems premature given the current relative lack of knowledge about the chemical kinetics of more conventional diesel-type fuels. One reviewer cited the project as having a nice approach to develop the full reaction and then simplify to a usable number of reactions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer described the modeling of RME as new and valuable. A number of reviewers commented favorably on the model development for useful fuels, citing n-hexadecane and methyldecanoate. A reviewer felt that program had a pretty good apparent understanding of the tradeoffs between simplification and accuracy. A reviewer felt that the development of mechanisms for several fuels that are of key interest to industry. The reviewer added that the program needs to be sure to acknowledge that “diesel fuel” and “gasoline” can vary significantly and insure that the surrogates can address these variations.

A reviewer stated that reduced-order chemical kinetic models are required by industry, and the project stands to provide those. The reviewer wondered whether matching fuel combustion properties through reduced order reactions or through the use of surrogate compounds would be the better approach. A reviewer felt that the project was pretty good work, with good feedback and validation mechanisms. Another reviewer wonders how many more fuel components for diesel and gasoline will be necessary to provide good HCCI/LTC predictive capability.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer commented that modeling is important for the engine to reach the market: the reviewer considers bio-fuel as a high priority. A reviewer stated that LLNL and DOE have established a very good technology transfer mechanism for this and related programs. Another reviewer added that most people are using the LLNL mechanism. A reviewer stated that good fuel models will likely be picked up by industry for their modeling work, and felt the program had an excellent amount of publications and industry collaboration. Another reviewer felt there was a need for more direct contact with industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

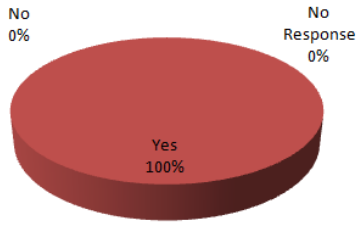
Two of the commenting reviewers felt that the budget was appropriate for the broad array of work being performed. Another reviewer saw evidence of widespread collaboration among worldwide peer group; the reviewer also saw evidence of feedback from experimentalists.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

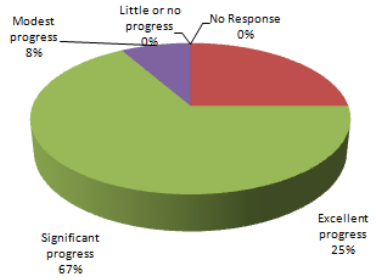
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Chemical Kinetic Research on HCCI and Diesel Fuels

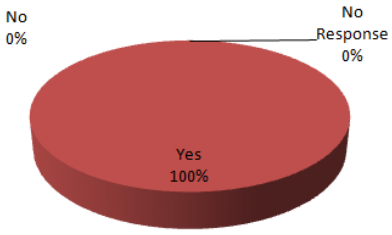
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



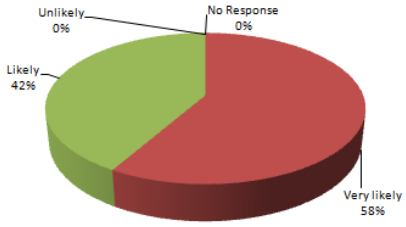
Question 3: Characterize the technical accomplishments and progress toward goals.



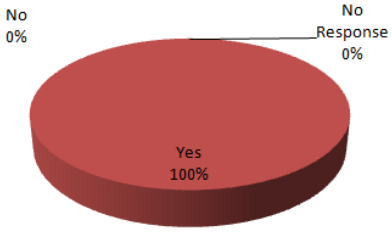
Question 2a: Are the goals of the project technically achievable?



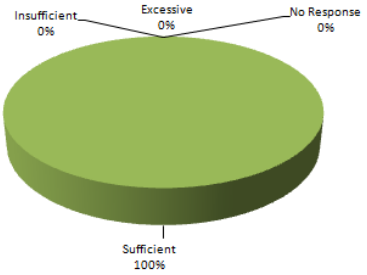
Question 4: How likely is the project team to move technologies into the marketplace?



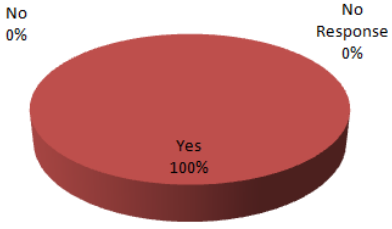
Question 2b: Have the technical barriers been identified and addressed?



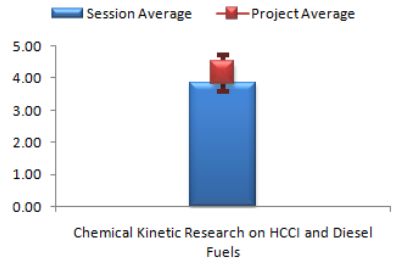
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Fuel Spray Research Using Advanced Photon Source (Christopher Powell, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that fundamental fuel spray research is potentially important for diesel combustion research. Other reviewers added that improved understanding of fuel spray will lead to improved engine performance. Another added that the study provided great data sets model validation which compliments those provided by Sandia. The goals were described as clearly stated, by another reviewer, and the role of the project clearly defined.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that quantified spray data was not available, but added that this work is very valuable for model improvement and that good models are vital for engine development. A reviewer stated that there was insufficient information on how this technology will find its way into the industry, other than Bosch's interest. The reviewer added that collaboration with Bosch seems to be too one-sided (as is always the case). Another reviewer question industrial partnerships. One reviewer wondered if Argonne had made industrial collaboration a top priority, and wanted to know if this would be measured and later evaluated versus metrics. A reviewer felt the project was straightforward with obvious benefits. The reviewer added that the x-ray technology for spray measurement seems to be a significant step forward in this technique. Another reviewer felt that some interesting results could be achieved. Another reviewer stated that GDI work would be very useful, and that the effect of orifice shapes and finishes a la Bosch would be a good extension.

One reviewer wondered if it would be possible to look at the interaction of multiple injections. The reviewer added that the closer to real engine conditions the project can get the more useful the data. The reviewer stated it is worth working toward these goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that it was good to see the program was moving to higher ambient pressure, which was seconded by another reviewer. Another reviewer felt that interesting results had been achieved. A reviewer felt that the project was making progress towards goals with completion of modeling studies of real sprays, etc.

A reviewer stated that the X-ray window selection was not yet finalized - this is a necessary prerequisite, but it seems far from the DOE's actual goals. The reviewers understand that good windows for high-pressure, high-temperature studies are needed, but their interest is really in the results which seem far removed from this.

Another reviewer said it was good to see the collaboration with Caterpillar and implementation of the Cat injector into their rig. The reviewer felt it was good that they had gotten Bosch involved in some of the testing. The reviewer would like to see more quantitative results from the measurements. The reviewer added that most of what has been shown are 2-D pictures of fuel density in the spray plume. The reviewer wondered what these pictures can be used for, and if there are modeling results that can

be compared to the spray measurements. Since one of the stated goals is to improve spray models, is it possible to investigate the end of injection leaning out demonstrated at Sandia?

One of the reviewers commented that the emphasis is on describing what happens in the spray, and felt there was a need to expand to define what we want the spray to look like and how different spray characteristics affect emissions and performance. The reviewer felt that to do this there has to be a second, deeper level of collaboration that may exist in pockets, but is not as widespread as it could be. The reviewer added that there is some evidence this is happening from the discussion, but wondered if Argonne could do more here.

A reviewer felt that significant progress was made to improve the facility to test at diesel like ambient pressures. The reviewer felt it would be useful to continue to push this limit up so that the entire operating range can be captured.

Another reviewer felt that the productivity of the project can be increased, that the output has not been commensurate with the amount of time that this project has been active.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Two reviewers commented that the program was well-connected with industrial partners; another said that it was good to see the collaboration with Bosch and a reviewer was encouraged that Bosch had agreed to non-competitive research. A reviewer felt that this was good, valuable work but wondered if there was as much technology transfer here as at other labs.

A reviewer stated that it was fundamental work to understand the spray patterns, and the project seemed responsive to industry partners. Another reviewer felt it seemed the technology was near term available (5 years or so), so that it could very likely be picked up by industry. The reviewer added that it seemed like the project could provide an excellent measurement technique for fuel system suppliers. Another reviewer stated that the study can directly apply into different injectors' evaluation, if the authors can develop a general empirical equation based on X-ray founding. The reviewer also suggested testing multiple injections to see the effect of jet to jet interaction

A reviewer felt the results are potentially important for the industry, but did not feel the technology transfer plan (to industry) was well formed (other than Bosch's interests). The reviewer also wonder if the researchers were up to date with work done at Chalmers University and elsewhere.

One reviewer answered modeling, support, and that the modeling work was close to the final stage of combustion development.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that the amount of funding seemed appropriate, considering the hardware and testing involved. Another reviewer felt that testing at high temperature and pressure is of value, and the replacement of windows should be expected and considered as a consumable for this sort of work. Another reviewer said the Caterpillar dyno engine sub project was important and should be funded.

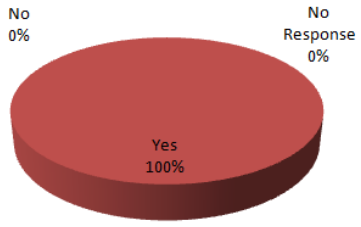
A reviewer felt the program made good use of existing national laboratory resources (X-Ray source). One reviewer expressed concern about getting Bosch to share proprietary information.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

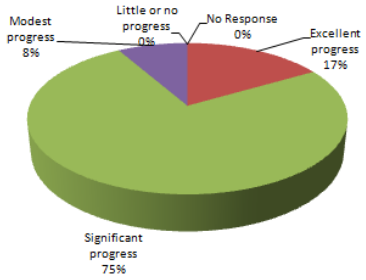
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Fuel Spray Research Using Advanced Photon Source

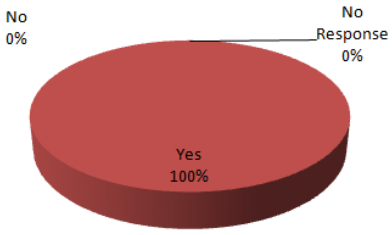
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



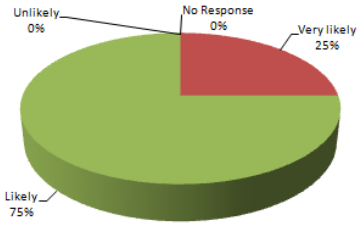
Question 3: Characterize the technical accomplishments and progress toward goals.



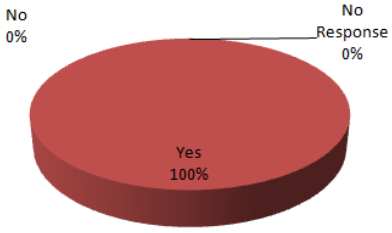
Question 2a: Are the goals of the project technically achievable?



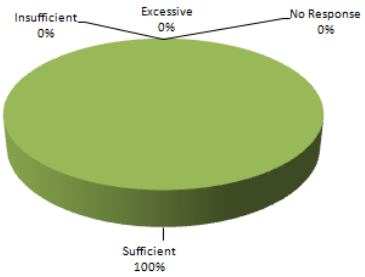
Question 4: How likely is the project team to move technologies into the marketplace?



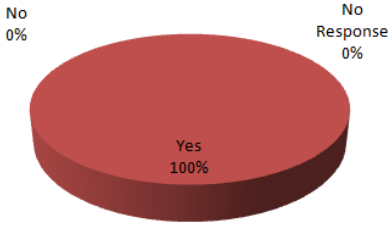
Question 2b: Have the technical barriers been identified and addressed?



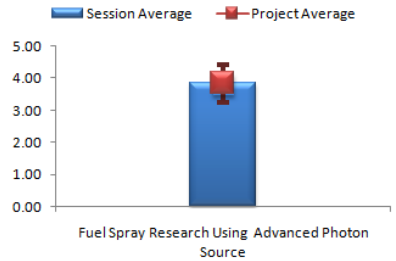
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



HCCI Engine Research and Modeling (Dan Flowers, of Lawrence Livermore National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Overall increased understanding of the HCCI engine modeling methods was mentioned by one reviewer as being very important for reducing the cost and effort to develop HCCI and mixed mode engines, which will reduce fuel use in the US. Another reviewer felt efficiencies would be increased in both diesel and gasoline engines. One reviewer felt that overall increased understanding of the combustion process through extensive advanced modeling should lead to identification of key adjustable parameters within advanced combustion processes which should lead to opportunities for efficiency improvement.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that CFD is crucial for advancing engine combustion. Another reviewer was glad that the work has been expanded beyond just HCCI. Another reviewer noted a well-laid out set of project plans.

A reviewer felt the return on this project seems low. More engine configurations and data need to be modeled to identify the model's deficiencies and improve the model. The reviewer wondered who in industry are using the models being developed. One reviewer felt the project needs to mention during the description of different projects and tool applications which opportunities for improvement are being pursued. The presentation highlighted the great tools being used but didn't get into the goals for their application.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt that CFD is crucial for advancing engine combustion. A reviewer commented that the program had a good systematic approach to the multiple problems and challenges that lie ahead, with a good plan in place for future progress. There were a number of positive comments concerning the progress in software and modeling work. A reviewer felt the program's application and what it will provide need to be highlighted.

A reviewer felt the project needs to be more focused. The reviewer did not see what the project was adding to its collaborations with Sandia, ORNL, and LANL. The reviewer felt that all of the results shown are matching the models to existing data, and that it would be nice to see this effort lead the experimental effort in some areas by developing ideas to be validated. The reviewer stated that it was good that the program was working on partially stratified combustion, but it that it would be nice to see more than just matching the existing experimental data. Another reviewer questioned why the project gets such a large dollar amount.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer cited the program's good history of technology transfer, and a cross fertilization between industry, national labs and academic institutions. The program's good industry and university

collaboration was also mentioned by other reviewers. A reviewer felt the program supported other work that is likely to reach the market. Another reviewer felt that if the technology progresses it will be due in part to work done under this funding. It was also expressed by a reviewer that there were a large number of interested parties within industry. It was also commented by a reviewer that the next generation of CFD codes would make this work extremely useful, and that the program had implementation in existing codes used throughout industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

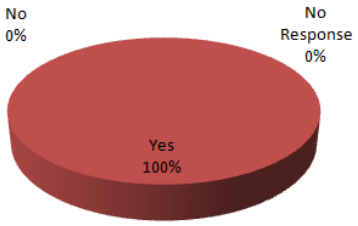
Two reviewers felt the funding level seemed high, and one of those reviewers wondered if the computers or computer time (for the modeling) was that expensive. Another reviewer cited difficulties in accessing persons from the project for support of other projects, leading the reviewer to believe the program was understaffed. The reviewer added that the program does great work and has a good understanding of what is required to progress to the state of the art. Another reviewer felt the program had good use of resources for a national lab.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

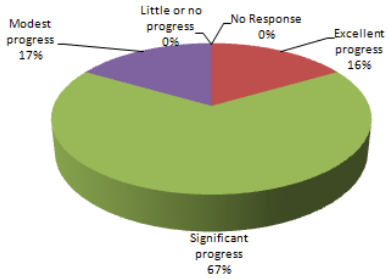
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: HCCI Engine Research and Modeling

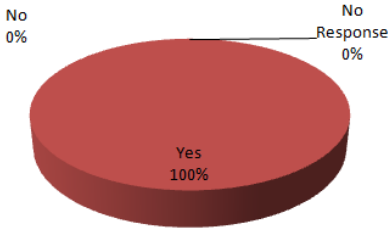
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



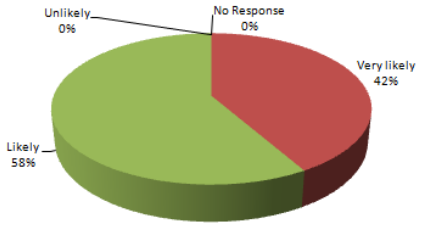
Question 3: Characterize the technical accomplishments and progress toward goals.



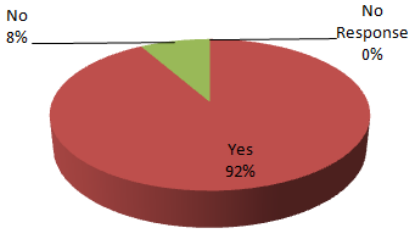
Question 2a: Are the goals of the project technically achievable?



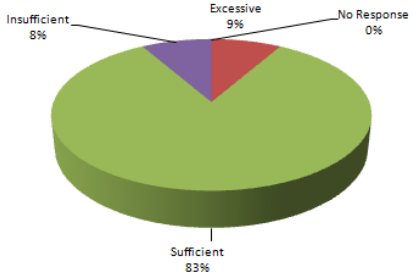
Question 4: How likely is the project team to move technologies into the marketplace?



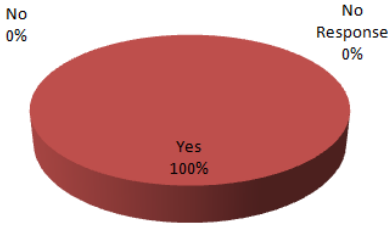
Question 2b: Have the technical barriers been identified and addressed?



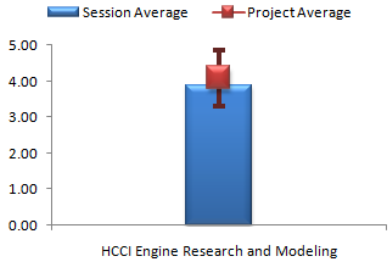
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Heavy-Duty Combustion Modeling (Mark Musculus, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
It was commented by a reviewer that the program supports DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. HCCI was seen by a few reviewers as important to the future of fuel economy improvements. It was also stated, by another reviewer, that the study will be good for reducing soot.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
It was said by one reviewer that this was very useful fundamental work that is necessary for the future deployment of HCCI technologies. Another reviewer went on that the program goals are well-defined in terms of objectives, task interactions and collaborations. Key accomplishment is developing a model to explain the behavior of unsteady sprays and the resulting in-cylinder fuel-air distribution. The program was also described as an excellent blend of experimental and model development, a view held by another reviewer.

One reviewer also felt that it would be good to have that the same students do the optical and modeling work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The modeling program was found to be making steady progress towards goals, by a reviewer. The modeling program was the topic of another reviewer, that the project had successfully addressed some of the physical parameters and then applied modeling or developed models to match the observations. The unsteady 1-D jet penetration model had the attention of a another reviewer, who saw it as being very useful in understanding details of optical engine data and encouraged continued development of this model.

Another reviewer felt that it was still early days in the progress of this modeling project, while another commented that more fundamental analysis will be necessary to further improve the model.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer stated that technology transfer is more appropriate than market transformation. Good interactions with industry and academics. Good tech transfer to engine designers is possible. Another reviewer commented that this program is contributing to understanding and predictive models that is necessary to commercialize low temperature combustion. One reviewer felt that the work was a model of what these programs are envisioned to be. "Observe, understand, model." The models and understanding developed here will be what goes to market. Another felt that the diesel engine industry would benefit from the study. It was also wondered by a reviewer when the model will be predictive with high enough confidence to be used for engine design and development.

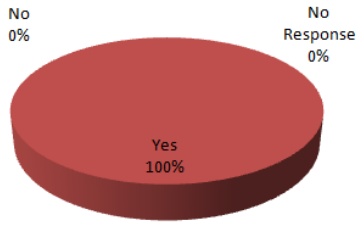
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Those who responded noted that funding was adequate.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

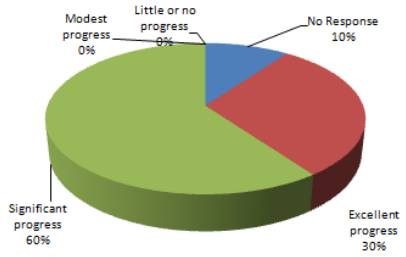
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Heavy-Duty Combustion Modeling

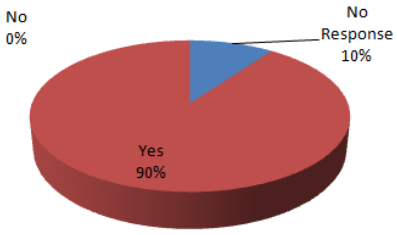
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



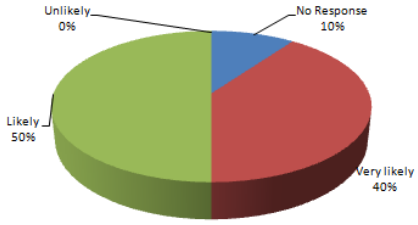
Question 3: Characterize the technical accomplishments and progress toward goals.



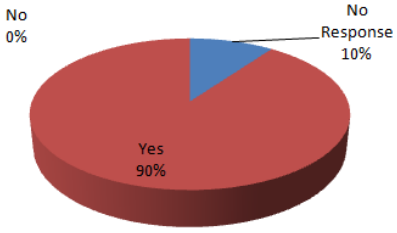
Question 2a: Are the goals of the project technically achievable?



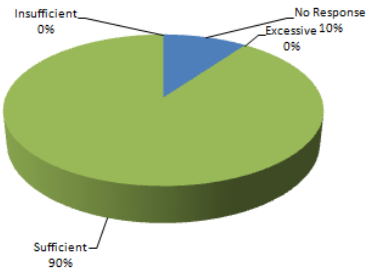
Question 4: How likely is the project team to move technologies into the marketplace?



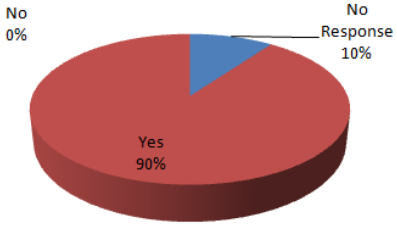
Question 2b: Have the technical barriers been identified and addressed?



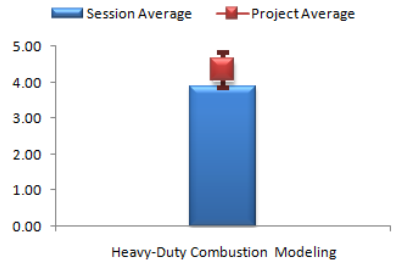
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Heavy-Duty, Low-Temperature, and Diesel Combustion Research (Mark Musculus, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer notes this program supports DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. It was also stated by a reviewer that the project is well aligned with the goal of developing a fundamental understanding of LTC - and what are its fundamental limitation in providing a higher efficiency combustion mode.

It was felt by other reviewers that barriers defined correctly would be of interest to industry. It was also felt that HD LTC would be important in the future and key to creating clean and efficient diesels engines.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
HD LTC was seen as an important area of research, as long as the fuel economy benefits outweigh the disadvantages. Another reviewer stated that the new focus on the influence of engine design parameters is producing valuable data and insights. The program goals are well defined in terms of objectives, task interactions and collaborations. A key accomplishment is using an optical engine to understand how engine design choices influence low temperature combustion. The work was seen, by a reviewer, as being good and systematic. The reviewer added that understanding of combustion process is to be transferred to numerical models. Another reviewer had a more specific comment, saying that the entrainment wave concept helps to explain gaps in one dimensional modeling, which should help KIVA model grid dependencies, which should help in designing HCCI operation at various bowl/swirl configurations. A reviewer also commented that there was good coordination with industry.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that good steady progress has been made. The reviewer adds that in-cylinder visualization is an important but potentially very large experimental field. The reviewer asked if the team considered design of experiments to reduce the bowl diameter/spray angle/injection timing matrix down to a manageable size. The reviewer continues, saying that this program is making significant progress toward goals. There is good interaction with industry and university partners. Key accomplishment is using an optical engine to understand how engine design choices influence low temperature combustion.

A reviewer praised the project for doing a good job using a systematic approach to investigate the effects of the bowl and nozzle geometry, adding that they don't need to run a full design-of-experiment -just look at known relevant conditions. The things that are being measured in the engine (toluene, formaldehyde, OH, PAH) are tied to a fundamental understanding of the mixing, ignition and combustion.

A reviewer stated the project team needs to make sure they stay on the task of developing the picture of LTC and not get too tied up looking at variations in hardware and operating conditions.

The unsteady jet model is a great innovation. This reviewer finds simple models like this to be very useful for increasing understanding of a problem. A reviewer also felt that physical interactions will require fundamental understanding in order to model effectively. Good results were shown.

Another responder commented that the project should continue to work on ways to overcome the HC and CO issues associated with LTC. It was felt by a reviewer that significant progress has been made on understanding effect of engine design variables on LTC. Looking forward to the data from the 80% bowl to complete the understanding gained from the 60% and 70% bowls, as well as the spray targeting and swirl variations.

Can CO and UHC emissions measurements also be made (a la Paul Miles) to complete our understanding of emissions formations? A reviewer stated that counter intuitive results seem well explained. This reviewer wondered what we do about the lean condition around the injector.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that this program is contributing to understanding and predictive models that is necessary to commercialize low temperature combustion. One reviewer stated that the work is focused on the right issues; engine design variables, fuel injection, numerical and conceptual modeling. Close collaboration with University of Wisconsin to update numerical models is ongoing.

Technology transfer was also commented on by a number of reviewers. One stated that these techniques are well-suited for technology transfer, rather than market introduction.

Another reviewer stated that the transfer is likely to be in the form of a model. Bringing in a modeler to help set up the test plans is a great idea that should be utilized in other projects. The project's good connection with industry was also commented upon.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

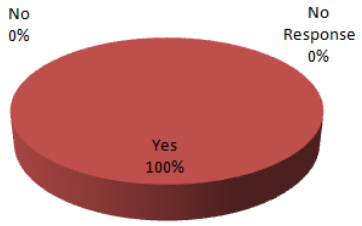
Progress seems commensurate with resources, according to a reviewer, while another felt that resources were adequate. One respondent added that the project needs to Needs to incorporate multiple injections and work towards solutions, in addition to "understanding".

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

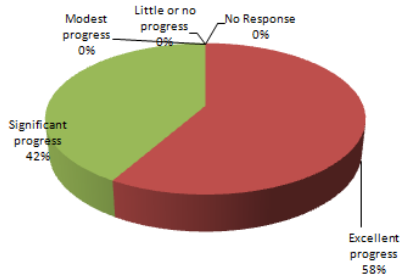
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Heavy-Duty, Low-Temperature, and Diesel Combustion Research

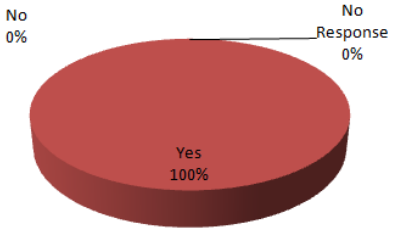
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



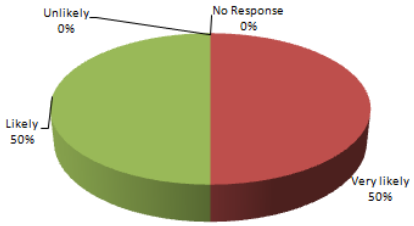
Question 3: Characterize the technical accomplishments and progress toward goals.



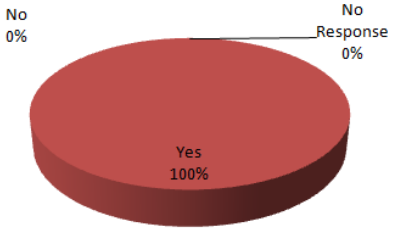
Question 2a: Are the goals of the project technically achievable?



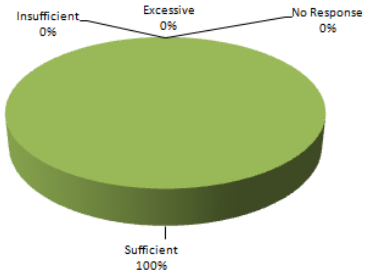
Question 4: How likely is the project team to move technologies into the marketplace?



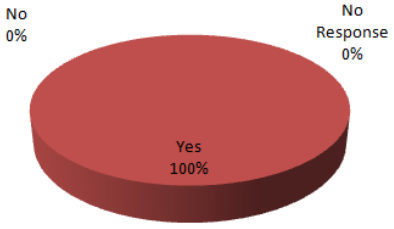
Question 2b: Have the technical barriers been identified and addressed?



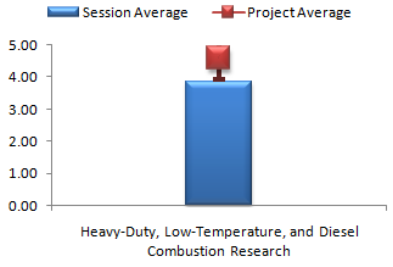
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Hydrogen Free-Piston Engine (Peter Van Blarigan, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer saw that the modeled or calculated efficiency of the free piston engine is potentially very good, but this is still theoretical. Another reviewer felt that the link to implementation in a vehicle was not defined. The same reviewer saw a need to expand on the systems approach to implementing the technology in a vehicle. Another reviewer did not see enough evidence that free piston engines are going to be a viable solution for transportation in the short to mid-team.

Another reviewer saw the program as supporting DOE goals for petroleum displacement because it aims to develop a novel engine configuration that incorporates a hydrogen-based combustion system. It was stated by reviewer that the project was investigating a method to potentially make a significant improvement in the efficiency of internal combustion engines. A reviewer said that it was a high risk project, but one that supports advanced engine concepts and hydrogen. Other reviewers saw the project as potentially increasing efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The project faces difficulties, in the words of a reviewer, with its broad scope and the essential re-engineering of the internal combustion engine. Another reviewer saw the project's goals as being well defines, but as having two significant barriers, including the availability of hydrogen as a fuel and the performance (in terms of efficiency, cost, operability and reliability) of the free-piston concept versus current or competing new technologies. The reviewer saw achieving competitive performance as the biggest barrier for implementation.

Other reviewers suggested technological concerns. One reviewer saw many potential problems in the scavenging system. Another reviewer saw limits to the benefits of increasing compression ratio in conventional engines caused by heat transfer and friction. The same reviewer saw significant noise as being caused by auto-ignition at all loads as loads increase, and there was no clear path to addressing emissions issues, since it was not clear that the exhaust temperature would support catalyst usage. Another reviewer was left unsure by the presentation, if the almost certain technological barriers that will arise on implementation of the technology can be overcome. One reviewer would like for the hardware and goals to be demonstrated on a laboratory scale, so that the barriers can be well understood.

A reviewer hoped that industry interaction would be maintained, while another thought there was good efficiency analysis.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer saw the project as having struggled with fairly limited physical accomplishments. The reviewer, among others, awaits the operation of a real steel engine with interest. Another was interested in seeing what the efficiency and emissions will be achieved with the upcoming demonstration engine.

One reviewer expressed concern that controlling the free piston engine had not been addressed in the current project. Two reviewers expressed concern that there was focus on the electric components at the expense of the combustion capabilities. Another simply wanted more attention placed on combustion capabilities and demonstrating motion control. A reviewer saw high risk with combining the dual linear alternators with a combustion system, which contributes to the apparent slow progress. The same reviewer wondered whether assumptions of the efficiency of the linear motor/generators been validated, as well as whether sufficient control of linear motor/generators been demonstrated to achieve target operability, control of compression ratio and control of work extraction. This reviewer suggested the program focus on verifying multi-cycle combustion operation with pistons controlled by simpler means, verifying control of the linear motors without combustion and combining the two.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

There was widespread concern about commercial application of this technology. It seems unlikely that industry will embrace this kind of technology - not that this means that this should not be pursued - but that it should be approached with realism. Concern was expressed, by a reviewer, if the project would deliver the efficiency that is claimed and that battery energy storage costs and transfer would cause unattractive pricing. The project was seen, by one reviewer, to be a fundamental experiment to look at the thermodynamic problem of using a very high compression ratio. Another saw it as a very unique approach which faces a number of hurdles. One reviewer was certain that if the demonstration was successful interest will pick up significantly.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

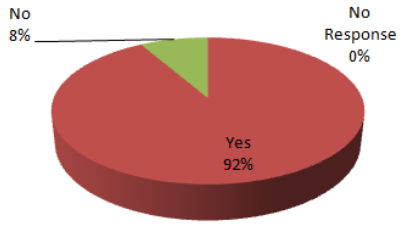
One reviewer saw the project as having shown good promise, even while on a starvation budget. Another felt that funding should only increase if the fuel efficiency advantage is demonstrated and if a path to market is defined.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

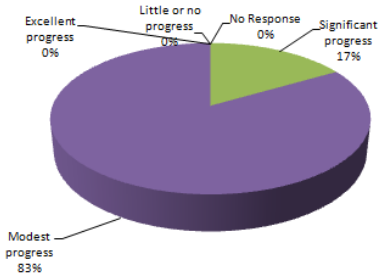
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Hydrogen Free-Piston Engine

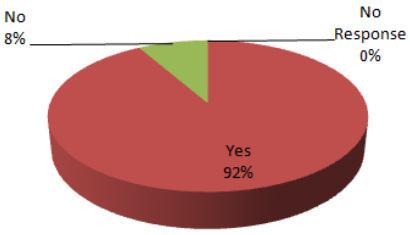
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



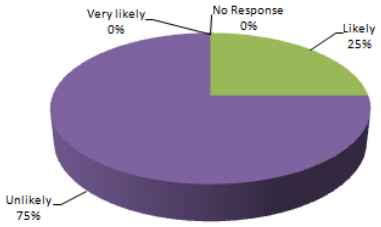
Question 3: Characterize the technical accomplishments and progress toward goals.



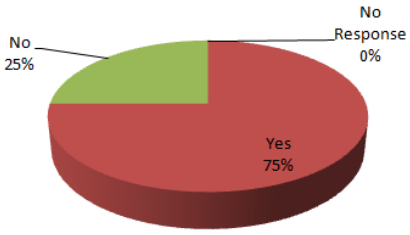
Question 2a: Are the goals of the project technically achievable?



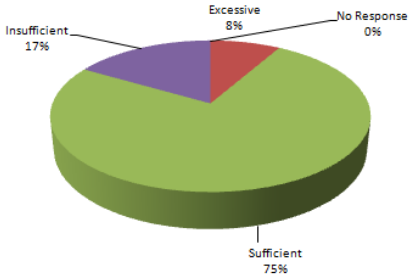
Question 4: How likely is the project team to move technologies into the marketplace?



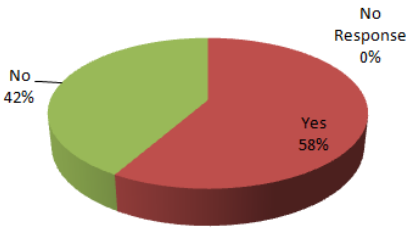
Question 2b: Have the technical barriers been identified and addressed?



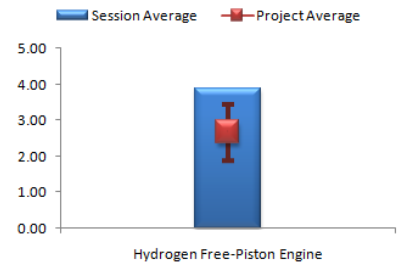
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Hydrogen Internal Combustion Engine Research (Thomas Wallner, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer saw the project as offering both improved fuel efficiency and alternative fuel utilization, but felt that hydrogen internal combustion engines research was moving out of favor with DOE. Two reviewers saw the hydrogen internal combustion engine approach as making sense, with hydrogen as a gap technology to establish a hydrogen infrastructure until fuel cell vehicles become commercially available. A reviewer saw the program as supporting DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for hydrogen-based combustion systems (comparing direct injection with port injection).

Another reviewer did not see hydrogen as an ideal fuel for a vehicle. A reviewer expressed concern that a hydrogen fueled engine would not have enough added efficiency over a gasoline or diesel engine to make it worthwhile and wondered how this would compare to low temperature diesels or advanced lean gasoline engines.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer found the program's goals as being well defined. The same reviewer saw accomplishments as the study of direct injection hydrogen internal combustion engine by investigating different injector configurations (comparing direct injection with port injection).

Two reviewers expressed concern about NOx emissions, one of whom did not find water reduction as practical. The other was curious what guided the testing, and how the various injector locations were chosen. The same reviewer also wanted to know if modeling was a factor.

Another reviewer saw direct injection hydrogen internal combustion as the only reasonable path for the technology that would enable high efficiency and power density. Concern was expressed that the goals were not comprehensive, and the reviewer blamed this on the project being in response to Ford, not out ahead leading the work. Other reviewers saw good industry cooperation, but one expressed concern the hydrogen was not an ideal vehicle fuel.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer saw the program as making progress towards the goal of studying hydrogen combustion in internal combustion engines. The reviewer saw a key accomplishment as the study of direct injection hydrogen internal combustion engine by investigating different injector configurations (comparing direct injection with port injection). A different reviewer saw the program as useful work aimed at overcoming technological barriers to hydrogen internal combustion engine deployment. A reviewer considered the program as doing an excellent job examining various nozzle configurations and helping understanding how best to mix the fuel and air. Another reviewer commented on the good brake thermal efficiency results. One reviewer saw the program as assisting development of an engine that achieved the milestone 45% peak thermal efficiency as a key accomplishment for 2007.

A reviewer suggested that the project choose a future emission standard, such as Tier 2 Bin 5 or lower and then estimate the NOx PPM level required to meet it. The reviewers impression was that the NOx measurements presented are very high. A different reviewer commented that NOx emissions should be normalized (e.g. g/kg-fuel) and plotted against advanced gasoline and diesel engine NOx emissions to see where this engine technology stands.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Concern was expressed by several reviewers about the lack of a hydrogen infrastructure, while one reviewer also felt the technology was competitive with fuel cells. Another reviewer saw interest in hydrogen as fading, but found the information on reformer gas as valuable. Some reviewers saw the industry partnership with Ford as important, but urged the project to stay ahead of Ford rather than follow.

One reviewer saw the program as yielding valuable public domain data on hydrogen combustion in internal combustion engines, and felt the technology would be a valuable transition to fuel cell vehicles. One reviewer felt that industry was looking at this approach very closely, and that more fundamental investigations might be recommended.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

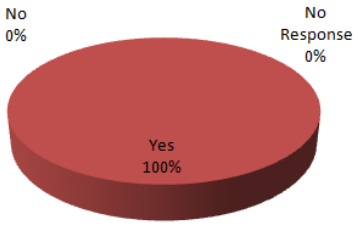
One reviewer found the project as having a low budget compared to the amount of work required to commercialize the technology. Another reviewer felt that funding was currently adequate, but should increase if sources of hydrogen become more competitive with other fuel options. A third reviewer felt this was the kind of project that was best kept small.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

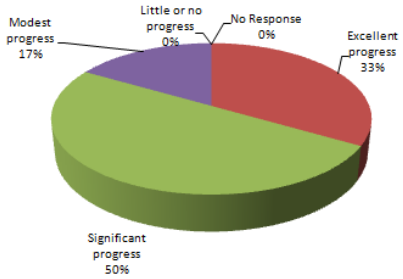
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Hydrogen Internal Combustion Engine Research

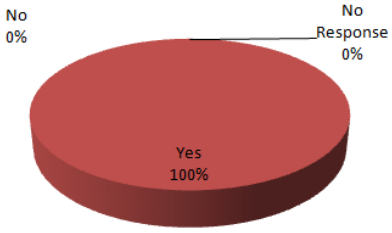
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



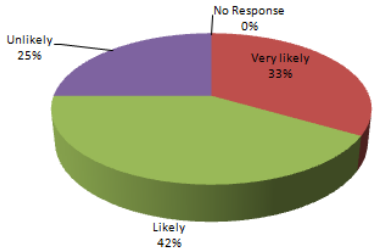
Question 3: Characterize the technical accomplishments and progress toward goals.



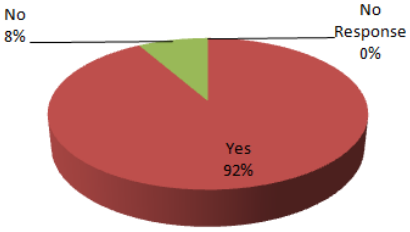
Question 2a: Are the goals of the project technically achievable?



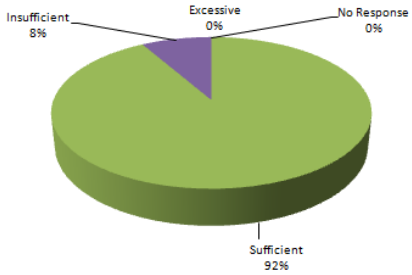
Question 4: How likely is the project team to move technologies into the marketplace?



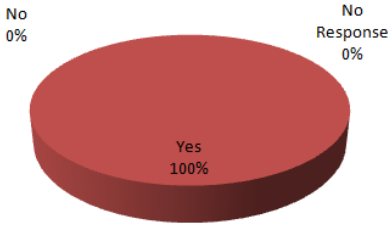
Question 2b: Have the technical barriers been identified and addressed?



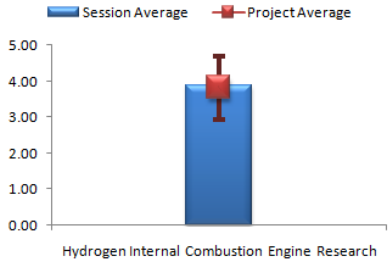
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Improved Engine Design Concepts Using the Second Law of Thermodynamics (Jerry Caton, of Texas A&M University)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The program was seen by a reviewer as a good, well-targeted use of DOE's limited basic science budget. The goal of the project was seen to improve the efficiency of internal combustion engines by understanding fundamentals of thermodynamic losses, and the program was viewed as supporting DOE goals by another reviewer. A reviewer noted the first principles look at ways to improve efficiencies in internal combustion engines, which the reviewer felt would provide insight to DOE and industry. Another reviewer found that using the second thermodynamic law to analyze the thermal efficiency of internal combustion is a very interesting topic. A reviewer thought the work is good, keeping a sanity check on other programs, so indirectly it contributes to the overall objective of reducing petroleum consumption. One reviewer was concerned that there was no link to experimental data and perhaps the program was too ideal to be of practical use in the real world.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer found the project to be a good generic study, and useful. Another saw the project as computational and open-ended with readily achievable goals. A reviewer saw the program goals as well-defined in terms of objectives, task interactions and collaborations. This program team is making good progress leveraging their respective facilities and capabilities to meet the goals of the program.

A number of reviewers urged the program to increase collaboration with industry partners in order to implement new technologies. One reviewer felt that that analysis should be expanded to include turbocharger, charge air cooling, EGR cooling, etc. The reviewer added that the approach should be expanded beyond in-cylinder, and wondered what other paths to improvement could be seen using this analysis.

A reviewer was unsure what engine design concepts can emerge from the analysis and felt that some thought should be devoted to actually incorporating the results into possible engine designs that would spell out the hardware needed. Another reviewer felt that analysis at partial load might help with understanding in this part of the engine map, even if unlikely to help overcoming any technical barriers. Another reviewer felt that some practical things need to be considered during simulation, such as the length of the stroke.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that this was a good, solid study that will aid future engine design. The reviewer added that this is a fundamental study, but better rooting in 'reality' would be of greater value - for example, multi-cylinder exhaust manifold tuning will improve exhaust breathing in an over-expanded engine. Another reviewer stated that this program is making reasonable progress toward goals, but that the program can add more value by extending the analysis method to assess the relative contributions to irreversibility of friction, turbo-machinery, heat exchangers, etc. Another reviewer felt the program should focus more on diesel engines for best fuel consumption potential, although

attention to (alternative) cycles for paper studies is thought provoking. Another reviewer thought that this was interesting work, and that it may be a good idea to do more.

A reviewer stated that progress is good, and agreed with the suggestion to look at indicated efficiencies, rather than brake at this stage of the project. Another reviewer found the work to be interesting, but felt it would be a good idea to do more comparison between the different combustion modes (SI, HCCI, diffusion controlled diesel, or PCCI diesel) to look at combustion availability destruction for these different processes. The reviewer went on to suggest separating the combustion process from the reciprocator device if this is possible. The reviewer felt that a useful outcome of this work would be a set of guiding principles for engine developers - which direction should various parameters be pushed, i.e. is longer vs. shorter combustion duration beneficial or is it path independent and so it doesn't matter?

Another reviewer urged a tie to industry and suggested working with indicated and pumping efficiencies rather than brake. The reviewer feels a few statements that explain the significance ("what does this mean?") of some of the Second Law Analysis results should be included for discussion.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The project was seen as having technology transfer predominately via graduate students employed by industry and through academic publications. Reviewers found that to be appropriate for a fundamental project. Reviewers felt that the project was investigating a very fundamental question, and that understanding and quantifying the results are worthwhile, even though there is not a marketable component. One reviewer added that a benefit of the program was adding a lot of graduate students to industry. One reviewer felt that while a lot of analysis work is being done, the significance of these needs to be better explained.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

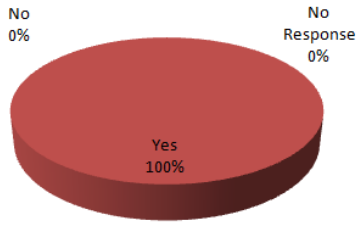
Several reviewers felt that resources were appropriate for a project of this size. One felt that there was good use of a low budget, while another reviewer felt that lots of work being done with very little funding, especially when consider having to customize software to use on their project. The reviewer wondered would it be beneficial to expedite EGR studies if there were increased funding available.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

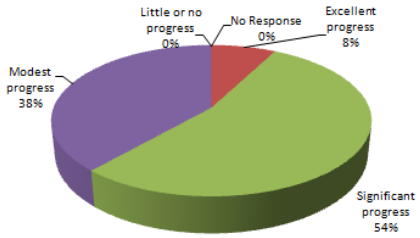
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Improved Engine Design Concepts Using the Second Law of Thermodynamics

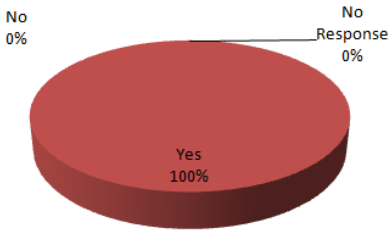
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



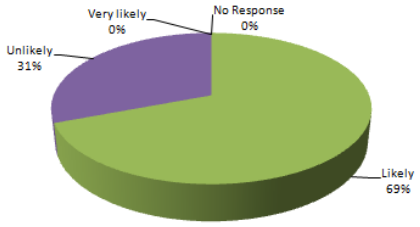
Question 3: Characterize the technical accomplishments and progress toward goals.



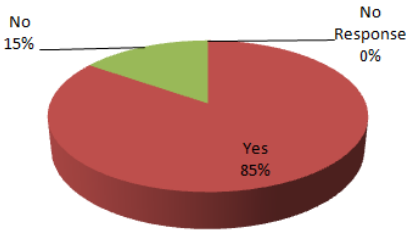
Question 2a: Are the goals of the project technically achievable?



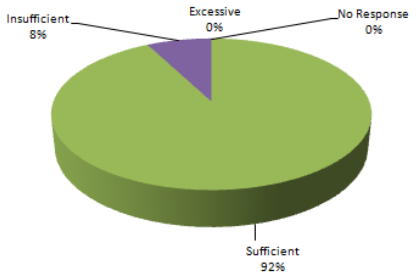
Question 4: How likely is the project team to move technologies into the marketplace?



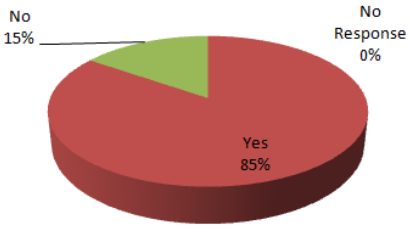
Question 2b: Have the technical barriers been identified and addressed?



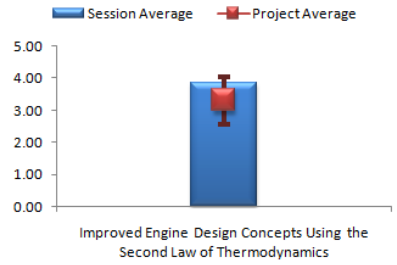
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



KIVA Modeling to Support Diesel Combustion Research (David Torres, of Los Alamos National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented that combustion CFD progress is need for HCCI development. Another reviewer felt there was support for diesel combustion work. A reviewer stated that the program should lead to improved combustion event understanding leading to opportunities to improve efficiency.

A reviewer felt that improved computational modeling is required for both conventional and advanced engine combustion studies and design. A reviewer added that the project establishes the modeling tools for efficiency improvements. Another reviewer stated that the numerical modeling supported the study. Another reviewer stated that developing an unstructured parallelized KIVA code will help improve diesel and gasoline engines by improving the tool used to develop them.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that multi zone and parallelization do add the necessary modules. Another reviewer stated that KIVA updates would find their way into industrial and academic research in an expeditious manner. A reviewer saw collaboration with the labs and industry. One reviewer commented that the project looks like its applying other's models and examining their inner workings. The reviewer added this seems to be trying to identify one model's ability over another. The reviewer wondered will the study's examination of ability and quality of results be significant given the overall resolution ability of the models to start with.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer commented that combustion simulation is the next step after diagnostics. It supports the implementation part of implementing the low temperature combustion in the engine. A reviewer felt that increased focus on industry relevant applications is good, giving the example of four valve geometrics. A reviewer said to keep up the good work. A reviewer said that the work seems to be looking at the work of various users of KIVA3 and 4 and looking at model results and trying to see which method had better results. The reviewer believed the model implementation of KIVA4 here was presented by others, and was unsure what the new work was here.

A reviewer would have liked to have seen more quantitative comparisons, feeling that the comparison show was just comparing pictures on a 3-D mesh which the reviewer considered qualitative only. The reviewer felt it would be useful to see a 2-D plot of a variable across the cylinder diameter or a histogram showing mass fractions at different equivalence ratios, for example. The reviewer added that on the whole, it seems they have made better progress this year.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reviewers commented favorably on the technology transfer, one citing the open-source nature of the updates as helping this. One reviewer would like to have seen reporting on the results of the industry collaboration.

A reviewer felt that improvements developed here will likely have to be implemented in other codes to gain more use by industry. Another reviewer felt that there may be value in the determination of which methods have superior results when applied in a specific manner, the reviewer added that this should be useful information to industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

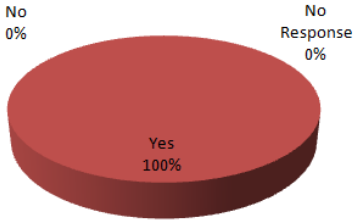
A reviewer commented that the budget is low, but progress was good nonetheless. Another stated that this was great basic work developing tools for use by engine designers. The reviewer added the team has good collaboration with its peers.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

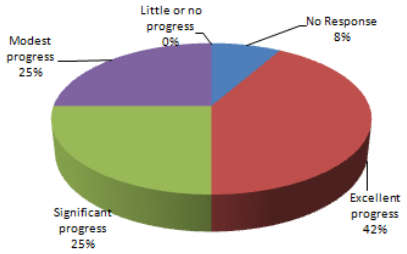
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: KIVA Modeling to Support Diesel Combustion Research

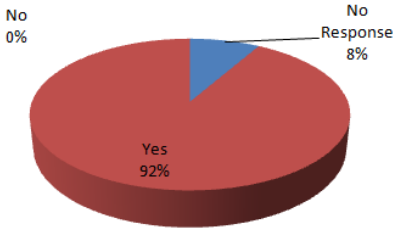
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



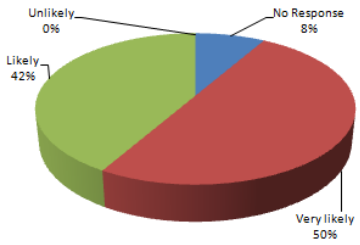
Question 3: Characterize the technical accomplishments and progress toward goals.



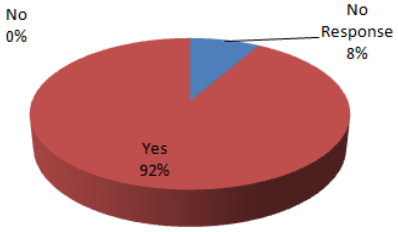
Question 2a: Are the goals of the project technically achievable?



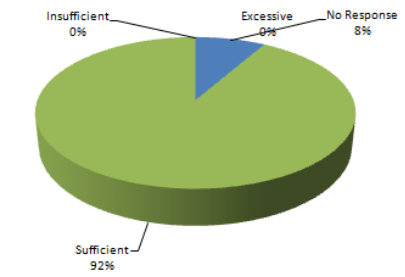
Question 4: How likely is the project team to move technologies into the marketplace?



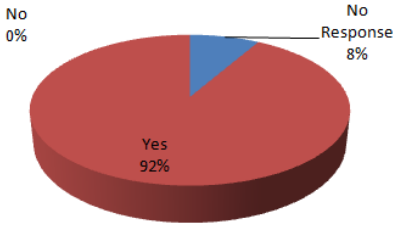
Question 2b: Have the technical barriers been identified and addressed?



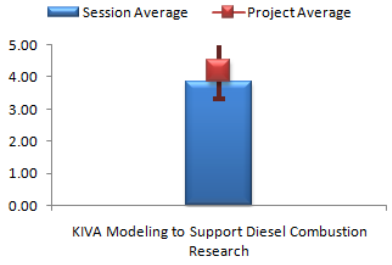
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LES Applied To LTC/Diesel/Hydrogen Combustion (Joe Oefelein, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The project was seen by a commenter as providing the next generation LES models to assist with the development of direct injection LTC/advanced diesel and hydrogen engines. All those engines are consistent with DOE's objectives in enhancing conservation of conventional fuels, as well as promoting the use of alternative fuels. Another reviewer felt that high-fidelity simulation of engine combustion is a very necessary adjunct to the experimental and analytical research conducted elsewhere under DOE funding. The program was also seen by a reviewer as supporting DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. One reviewer saw the goal of the project being model development, but also felt this would untimely lead to advances which support the goal of petroleum displacement.

A reviewer said that high-end numerical models capture the understanding from the engine experiments. They can be applied over a range of products design and development. The project was seen as high risk by a reviewer, but as representing the future of modeling with high fidelity predictive models. Another reviewer saw the basic work as valuable, and the hydrogen work's relation to diesel low temperature combustions as well explained. The reviewer did add an interest in reversing the role, i.e. doing the diesel first, then applying the hydrogen.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The goals of the project were seen as appropriate, by one reviewer. The goals were also seen as well defined. A number of reviewers commented positively on the computer modeling, seeing that as a study to confirm experimental and analytical results obtained elsewhere. The project was seen as being primarily about model development, and the numerical model was expected to contain the necessary physical processes. One reviewer saw the project as a tremendous undertaking, which could not be handled by industry and beyond the means of academia, and hence left to government.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The project was seen, by a reviewer, as having being realigned from an emphasis on hydrogen, to a more general diesel and LTC approach, which the reviewer saw as a good modification. A reviewer stated that the LES direct injection model can provide insight to develop hydrogen engines, but added that the hydrogen research does not appear to be technical barriers for the near to intermediate future. The reviewer also added that the program provided a bridging technology toward a future transition to a hydrogen economy.

One reviewer said that they liked the project and thought it was a good idea to take a small part of the resources and use then to look at a simple combustion problem with a very powerful computer in order to get an idea of the long term capabilities and usefulness of modeling. The reviewer added that they felt the program was in transition from hydrogen to looking at gasoline fueled engines, the reviewer hoped that the original objective of using LES in a detailed model would not be lost.

The project was seen as a tremendous task, by a reviewer. Another reviewer found the main impact as being to explore computationally-intensive methods for transient fuel injection and combustion related to reciprocating engines. This is useful for industry because it shows what is possible as computer resources become available. The reviewer expressed concern that the work is still very fundamental and is not having an impact at the design level. To be more valuable to the community, it is desirable to include two phase flows and perform a design-of-experiments set of calculations to assess the impact of engine geometry variations. The reviewer also cautioned that the group needs to make faster progress developing a validated suite of benchmark simulations.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer felt the project would have more immediate impact if the simulation models were transferred to multiple manufacturers working on the development of diesel engines, with more near term potential, giving the examples of other gaseous fuels beyond hydrogen, advanced direct injection gasoline, advanced direct injection diesel. Another reviewer felt that the program was limited by the focus on hydrogen engines, which also limited the number of collaborators. Another reviewer saw the transition of results to Ford as assisting in the company's research and development of hydrogen engines, which would slowly transition to niche markets as long as the infrastructure issues are overcome.

Another reviewer found that there had been a useful transfer of knowledge back and forth from modelers, experimentalists and computational specialists. A reviewer also saw the technology as transferring to modelers and eventually transition to the marketplace. One reviewer commented that the fundamental research and modeling provides the understanding necessary to design and develop production capable combustion systems.

Two reviewers felt that in addition to the focus on hydrogen, the program indirectly supported the building of hi-level combustion, and that the modeling would allow a look at more complex fuels.

One reviewer felt the models would not have an impact for some time, until there is sufficient computer power, but felt that those models would eventually change the way engines are designed. Another reviewer felt the program was pioneering the use of advanced computational tools, but that the impact of the program remains to be seen.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

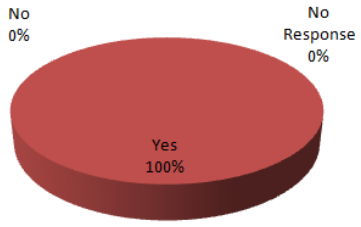
Most reviewers felt that funding was sufficient. Two reviewers added that with more focus on diesel or LTC, more funding would be desirable. The team's leveraging of other program resources received positive comments from two reviewers, and the computer time grant as encouraging.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

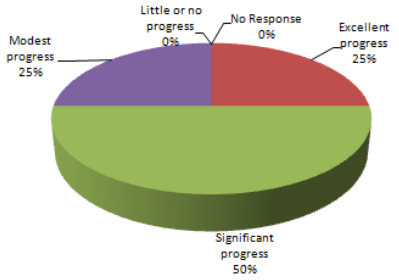
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LES Applied To LTC/Diesel/Hydrogen Combustion

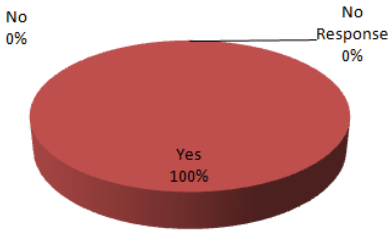
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



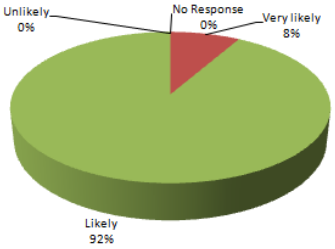
Question 3: Characterize the technical accomplishments and progress toward goals.



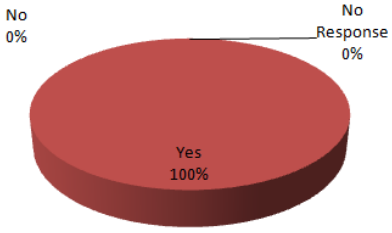
Question 2a: Are the goals of the project technically achievable?



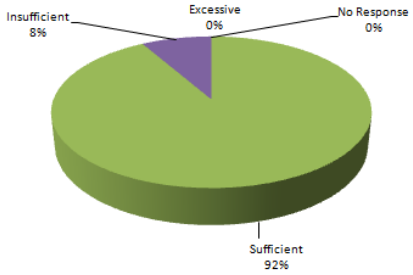
Question 4: How likely is the project team to move technologies into the marketplace?



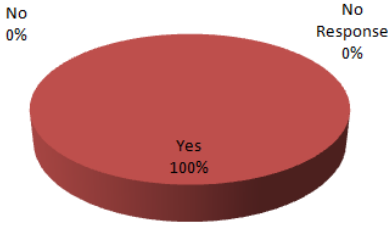
Question 2b: Have the technical barriers been identified and addressed?



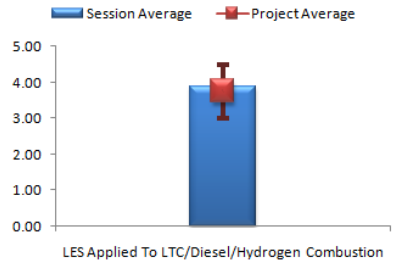
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Light-Duty Combustion Modeling (UWI) (Paul Miles, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The reviewers had universally positive responses. One reviewer stated that HCCI/PCCI will save significant amounts of fuel, if it works out to its full potential. Another felt this program supports DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. Another reviewer commented that the modeling component of the activity would improve fundamental understanding of LTC. It was commented by a reviewer that fundamental understanding and translation into useful models should enable faster development of diesel engines. The numerical simulation was seen, by a reviewer, as being an effective tool to study unknown effects in LTC engine research. Another reviewer commented that the project aimed to improve efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer saw the project as having a sound strategy in place. The reviewer found the project to be well-coordinated with the industrial partners. Another reviewer found the program goals are well defined in terms of objectives, task interactions and collaborations. A key accomplishment is modeling of in-cylinder CO and unburned hydrocarbons and examining the influence of turbulence. A third reviewer found good cross-industry, national laboratory and university collaboration.

It was also suggested by a reviewer that the model needs to be improved. Maybe the effect of swirl ratio on fuel distribution in cylinder needs to be considered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer found that the modeling program is making progress toward goals. Good interaction with industry and university partners. Good effort to interpret the experimental results. It was stated, by another reviewer, that the kinetics studies are innovative - more detail than this reviewer had seen anywhere else. They are doing a good job trying to couple the optical measurements to the kinetics modeling results. They are focused on combining the modeling work with the experiments to develop a complete picture of LTC. It was also noted by a different reviewer that the model need be improved to predict CO at different injection timing and a reviewer also commented that a large area of work remains to be done in this area.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
All responses were positive in this area; one reviewer commented that this program is contributing to understanding and predictive models that is necessary to commercialize low temperature combustion. One reviewer saw potential benefits to the entire industry if the improved model can be embedded into KIVA. It was also observed that the project was well-connected with an industrial partner. The modeling work being done here will ultimately help improve the fundamental understanding and engine designs. It was also noted, by a reviewer that there was good industry involvement in this (and related) project(s).

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

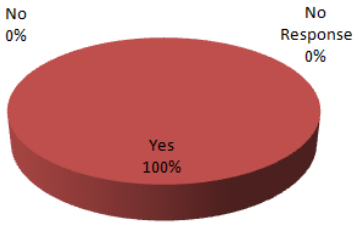
Overall the funding was found to be sufficient, with one reviewer stating that compared to the experimental program, the modeling portion of this work does not appear to have critical mass. It may be better to increase funding of this task, or more closely link this task to one of the larger modeling efforts at SNL.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

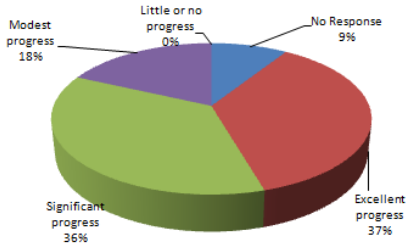
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Light-Duty Combustion Modeling (UWI)

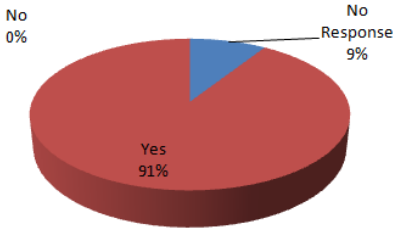
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



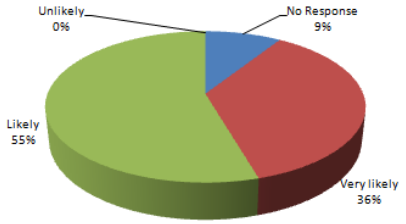
Question 3: Characterize the technical accomplishments and progress toward goals.



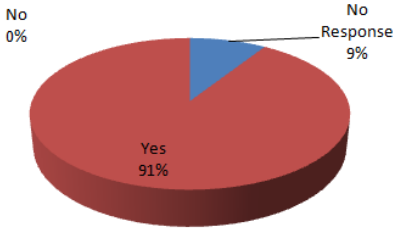
Question 2a: Are the goals of the project technically achievable?



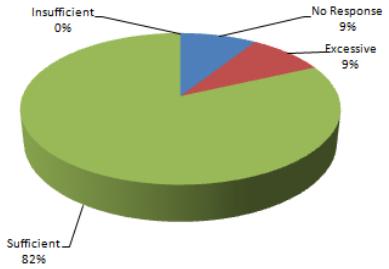
Question 4: How likely is the project team to move technologies into the marketplace?



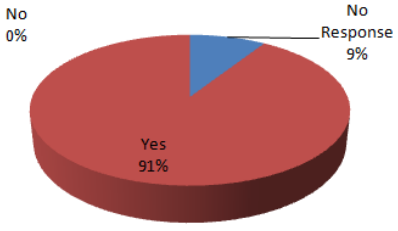
Question 2b: Have the technical barriers been identified and addressed?



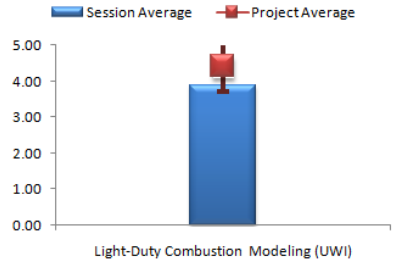
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Temperature Diesel Combustion Cross-Cut Research (Lyle Pickett, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The study was seen, by one reviewer, as a development of a toolkit of methods to be used by others in HCCI engine design and development. Another reviewer commented that understanding which addresses the barriers of low temperature combustion was being developed. One reviewer stated that the program was providing a fundamental understanding of diesel sprays as they relate to combustion and emissions formation, which will help improve both heavy- and light-duty diesel engines. The fundamental transfer of data to universities will support model improvement, according to one reviewer. Another reviewer saw this as a welcome study on multiple injections. One reviewer said that Lyle seems to have really reached out to industry for collaboration. The reviewer added good "rub off". One reviewer stated that although this work is done in a constant volume vessel and not an engine, this kind of work is very much needed because well-controlled experiments, unconfounded by engine complexities, can be conducted specifically to isolate and understand physical and chemical process for injector design as well as spray modeling. The program was seen, by a reviewer, as supporting DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The project was seen by a reviewer as providing a good systematic approach to a wide set of fundamental and applied problem areas in HCCI engine design. The program's goals are well defined in terms of objectives, task interactions and collaborations. Key accomplishment is imaging of spray in optical chamber showing spray behavior as a function of injection shape and ambient temperature, yielding useful information for spray model development. One reviewer said that the project seems to be working cross functionally, i.e. building on work of others (Paul, Mark) well! Another reviewer stated that the project is well connected to several industry partners and to other labs and universities through the Engine Combustion Network.

One reviewer said the project should aim to quantify the size (volume or mass) of the lean region during the end of injection as a percentage of the total mass injected, and see if this correlated with the amount of unburned HC in engine experiments. Another reviewer commented that there was good fundamental information for liquid phase residuals from spray patterns. Researcher indicated four projects using information but unclear as to how much this will impact deployment technologies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer said the project was a useful development of a number of engine design technologies that will be invaluable to other engine developers. Another reviewer stated that this program is making steady progress toward goals. There is good interaction with industry and university partners. Key accomplishment is imaging of spray in optical chamber showing spray behavior as a function of injection shape and ambient temperature, yielding useful information for spray model development. Another reviewer commented that project had done a good job relating the conditions and results of the vessel to those in a real engine. It was added that improving the understanding of the phenomena

which occur at jet shut down (EOI) is very useful. This has been identified as a source of hydrocarbons and combustion inefficiency and an improved understanding is needed.

The laser ignited jet was a great idea. The reviewer would like to see more of this. This is a project for which the combustion vessel is ideally suited. This reviewer thought this kind of work will quickly lead to an improved understanding of lifted flames. Another reviewer found the understanding of liquid penetration in transient sprays as useful in enabling early or late fuel injection without wall wetting, which is important for LTC as well as dealing with diesel after treatment. It was commented by a reviewer that the barriers to LTC combustion and how this facility can help is well understood by these researchers. The collaboration with Musculus and his observations and understanding of the lean region at the end of injection is good. Why was an in-house rate-of-injection meter developed? Why not use available off-the-shelf rate-of-injection meters?

One reviewer felt the focus was on a resolution of problems commons to others and wished to know what the process would be, to the projects findings to more basic modeling.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Three reviewers spoke highly of the engine combustion network web site. One reviewer found the technology transfer with other research groups to be good. Collaboration with the Musculus project, on both the 1-D jet model and on the imaging of the leaning effect near the injector at the end of the injection, was seen to be good. The collaboration beyond the traditional organizations who work on DOE programs was also pointed out as good. The program was seen as yielding valuable insights required to make HCCI combustion commercial. Publication of the results was also seen as prompt and widespread by a reviewer.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

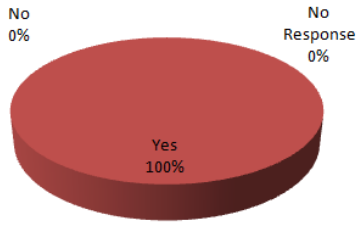
One reviewer stated that greater budget was always better, but noted the project seems to be efficient in its budget per unit work output. The other responding reviewer felt that resources appear to be adequate.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

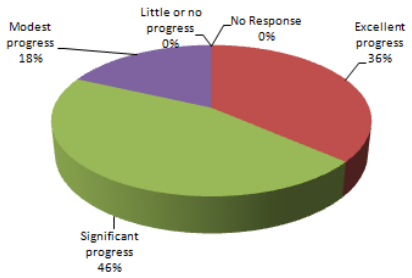
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Temperature Diesel Combustion Cross-Cut Research

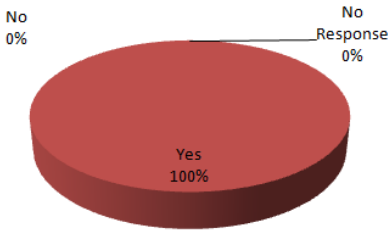
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



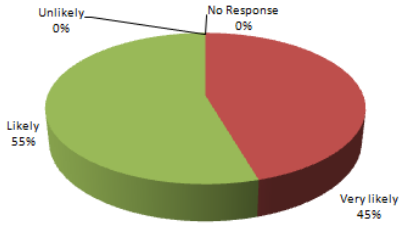
Question 3: Characterize the technical accomplishments and progress toward goals.



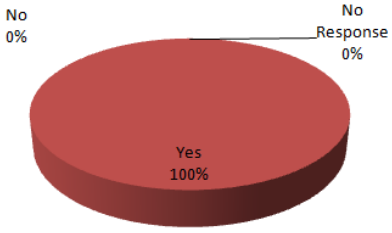
Question 2a: Are the goals of the project technically achievable?



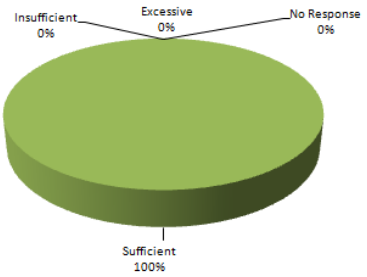
Question 4: How likely is the project team to move technologies into the marketplace?



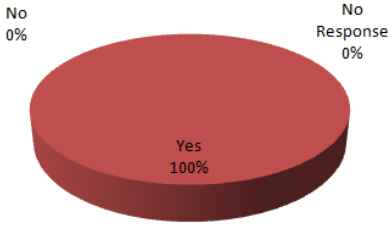
Question 2b: Have the technical barriers been identified and addressed?



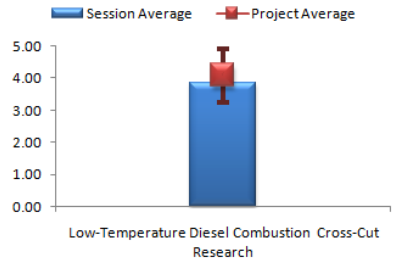
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Optimizing Low-Temperature Diesel Combustion (Rolf Reitz, of University of Wisconsin)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer found that numerical simulations are an effective tool for HCCI study. Others saw low temperature combustion as an important potential adjunct to conventional diesel combustion for reducing aftertreatment costs while maintaining efficiency. Program goals were seen as improving the understanding of diesel LTC as well as reducing exhaust emissions while preserving efficiency. A reviewer said that the research was consistent with other LTC research and has the long term potential to accomplish the projects goals. A reviewer saw the program as supporting DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. Another reviewer saw good synergy with industry and good communication.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that in-cylinder FTIR measurements of exhaust species are exciting and should provide a much deeper understanding of the combustion process. Another saw the program as doing a lot of fundamental work the supports other projects with very efficiently used money. The projects strategy was seen by a reviewer, as a good strategy for project success.

Reviewers commented favorably on the modeling, one viewing it as a key accomplishment. Reviewers also noted the collaboration between the various labs and universities. A reviewer commented that involvement with two will provide opportunities for deployment, but it would be nice to see more specifics on how this will be achieved. A reviewer stated that variable spray geometry has been "on the table" for decades with little or no visible progress in developing hardware. Dual injectors as used in this program are a satisfactory tool, but someone needs to develop a path towards a production solution. The reviewer added that focus and scope were well defined.

A reviewer felt a good job had been done identifying barriers and addressing them with results. However, another reviewer felt the need for a second injector should be clarified, and wondered whether this would be a practical approach. A reviewer found the improvements in exhaust emission prediction and model calibration have been carried out, but felt that accuracy needed improvement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that the program had an excellent systematic approach to this large project and experimental matrix. Another said that the program is making strong progress toward goals. There is good interaction with industry and national lab partners. There are numerous advances aimed at retiring risk with low temperature combustion. Another reviewer felt that a very impressive amount of work completed. A reviewer also stated that the project is well coordinated and wide in scope, while another reviewer added that a lot of relevant results had been shown.

Another reviewer said that this is a big program with a wide range of activities. The activities address many different aspects of optimizing LTC in diesel engines. They are looking at some novel techniques such as grouped nozzles and multiple injectors which are good. The reviewer added that

the title of project is "optimization", but need to also focus on developing a fundamental understanding of the various strategies they are studying.

One reviewer felt the model needed to be further improved.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The program's technology transfer plan and results with consortium partners were seen as good by a reviewer. Technology transfer, in general, from Wisconsin, was described as historically excellent by a reviewer. The program was seen as yielding valuable insights into mixture preparation and low temperature combustion in internal combustion engines by a reviewer. The collaboration was described as good by a number of reviewers, and the work was described as widely published by a reviewer.

One reviewer stated that developing fundamental understanding and model development/improvement will be crucial to future efficiency and emission improvements. The model was described as good for HCCI study in both diesel and SI engines. A reviewer stated that the project would be moved forward by others. A comment, by another reviewer, was that this project is coordinated and leveraged with the ERC's other funding sources. Good interaction with the two consortiums (LTC & DERC). The significant number of industrial partners should provide a high probability of tech transfer in this project.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

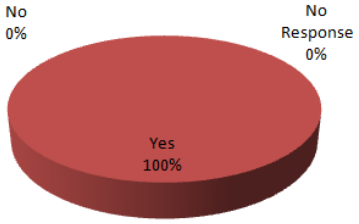
The project was seen as good use of available funding by a reviewer. Another felt that this was a very productive program and that it should be considered for increased funding. These types of projects were described as extremely cost effective, by a reviewer, who added that universities are a good area to fund. One reviewer questioned if the funding was too high. The reviewer states that in spite of the wide range of objectives with good progress that the funding level was significantly higher than at other universities. The reviewer was also concerned that generating patents at universities could hinder the availability of new technology tech transfer. The reviewer gave the example of will the model enhancements being developed be available to others wanting to collaborate and run their own models, or will these only benefit future work at UW-Madison?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

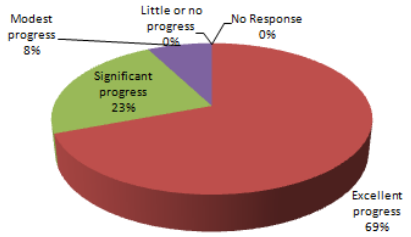
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Optimizing Low-Temperature Diesel Combustion

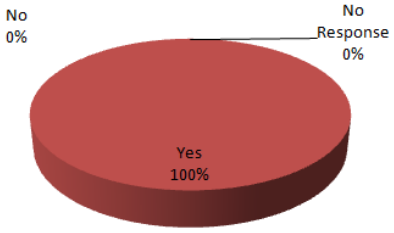
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



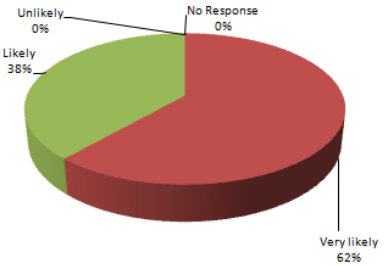
Question 3: Characterize the technical accomplishments and progress toward goals.



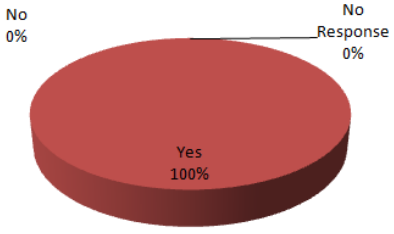
Question 2a: Are the goals of the project technically achievable?



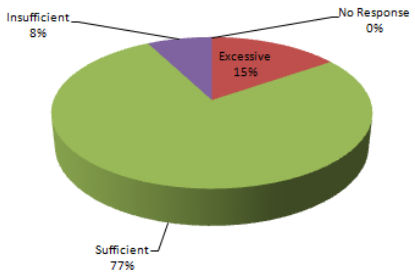
Question 4: How likely is the project team to move technologies into the marketplace?



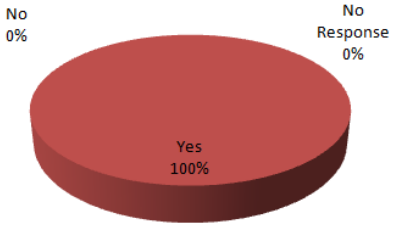
Question 2b: Have the technical barriers been identified and addressed?



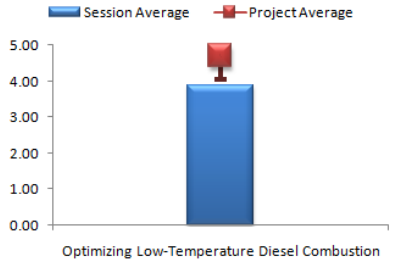
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Sandia Hydrogen Combustion Research (Sebastian Kaiser, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Concerns were expressed by a variety of reviewers about the program's hydrogen focus. One reviewer felt that hydrogen was not a viable short- to intermediate-term technology. Another commented that with DOE's apparent move away from hydrogen the reviewer was unsure where these "orphan" projects fit into the scheme of things. One reviewer was curious where the hydrogen would come from.

Another reviewer saw the program as providing fundamental measurements, such as composition and velocity fields, on mixture of a gaseous fuel (hydrogen) with air in an optical engine. The reviewer added this activity is needed to support model development for hydrogen injection to develop direct-injection hydrogen engines. One reviewer saw the program as supporting the goal of transitioning away from a fossil fuel-based transportation sector. The reviewer added that hydrogen internal combustion engines are a valuable bridging technology that can use the existing IC engine infrastructure. The hydrogen internal combustion engine approach was seen as making sense to two other reviewers as a gap filling technology to the establishment of a hydrogen infrastructure. One reviewer saw the in-cylinder fuel/air ratio as a benefit to combustion studies.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The program's strategy was seen as appropriate for the goals of the investigation by one reviewer. Another reviewer stated that there was a clear and systemic layout of the obstacles facing the direct injection hydrogen internal combustion engine work. It was felt by a reviewer that the direct injection hydrogen optimization was in its infancy, and that understanding will enable fast progress.

The program's key accomplishments, according to another reviewer, are acquiring data for understanding of hydrogen operation and data for validating advanced computer models. The reviewer added that the program goals were well defined. One reviewer also expressed that the program had a good method for combustion study.

A reviewer expressed concern that the barriers of production, transportation, and storage of hydrogen fuel were not being addressed. Another reviewer saw the optical engine flow field study as good, but time consuming and the reviewer felt that it the study was combined with 3D modeling the effects will be better.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer saw the optical diagnostic measurements as providing insight to assist LES model development, which in turn will assist the development of hydrogen engines. Another reviewer saw useful developments of hydrogen related tools and experiments. One reviewer stated that this program is making progress toward goals of studying hydrogen combustion in an optical internal combustion engine. A key accomplishment is the study of direct injection hydrogen internal combustion engine, as well as the acquisition of unique data for understanding hydrogen operation and data for validating advanced computational models. One reviewer saw the information helping understand how to

optimize fuel spray and fuel-air mixing in direct injection hydrogen. A reviewer commented that the program included the same combustion system as 45% BTE demonstrated at Ford.

One reviewer describes the program as "useful"; another described the program's results as confirming the intuitive thoughts.

The program was seen by a reviewer as showing more results then in the past, with PIV results that have proved very useful for this gas jet based system. The reviewer added that a lot of progress had been made in understanding hydrogen internal combustion engines, and the reviewer suggested that the program chooses a future emission standard, such as Tier 2 Bin 5 or lower and then estimate the NOx PPM level required to meet it. The reviewer has the impression that the NOx measurements presented were very high.

One reviewer expressed concern that hydrogen research no longer appears to be on the critical path in overcoming the DOE program's key technical barriers for near to intermediate use. The same reviewer saw this as the bridging technology for a future transition to a hydrogen economy. Another reviewer was concerned that the number of experimental conditions was limited and would have liked a closer connection to industry so that the engine was being developed while the project focuses on basic understanding. A reviewer would like to see more fundamental mechanisms analyzed, so results can be applied to other engines and fuels.

One reviewer did not see the hydrogen projects as having a lot of value.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Concern was expressed by some reviewers that the project would only be relevant with developments in hydrogen storage and infrastructure. The project was seen by a reviewer as being competitive with fuel cells, and another saw the technology moving to the marketplace once the infrastructure was in place.

The program was seen by a reviewer as yielding valuable public domain data on hydrogen combustion in an internal combustion engine. Another reviewer felt that future work planned on advanced direct injection of hydrogen, if simulations/modeling pan out, may enable hydrogen engine deployment into the marketplace. This reviewer was skeptical that the current level of research will assist deployment of a hydrogen internal combustion or fuel cell vehicle.

The project's partnership with Ford was mentioned. One reviewer saw the collaboration with Ford as good, but another wondered if the project was merely trying to keep up with Ford, rather than stay ahead. One reviewer was concerned that there was only one industry partner.

A switch in technology focus from hydrogen to hybrid and biofuels was mentioned by one reviewer, while another reviewer saw the project as well connected to industry and other national labs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

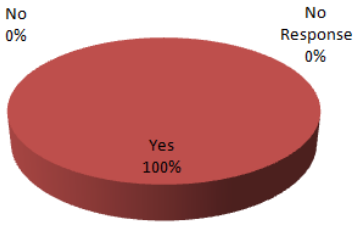
Resources were considered adequate by some of the reviewers, while others felt more funding was needed if hydrogen was to be made mainstream. One reviewer felt the funding reflected a low level of interest from DOE in hydrogen. A reviewer also said that the initial goal of the program had been met.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

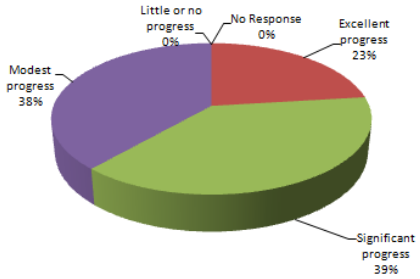
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Sandia Hydrogen Combustion Research

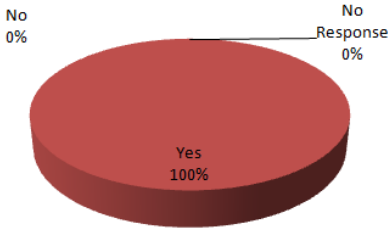
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



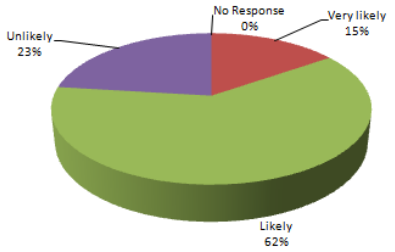
Question 3: Characterize the technical accomplishments and progress toward goals.



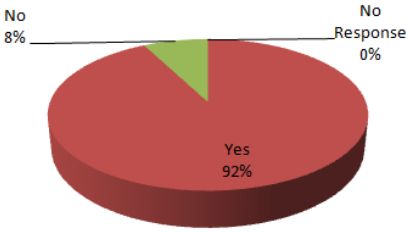
Question 2a: Are the goals of the project technically achievable?



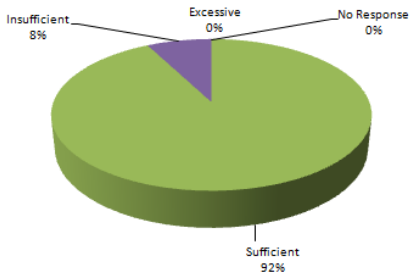
Question 4: How likely is the project team to move technologies into the marketplace?



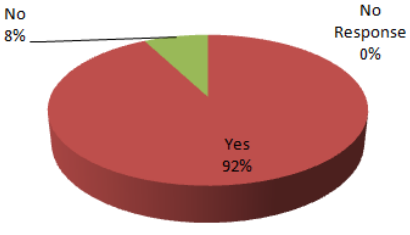
Question 2b: Have the technical barriers been identified and addressed?



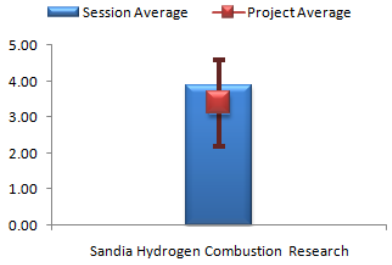
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Small Bore Advanced Combustion Engine R&D (Paul Miles, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many of the reviewers commented on low temperature combustion. One reviewer felt that better understanding of LTC would likely help in achieving emissions targets with better fuel economy. Another reviewer said that Paul is working in the right area. Controlling HC and CO in LTC is a key barrier to diesels being brought to the US market. This project's goal, stated a reviewer, is to improve the fundamental understanding of diesel LTC and the mechanisms by which the combustion efficiency can be improved. Another reviewer saw CO and unburned HC as two fundamental issues that need to be dealt with in the commercialization of LTC. CO and HC issues were also touched on by a reviewer who saw the aims as being improving thermal efficiency indirectly by understanding sources and mechanisms for CO and HC emissions. Another reviewer saw CO and HC distribution maps as filling the gap in emission study, which can direct the study of LTC engines. A reviewer saw HCCI or LTC as having the potential to reduce fuel consumption in both LD and HD engines - probably only for select engine and cycle applications. The full potential of these technologies will require significant levels of basic and applied efforts such as these.

While a reviewer saw the program supporting DOE goals for petroleum displacement, aiming to provide physical understanding and predictive capabilities for high efficiency combustions systems they would have liked to have seen more work looking at ways to overcome GC and CO problems. Another reviewer stated that engine-out emissions are the key roadblock to implementing low temperature combustion with reduced after treatment costs. The presentation was also seen as a nice visualization of relevant combustion processes.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Among positive reviews, one saw the project as a good high level collaboration across the board. The reviewer added this project should be an example or model for industry-laboratory-university collaboration. Deployment of these technologies in the commercial arena will undoubtedly follow if these technologies turn out to be useful. Another reviewer saw the program, overall, as doing valuable scientific work. The program goals are well-defined in terms of objectives, task interactions and collaborations. A key accomplishment is measurement of the regions in the cylinder where CO and UHC is formed, and how formation depends on engine operation. A reviewer also saw the strategy as sound, with good coordination with the industrial partners. Another stated the project goals are largely to increase understanding of combustion processes. The key is optical experiments aimed at looking at in-cylinder spatial and temporal sources of HC and CO emissions. This understanding is designed to be transferred to numerical models that simulate the combustion process. One reviewer stated that modeling and validation on an engine seems a good approach. It was also commented, in another review, the combination of experimental test and numerical simulation can save time and cost, and also can fundamental understanding engine combustion.

One reviewer saw the collaboration between National Labs and universities to get a comprehensive look with simulations, optical engine data and metal engine data as excellent, but added that using the fast FID may enable some interesting speculation, but may not yield many conclusive results. Another reviewer expressed doubts that full advantage was being taken of Paul's work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Among the several positive comments, one reviewer found the project to be very good, with its widespread collaboration between energy, auto, engine companies and universities. Another reviewer commented that they have a good plan in place to address the key technical problem they are working on. They have been making steady progress against the plan. The timeline clearly showed the plan and progress. The topic is very relevant and useful. The same reviewer added the kinetics studies are innovative and they are doing a good job trying to couple the optical measurements to the kinetics modeling results.

It was also commented, by another reviewer, that the program is making significant progress toward goals. Improvements have been shown in interactions with industry and university partners. The reviewer had a positive response to the production of useful data for CO and UHC showing the in-cylinder distribution, and that optical engine behavior is correlated with metal engine behavior.

A mixed review advocated that this project is showing good correlation between metal engine and the optical engine, but not perfect correlation. To what extent are more questions than answers being exposed? This is obviously a highly complex area, and achieving good experimental-analytical-model correlation is extremely important.

Concerns were also expressed, one reviewer stating that the work was relevant, and focused on the right issues. The commenter continues by noting that sources of unburned hydrocarbons have been identified to be from the injector and from quenching along the bore walls. CO sources are also identified to be in the squish region, associated with lean fuel air mixture. The behaviors of these sources, with start-of-injection and engine load, are being identified.

A reviewer thought that understanding the formation of HC and CO within the bowl could be a key factor. The model predicts high CO and HC within the bowl, while the optical diagnostics could only probe the clearance and squish regions. What about CO and HC sources in the jet-to-jet interaction regions within the bowl. Model results should already be available. Could it be that we are looking the wrong region for the original sources?

PLIF experiments at 355 nm to probe HC sources within the bowl should be given high priority.

One reviewer saw the model as still having weaknesses to predict CO at certain injection timing. Another reviewer felt that additional industry interface would accelerate the progress, suggesting regular quarterly reviews, which would have a more universal attendance.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer saw the program as contributing to measurements and predictive models of in-cylinder processes that are necessary in order to commercialize low temperature combustion. Partnership with GM is a plus. Another felt the program was well connected to OEM. A reviewer stated that there was good collaboration with UW, which will transfer knowledge into useful models.

One reviewer felt that identifying and describing the problem is the first step. As the problem with CO and HC is described better, solutions to address these problems will follow. There is close collaboration with industry and the results are being widely published. Another imagined that some

form of this modeling work will be useful for industry, while another felt that the study will benefit for LTC engine design.

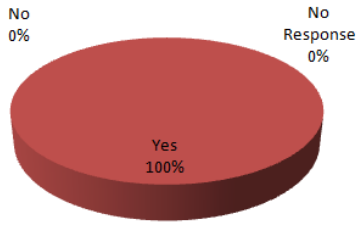
Concern was expressed by one reviewer that the program was based away from the industry center and hoped that there would be more proactive interaction with industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All responding reviewers found funding to be adequate. Additional reviewer comments were that progress is good, albeit slow and that cross-collaboration makes good use of the available funding. "Great work" was the comment of another reviewer.

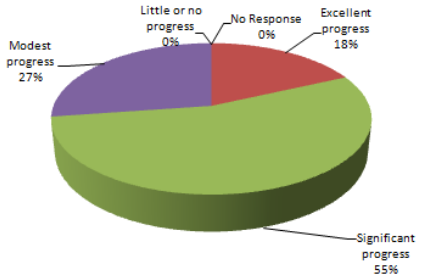
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Small Bore Advanced Combustion Engine R&D

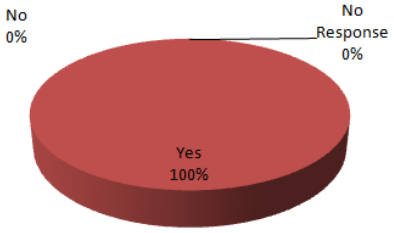
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



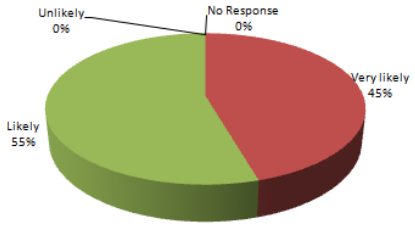
Question 3: Characterize the technical accomplishments and progress toward goals.



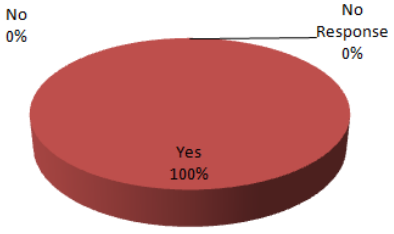
Question 2a: Are the goals of the project technically achievable?



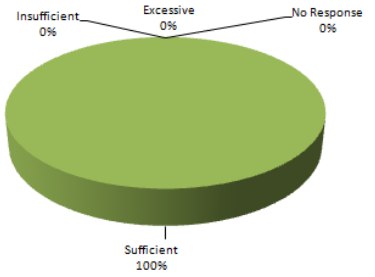
Question 4: How likely is the project team to move technologies into the marketplace?



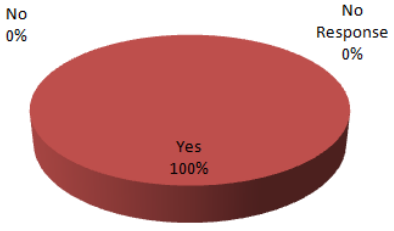
Question 2b: Have the technical barriers been identified and addressed?



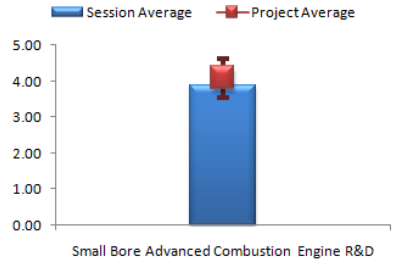
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Spark-Assisted HCCI Control (Dean Edwards, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 11 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer felt that spark-assisted HCCI might be an important aspect of light duty fuel economy. Another reviewer said that the goal is to use HCCI combustion mode to improve the efficiency of an SI engine. Another saw the program as aiming at understanding LTC combustion for higher part load efficiency a reviewer felt the program supported gasoline efficiency improvement through HCCI by addressing one of the main barriers, control.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt the program was based on scientific results. Another saw the program as being open-ended in its scope, which the reviewer did not view as a bad thing. One reviewer saw the program goals as well in terms of objectives, task interactions and collaborations. The reviewer saw the key goal as demonstrating HCCI in a production-level engine platform for improved fuel efficiency and reduced emissions.

A reviewer saw well-defined project goals, but would like to have seen a rigorous analysis or sensitivity study of what boundary conditions impact stability and to what extent. The reviewer went on that variability is mapped, and it looks like that work is the next planned. Bottom line is: How do we control the instability? Is there a path or is this a dead end as far as implementing the technology? The reviewer added that this is a huge undertaking

A reviewer felt that a single-cylinder engine would be a good tool to use for a program like this. Another reviewer expressed that spark-assisted HCCI is being understood and developed, and wondered if this would be a possible solution to extending the HCCI load regime.

One reviewer felt it was still not clear that the integrated control approach will allow spark assistance to improve HCCI operation stability. The reviewer wondered if this would just improve the transition between SI and HCCI, or if it will actually increase the operating range of HCCI mode. Another reviewer felt the program needs to address the tailpipe emissions capability. A link between "use of advanced LTC modes to reduce the formation of emissions in-cylinder to reduce aftertreatment system requirements and associated costs" is not clear. Another reviewer felt that further development of the combustion mode prediction model will be key. The reviewer wondered what other improvements can be made?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer felt that the program is making steady progress toward goals. There is good interaction with industry partners. Key accomplishment is characterizing performance with variable valve and advanced sensors and controls. Mixed mode operation and understanding cycle-to-cycle variation are key contributions. Other reviewers seconded that there was good collaboration. A reviewer stated that the researchers have a good overall view of the problems facing them. Another reviewer felt that they are investigating a novel approach to extend the operating range of HCCI and to improve stability. The modeling part of the effort is very useful in trying to understand the details of what is going on in-cylinder. The reviewer added that it would be good to focus more on the control aspect

of the program and try to understand how to control the combustion, not just to understand the instability but to be able to control it.

Progress in 2007 was seen to have improved by a reviewer. Another reviewer felt that modeling strategy and controls seemed well thought out. Another reviewer felt the question could not be answered accurately yet. The reviewer found the project very interesting and wondered how to control HCCI.

A reviewer expressed a number of concerns. The reviewer would have liked a more detailed description of the combustion chamber, adding that injector and spark plug layout is needed. The reviewer felt that the project operated on a knife's edge between SI and HCCI modes. The reviewer added that the present cycle combustion mode is being influenced by the prior-cycle combustion efficiency, which does not inherently seem like a good idea to begin with. The reviewer wondered if this concept will prove to be robust. The authors themselves admit to this in slide #13. Now the work is migrating towards a controls focus. The reviewer added this could be "throwing good money after bad." It should be shown that efficiency gains and emissions reductions are well worth the while before continuing on this path. The reviewer continued by stating that going to a multicylinder at this early a stage with only partial understanding seems premature. A lot of work and energy is being expended in acquiring and setting up this multicylinder engine with not much real progress in understanding the combustion concept. The reviewer ended that in all likelihood there will be cylinder-to-cylinder differences in the multicylinder engine that will confound spark-assisted HCCI phenomena being studied.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer found that the technology transfer seemed sound, and the results of this project would be of interest to OEMs, if it works. Another reviewer felt the program was yielding valuable insights that are required in order to make HCCI combustion commercial. The connection with Delphi provides a path to market. Another reviewer stated that the project seems to be well connected and cross functional. Another reviewer felt a lot more work needs to be done.

One reviewer felt that it might be problematic to control transients. The reviewer expressed concern that there might be patent problems, believing that the technology was discovered by the Ford group long ago and that there are patents. A research stated that the approach of predicting misfire may work in a lab, but was unsure if this approach would be robust to sensor and engine variability as well as external noise factors such as ambient temperature and humidity? If not, said the reviewer, OEMs won't be able to use it.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

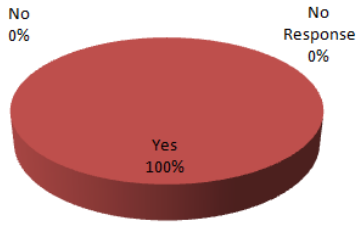
Collaboration with Delphi was seen as good for the tools. Another reviewer felt that this project, among others, would benefit from a single cylinder engine readily available at a reasonable cost. A reviewer commented that making the project goals and expectations to fit the budget is the important balancing act.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

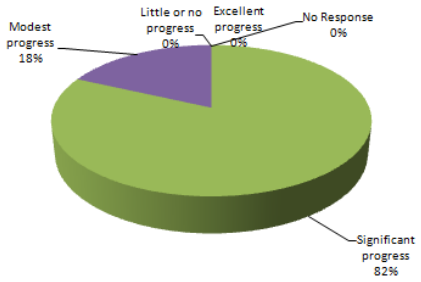
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Spark-Assisted HCCI Control

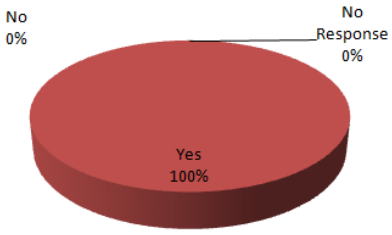
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



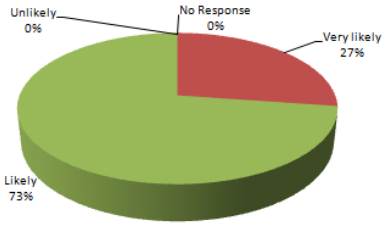
Question 3: Characterize the technical accomplishments and progress toward goals.



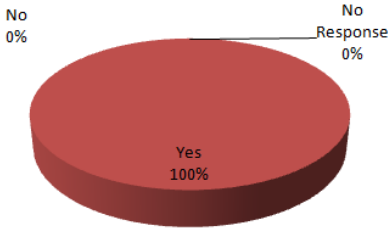
Question 2a: Are the goals of the project technically achievable?



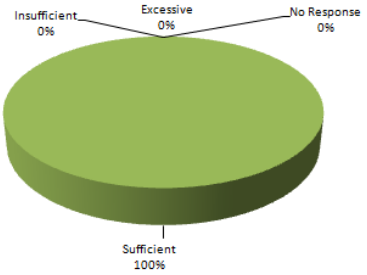
Question 4: How likely is the project team to move technologies into the marketplace?



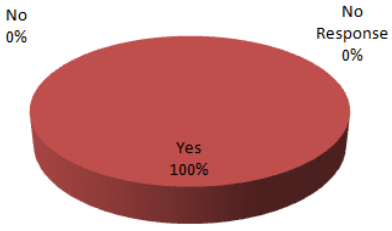
Question 2b: Have the technical barriers been identified and addressed?



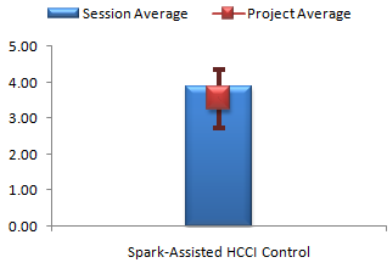
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes (Josh Pihl, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The program is seen, by a reviewer, as supporting DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. Another reviewer stated that this is a good advanced project, and little funding was required, but findings will help define future on engine projects, i.e. compound cycles. Another reviewer stated that the project was a good fundamental investigation of efficiency. Another reviewer saw the goals as improving the efficiency of internal combustion engines by understanding fundamentals of thermodynamic losses. A reviewer stated that combustion irreversibility study is a fundamental research, which will benefit for both diesel engine and SI engine combustion efficiency improvements. A reviewer said that using first principles to look for opportunities to improve efficiency, which will both provide DOE and OEMs direction for future projects.

A reviewer said that recovering combustion availability is directionally correct for supporting DOE objectives. The reviewer would like to see more practical implementation ideas. Another reviewer found the work very speculative.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The strategy was seen by one reviewer as very speculative, another as not being included in the project. Another reviewer felt that there was no clear path to extend the information to internal combustion engines, which was echoed by another reviewer. A reviewer felt that the technical barriers of improving the energy efficiency of an on-board reformer, using a real-world fuel, are beyond scope of this work. Another reviewer stated the program's goal of demonstrating reduced combustion irreversibility with a constant-pressure combustion (CPER-TCR) is not well-connected to goal of improving internal combustion engines.

One reviewer warned that the project needs to stay connected with industry partners. A reviewer felt that the project, in its first stages, fundamentally works. A reviewer felt that there was good understanding of the program's objectives and hurdles, and that this was obviously a long term project. Another reviewer commented that understanding combustion availability destruction is a very interesting subject that could potentially open a lot of avenues for improving efficiency. I will be keen to see future results.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer saw slow progress and wondered how the low pressure combustion will add to knowledge (we know about combustion availability but it is a fundamental limitation that low pressure combustion studies will not allow us to break). Another reviewer said that the thermodynamic analysis failed to show the benefits of constant-volume combustion over constant-pressure combustion. Since other programs within DOE are dedicated the study of constant pressure combustion (for gas turbines) the value of the proposed experiments to VT is not clear to the reviewer.

One reviewer felt that the second law analysis of IC engines is a very important topic and it could lead to improvements in engine cycles, but was concerned that the current experiment uses constant pressure, steady combustion which is the basis of today's Brayton cycle even though a key thermodynamic advantage of IC engines is constant volume combustion (IC engines are typically ~5% more efficient than gas turbines at similar output power).

A reviewer felt that the program should focus on using availability analysis to improve the efficiency of IC engines through constant volume combustion. Another reviewer saw the project as having a very lofty goal, but thought it a good idea for at least some part of the DOE program to be looking at very fundamental things like this. The reviewer found the project very interesting and was curious to see what they will be able to show. They need to make sure to stay connected with reality. It would also be good to see them run the experiment over a range of conditions (if possible) to see how the results are affected. The reviewer wondered is there a modeling component of the project? If not, then why?

A reviewer saw the progress as good, considering that it is a proof of principle project. Another felt that the work could be relevant for external combustion engines, but perhaps not for internal combustion engines? Another reviewer felt the project shows the potential from stoichiometric engine plus waste heat recovery. One reviewer found the project to be in its first stages.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer questioned where the technology transfer would go from this project, and how other than high level academic papers. Another reviewer commented that this was not a well-thought-out plan. The technology transfer path for IC engines is not clear. This program will provide much more value to the community if it addresses reducing irreversibility in the context of cyclic, unsteady, constant volume combustion processes. Another reviewer felt the project was in its very early stages, and that the path to practical implementation in an internal combustion engine was not clear. One reviewer felt that even if the principle of the experiment was proven to be possible it would not enable a fuel reformer as a commercial solution to improve fuel efficiency. A reviewer found the project as very risky to look for ways to avoid availability destruction caused by combustion. The reviewer felt it unlikely to give usable solutions since the gradients enable internal combustion engines to generate power; however, the risk is worth the gain in understanding and the potential gain in avenues to improve efficiency.

One reviewer felt the project was investigating a very fundamental question. Understanding and quantifying the results are worthwhile even though there is not a marketable component. Another reviewer felt it was too soon to rate the project, and that the program could use some industrial partners. The program was seen as very long term, by another reviewer. A reviewer stated that the technology could be applied to both diesel and SI engines.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

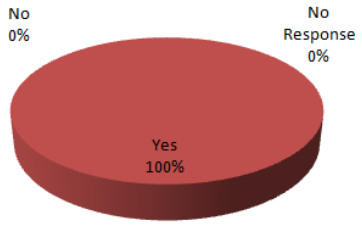
A reviewer questioned if the potential payoff was there, for a project the reviewer described as potentially open ended with high risk. Another reviewer stated that the project appears to be relatively low cost for a demonstration project, and that current funding was sufficient until proof of concept is achieved. Another reviewer stated that funding should continue if the focus becomes reducing irreversibility in the context of cyclic, unsteady, constant volume combustion processes.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

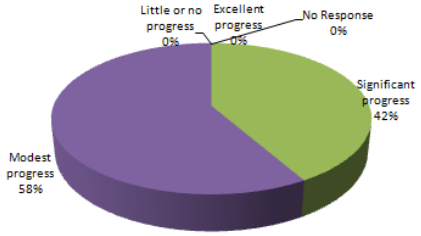
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes

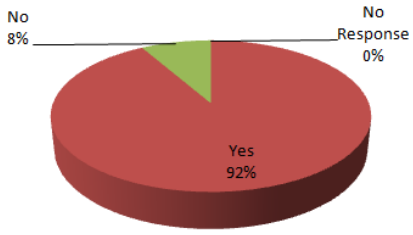
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



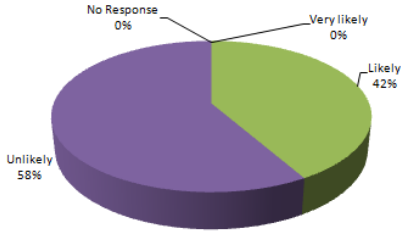
Question 3: Characterize the technical accomplishments and progress toward goals.



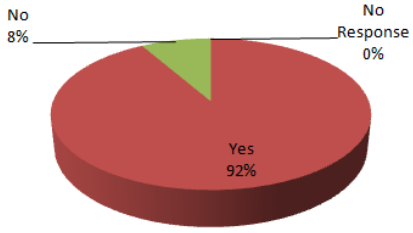
Question 2a: Are the goals of the project technically achievable?



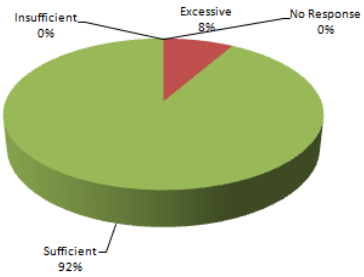
Question 4: How likely is the project team to move technologies into the marketplace?



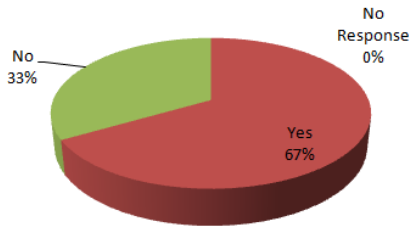
Question 2b: Have the technical barriers been identified and addressed?



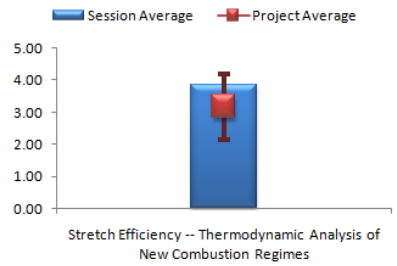
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines (Dennis Assanis, of University of Michigan)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer saw the program as having a good holistic, multi-group approach to LTC research. The goal was seen, by a reviewer, as to expand the operating range of LTC combustion in order to improve emissions and efficiency. Another reviewer added that the program supported model development to improve engine development in the future. A reviewer stated that the program supports DOE goals for petroleum displacement because it aims to provide physical understanding and predictive capabilities for high efficiency combustion systems. A reviewer felt that the program had the long-term potential to accomplish its objectives.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer was happy to see that this project is working on the issues of transient engine operation. The reviewer believes this will be one of the key barriers to overcome in order to deploy LTC in the marketplace. Another reviewer saw this as a comprehensive, multi-front attack on the problem. The reviewer added that there were many barriers still remain but the program had a competent approach to the problem.

A reviewer felt that program focused on important problems like how to extend the HCCI regime and transient control. The reviewer added that the project supported other projects and was cost efficient.

Some of the reviewers spoke highly on the industrial collaborations and the collaboration between the various labs and universities. A reviewer felt that the program goals are well defined in terms of objectives, task interactions and collaborations. The reviewer added this program team is making good progress leveraging their respective facilities and capabilities to meet the goals of the program.

One reviewer added that they would like the gasoline HCCI programs to have a closer association with the diesel projects, in order to help or transfer knowledge from diesel to gasoline and vice versa.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The program was seen as making good progress towards its goals, by a reviewer. Good interaction with industry and national laboratories was also cited as well as numerous advances aimed at retiring risk with low temperature combustion. A reviewer said there was a good blend of modeling and experimental work

Some reviewers found the boosted HCCI work as interesting and would like to see more modeling and bar work on that. The program was seen as big with many subtasks, with the goal of expanding HCCI. The control of HCCI based on wall temperature was also seen as interesting by a reviewer. A reviewer was glad to see the inclusion of biofuels in the program. The reviewer added there was good collaboration with LLNL on the chemical kinetics of methyl-butanoate. A reviewer saw VVA control to extend HCCI operating range as a key development that may assist in overcoming technical barriers for low temperature combustion.

One reviewer felt that good progress had been made, but that there was still no evidence of good transient control methodologies. The reviewer added that tough problems always seemed to be listed under 'Future Plans'.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The program's collaboration was widely praised. It was noted that there was good technology transfer from the consortium to industry as well as from industry to consortium. A reviewer felt there was excellent involvement of universities and labs to develop important tools. The primary method of technology transfer was seen, by a reviewer, as being through publications and students who graduate from the program. One reviewer expressed concern that the discussions seemed to all be with GM or Ford. The reviewer hoped this would be widened, perhaps including overseas companies.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

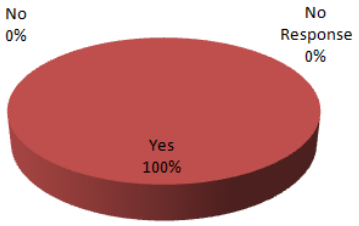
Reviewers found a good level of available resources. The work was seen as well distributed amongst the consortium. One reviewer felt the funding levels were high, but appropriate when considering the project. A reviewer would have liked to know how the funding was distributed amongst the consortium participants.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

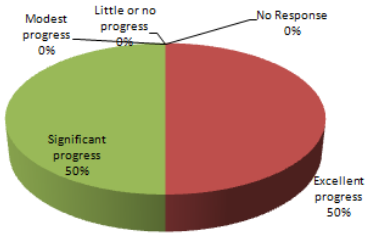
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines

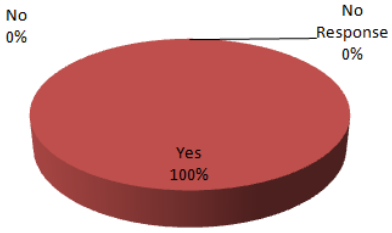
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



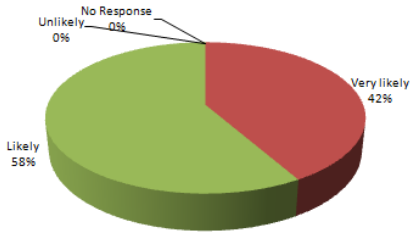
Question 3: Characterize the technical accomplishments and progress toward goals.



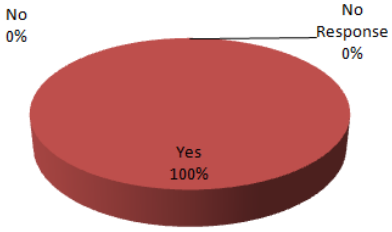
Question 2a: Are the goals of the project technically achievable?



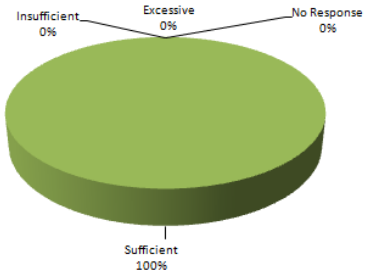
Question 4: How likely is the project team to move technologies into the marketplace?



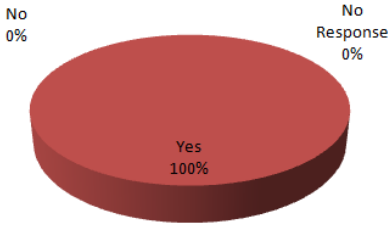
Question 2b: Have the technical barriers been identified and addressed?



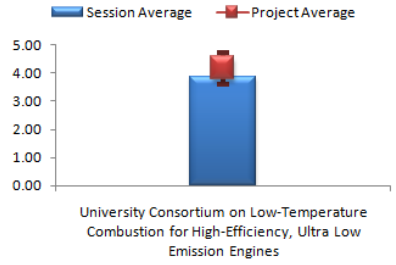
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Visualization of In-Cylinder Combustion R&D (Steve Ciatti, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer felt that improving power density of LTC/HCCI concepts is important to support DOE objectives. A number of reviewers saw the goal as being to improve understanding of the combustion process in order to improve efficiency. A reviewer felt that a study of alternative fuel utilization at low emissions and high efficiency was DOE compatible.

One reviewer felt the objective was noble, but the path unclear. The reviewer added that the actual testing program was undefined, although the reviewer found the application of chemical luminosity as interesting. The reviewer wondered if this work wouldn't be better handled in a fuels program. A reviewer felt the testing process was sketchy and another was struggling with this project.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that focus on improved power density strategies could be a technology transfer enabler to bring high load HCCI to market. The reviewer added it will be interesting to see how this can be achieved with a fuel resembling gasoline (in a diesel like engine) without reducing the octane value of the fuel below what is currently available as a low-sulfur, real-world gasoline blend stock. The reviewer wondered if the Sturman digital fuel injection system would be a better fit for a low lubricity fuel like this.

A reviewer felt the goal of the project was not completely clear, but felt that it would be useful to examine both high and low cetane fuel as well as other properties such as volatility and their impact on diesel LTC to understand why one OEM says low cetane is better and another says high cetane is better.

Other reviewers felt that the project requires more definition on what may be obtained with multi-injection. A reviewer felt that there didn't seem to be much new with the project.

Another reviewer felt the imaging technique and spectroscopic measurements are useful, but the project needs to define carefully the experimental plan, select design changes and LTC strategies, and also differentiate them from work done in industry. A reviewer felt there was not enough experience with this type of project at Argonne to run this type of program, and the reviewer wondered if the laboratory had relationships with Wisconsin, for example. One reviewer felt this type of work more suitable to an OEM, and was unclear what specialty Argonne brought to the study.

One reviewer thought it would be interesting to look at formaldehyde formation and emission from LTC and HCCI combustion, to see if there is any? Another reviewer stated that it was still early for this project and the plans are still fluid, which the reviewer described as good.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A number of reviewers stated that this is a new project and no progress was expected. Some reviewers saw engine set up and benchmarking as the only progress so far. Another reviewer was unclear how well-thought-out the project is, and though the described work sounded similar to work published by

Shell. The reviewer felt a need for a more detailed plan, which would answer what the purpose of the visualization measurements is and what specific quantities are going to be measured. Another reviewer felt that no new technology was used in the production engine, and that the test cell was built up for a low temperature combustion study. One reviewer stated that seven months to get the engine running seems like a long time, and is indicative that progress is going to be slow. Another reviewer stated that potential is there for significant progress in a timely manner, now that the test cell has been set up.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A number of reviewers commented that the project was not well explained. Another reviewer felt the plan for technology transfer was not fell formed with respect to collaboration with industry, universities or other national labs. The reviewer added that market pull for LTC would depend on power density goals being met. A reviewer felt that the lack of consensus over which direction to take cetane, would make it unlikely that the research would result in a fuel change. The reviewer added that the wide range to cetanes seen in the field in the US is already a major barrier for bringing diesel to North America, and that pushing for lower cetane fuels will make this issue worse.

Some reviewers expressed concern that even if the results indicate a benefit to using a low cetane, other issues, such as cold starts, will prevent change of fuel. One reviewer commented that there was slow progress, but the technology being used is known. Reviewers also felt that if a benefit to using low cetane fuel can be established there will be interest from industry partners.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

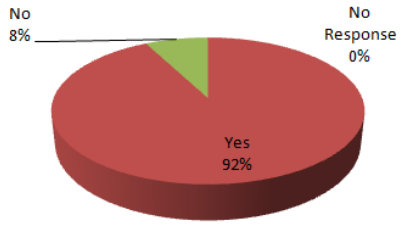
A reviewer stated that funding was appropriate for the objectives, while another reviewer felt that the project made good use of other Argonne National Laboratory diagnostic's techniques with good cross-fertilization potential.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

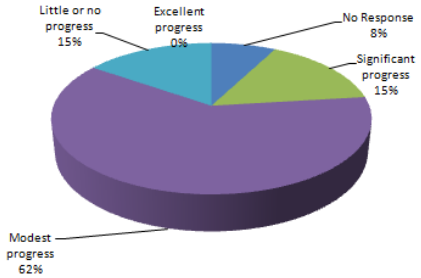
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Visualization of In-Cylinder Combustion R&D

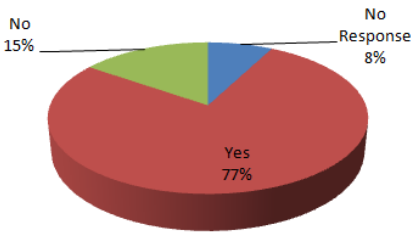
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



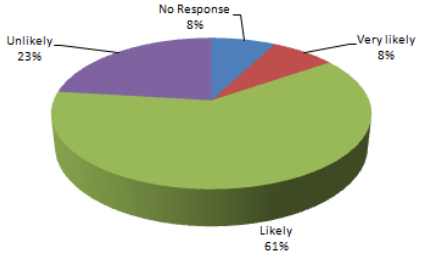
Question 3: Characterize the technical accomplishments and progress toward goals.



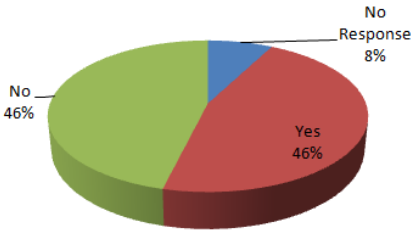
Question 2a: Are the goals of the project technically achievable?



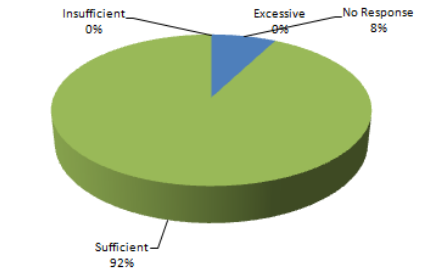
Question 4: How likely is the project team to move technologies into the marketplace?



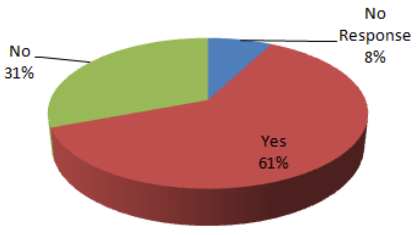
Question 2b: Have the technical barriers been identified and addressed?



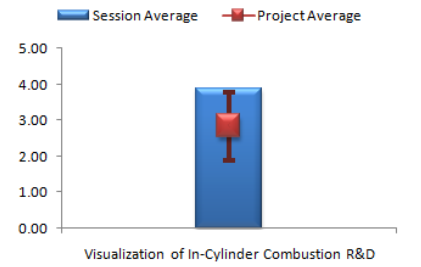
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



8. High Efficiency Clean Combustion and Enabling Technologies

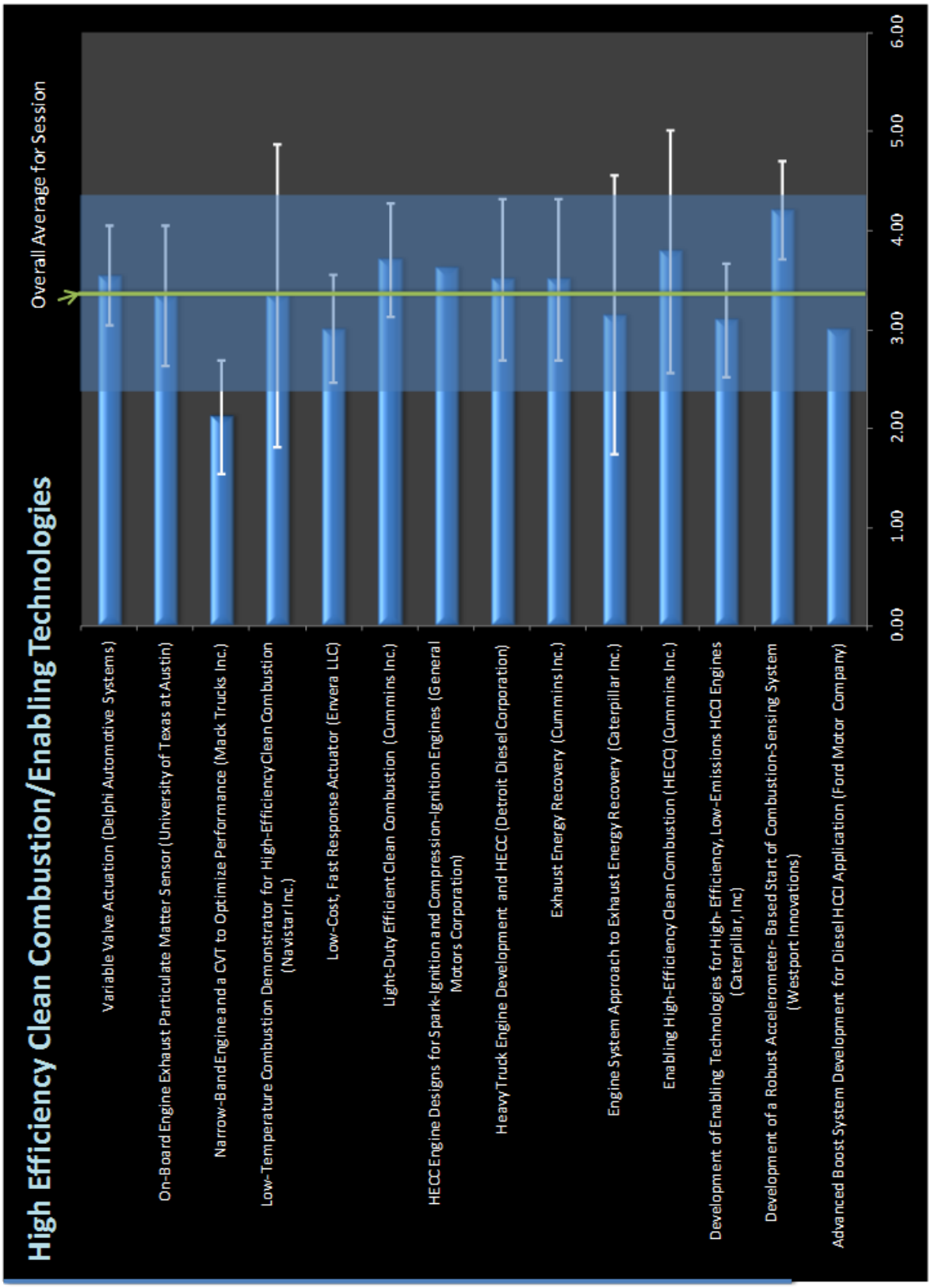
Introduction

High Efficiency Clean Combustion and Enabling Technologies involves development of critical technologies necessary for achieving DOE VT goals for efficiency in advanced combustion engines. Enabling technologies work focuses on fuel systems, engine control systems, and engine technologies. Fuel systems R&D focuses on injector controls and fuel spray development. Engine control systems R&D focuses on developing engine controls that are precise and flexible for enabling improved efficiency and emission reduction in advanced combustion engines. Engine technologies development will be undertaken to achieve the best combination that enables advanced combustion engines to meet maximum fuel economy and performance requirements. These include variable compression ratio, variable valve timing, variable boost, advanced sensors, and exhaust emission control devices (to control hydrocarbon emissions at idle-type conditions) in an integrated system.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
8-4	Advanced Boost System Development for Diesel HCCI Application (Harold Sun, Ford Motor Company)	3.00	0.63
8-7	Development of a Robust Accelerometer- Based Start of Combustion-Sensing System (Jim Huang, Westport Innovations)	4.20	0.63
8-11	Development of Enabling Technologies for High- Efficiency, Low-Emissions HCCI Engines (David Milam, Caterpillar, Inc)	3.09	0.83
8-15	Enabling High-Efficiency Clean Combustion (HECC) (Don Stanton, Cummins Inc.)	3.79	1.05
8-19	Engine System Approach to Exhaust Energy Recovery (Rick Kruiswyk, Caterpillar Inc.)	3.14	0.69
8-22	Exhaust Energy Recovery (Chris Nelson, Cummins Inc.)	3.50	0.76
8-25	Heavy Truck Engine Development and HECC (Houshun Zhang, Detroit Diesel Corporation)	3.50	0.90
8-28	HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines (Ken Patton, General Motors Corporation)	3.62	0.77
8-31	Light-Duty Efficient Clean Combustion (Tim Frazier, Cummins Inc.)	3.70	0.82
8-35	Low-Cost, Fast Response Actuator (Charles Mendler, Envera LLC)	3.00	1.08
8-39	Low-Temperature Combustion Demonstrator for High-Efficiency Clean Combustion (Willy Ojeda, Navistar Inc.)	3.33	1.12

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
8-43	Narrow-Band Engine and a CVT to Optimize Performance (Bahman Habibzadeh, Mack Trucks Inc.)	2.11	0.60
8-47	On-Board Engine Exhaust Particulate Matter Sensor (Matt Hall, University of Texas at Austin)	3.33	1.07
8-51	Variable Valve Actuation (Jeff Gutterman, Delphi Automotive Systems)	3.54	1.05
	Overall Session Average and Standard Deviation	**3.38**	**0.97**


High Efficiency Clean Combustion/Enabling Technologies
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Variable Valve Actuation (Delphi Automotive Systems)
On-Board Engine Exhaust Particulate Matter Sensor (University of Texas at Austin)
Narrow-Band Engine and a CVT to Optimize Performance (Mack Trucks Inc.)
Low-Temperature Combustion Demonstrator for High-Efficiency Clean Combustion (Navistar Inc.)
Low-Cost, Fast Response Actuator (Envera LLC)
Light-Duty Efficient Clean Combustion (Cummins Inc.)
HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines (General Motors Corporation)
Heavy Truck Engine Development and HECC (Detroit Diesel Corporation)
Exhaust Energy Recovery (Cummins Inc.)
Engine System Approach to Exhaust Energy Recovery (Caterpillar Inc.)
Enabling High-Efficiency Clean Combustion (HECC) (Cummins Inc.)
Development of Enabling Technologies for High- Efficiency, Low-Emissions HCCI Engines (Caterpillar, Inc.)
Development of a Robust Accelerometer- Based Start of Combustion-Sensing System (Westport Innovations)
Advanced Boost System Development for Diesel HCCI Application (Ford Motor Company)

Advanced Boost System Development for Diesel HCCI Application (Harold Sun, of Ford Motor Company)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that improved turbocharging efficiency will be an important component development for reducing fuel use for various LTC combustion regimes. Another noted that HECC technology is planned, enabled by a focus on the air-plug-EGR handling system. One other person commented that the air system handling is basic and important to improving engine thermal efficiency. Improving turbocharger efficiency can reduce engine back pressure and PMEP.

One reviewer stated that this looks like a good program to support LTC advancement. However, little work has been published on how the turbocharger system fits into, can enhance, or hinder the LTC combustion concepts. One final reviewer stated that he or she is not sure that the turbo project alone can achieve the DOE objectives due to the issues mentioned below and despite the technical justification provided.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that this project is just getting started, while another added that this is difficult to assess at this stage of the project. One person added that the project is in its very early stages and available options for turbo design should be more flexible – otherwise it merely becomes an exercise in building a pre-designed piece of equipment.

One reviewer commented that redesigning/modifying a current TC to match an engine is a direct approach to reach the target. However, it will be challenging to design a TC considering both LTC mode and other modes. One person added that the group needs to engage turbo supplier(s) soon to get feedback on incorporating these methods on small turbos. One final reviewer added that he or she is not sure if Ford is in a position to deploy results from the analysis – seems that a turbocharger partner may be advantageous to the program. For example, if the full turbo system does not work, minor advances may not be adopted into real hardware without a turbocharger partner. Additional barriers exist involved in the details of matching compressor/turbine, and classical equations are not sufficient for this. Detailed flow effects and pulsation will have a large influence on the actual testing result. This reviewer thinks the turbocharger/air system alone is not sufficient. There should be a large effort to adapt the engine/air system for the matching effort traditional to any development project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Multiple reviewers indicated that the project is new and has not developed results yet. One reviewer added that detailed planning was shown however, while another person said that the project is on its plan. One final reviewer added that this project is just getting started, but barriers in developing a boost system that meets overall efficiency seem to be well understood. This reviewer added that the timeline shown for the project seems too long.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer commented that Ford has the internal resources needed to enable it to bring this advanced boost system into the marketplace, while another person noted that Ford is an OEM, so taking this to production is relatively easy. One reviewer stated that matching turbocharger performance to the new combustion regimes will be a key enabler to meeting emission and efficiency targets. One other respondent remarked that component development such as this usually finds its way into production if the results of the work are good enough, and if it fits the company's product plans.

One final reviewer is not sure if Ford is in a position to deploy results from the analysis – seems that a turbocharger partner may be advantageous to the program. For example, if the full turbo system does not work, minor advances may not be adopted into real hardware without a turbocharger partner. Additional barriers exist involved in the details of matching compressor/turbine – classical equations are not sufficient for this. Detailed flow effects and pulsation will have a large influence on the actual testing results.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that there seems to be an appropriate level of planned accomplishment for the moderate funding level this project received in FY08.

To contrast, one person stated that he or she thinks resource efficiency would improve with the input of a turbomachinery supplier or other expertise. Another commented that there is a very long timeline for this project. This reviewer wanted to know how much input was being contributed from the turbo companies. One other reviewer indicated that there seems to be excessive subsidization of something that the company should develop on its own if it is very critical to the company's future product plans. If it is not central to the future product plans, then it should not be pursued or funded by DOE.

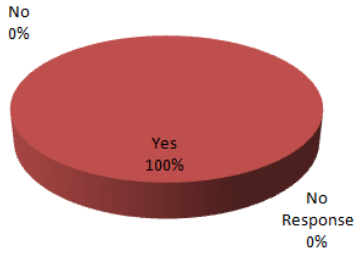
One final reviewer noted that the Cummins project and Ford project have the same level of funding. However, this Ford project only described the development of an advanced boost system for HECC/HCCI/LTC combustion. Is the existence of a HECC engine assumed? If so, then why the high level of funding? If not, then why was nothing presented on the development of an engine?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

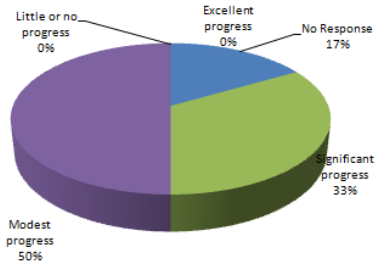
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Boost System Development for Diesel HCCI Application

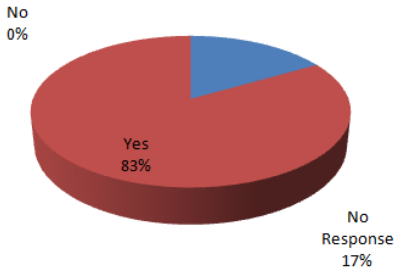
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



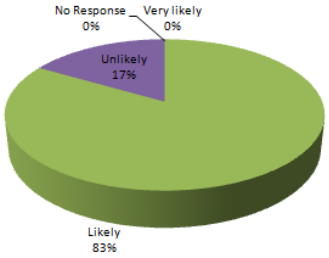
Question 3: Characterize the technical accomplishments and progress toward goals.



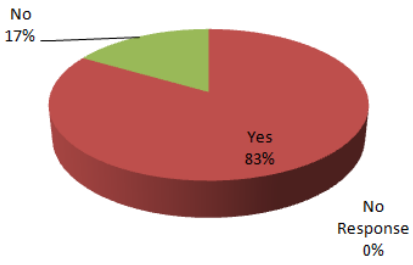
Question 2a: Are the goals of the project technically achievable?



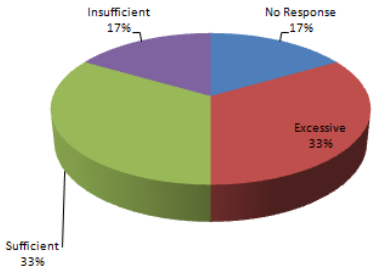
Question 4: How likely is the project team to move technologies into the marketplace?



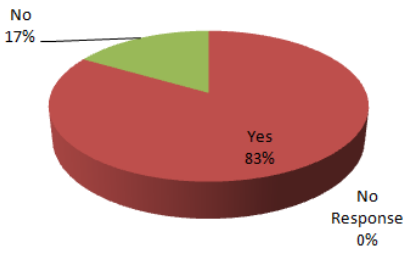
Question 2b: Have the technical barriers been identified and addressed?



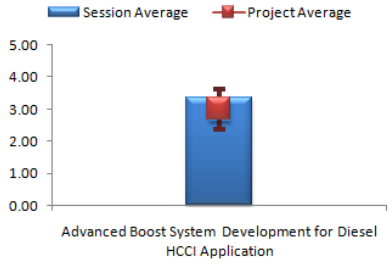
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Development of a Robust Accelerometer- Based Start of Combustion-Sensing System (Jim Huang, of Westport Innovations)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the start of combustion is an important piece of information for LTC and other alternative combustion modes, which in turn are important for reduction of future fuel use. One person commented that using knock sensor to predict combustion and recovery in-cylinder pressure has a lot of potential for improving engine combustion and combustion control. Another commented that this is an enabling technology for HCCI and LTC, while one other reviewer added that this is an enabling technology for advanced combustion techniques, perhaps, and also for basic OBD2 requirements for light-duty diesel. One respondent indicated that SOC combustion sensors are needed to enable HECC and other advanced combustion concepts.

Two reviewers stated that it served DOE goals indirectly, with one adding that an improvement in efficiency can be gained if the sensor can be used to compensate for variations in fuels, engine-build tolerances, or operating conditions. One final reviewer stated that this project will indirectly support DOE fuel economy improvement goals through the use of a combustion sensor to better control the combustion event and thus allow for further optimization of the engine thermodynamic cycle from a break thermal efficiency viewpoint. This sensor (if successful) will have a small impact, but if integrated with other technologies it could make a noticeable difference.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Multiple reviewers commented on the good technical approach of the project. One person noted that some of the results show the approach is viable, while another reviewer stated that the barriers are well understood, and most of the remaining work involves improving the robustness and durability of the sensor. One other individual suggested that the project is nearing its end (contrary to other reviewers) and seems to have been successful.

One response remarked that there have been good results considering the recent start and very low level of funding. Westport is in a good position to implement the technology with a range of OEMs. Another reviewer stated that the technology looks to be close to deployment readiness. This reviewer agrees that this technology would be a more desirable combustion monitoring system than an in-cylinder sensor, and this makes it a likely candidate for deployment. However, it needs to be especially robust, since the need to access the main bearing caps does lend itself to replacing the sensors very easily. One other reviewer indicated that there is a need to address accuracy with a less-than-full complement of sensors. For cost reasons, fewer sensors are better.

One person asked what approach is planned to determine the transfer function of the piston/rod/bearing assembly. One final reviewer said the initial results have been very promising, but the sensor-to-sensor and engine-to-engine accuracy will be difficult to overcome considering the power cylinder dynamics will vary from engine to engine.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that very little time has passed so far, so the results are impressive. There is good attention to the appropriate level of details, including error levels and statistical variation. Another person stated that there was good progress for the first year, and the goals were met very quickly. This reviewer is not sure where the goal of 0.5 deg CA standard deviation was derived from – did it come from Cummins? One reviewer noted that some data prove the assessment, while another person remarked that the initial results that show correlation to lab grade cylinder pressure measurements are encouraging to say the least. Much additional work is needed to further quantify the reliability and durability of this sensor and its use for engine control within a real world engine environment.

One person felt that the project is nearing its end and seems to have been successful. One reviewer noted that the SOC error target was achieved, the engine-to-engine standard deviation error of less than 0.5 deg CA was achieved, and the sensor-to-sensor standard deviation error of less than 0.5 deg CA was achieved. One final reviewer stated that they have already demonstrated some of their goals and are now looking at 'bonus' goals.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that Westport seems interested in using this technology and so needs to find a third party to develop a commercially hardened version of this sensor and its accompanying electronics/computational hardware. Other OEMs should be interested too - it just depends on whether they know where to look or are indeed looking. Another person suggested that the group keep working to get some OEMs interested in this and hearing their feedback. One reviewer said this program will require substantial additional financial resources for transition to occur unless a sensor OEM decides to co-fund or fund this effort. Though the initial results are promising, it seems unlikely that an OEM would invest the millions of dollars necessary to develop this sensor for engine control.

Another respondent remarked that this is a much needed sensor for enabling advanced combustion. However, what needs to be added to the program scope is the development of the sensor for HECC/HCCI/LTC and dilute gasoline stratified-charge combustion engines. This seems like this will be an excellent project for the next phase of sensor development. One response commented that the sensor has a wide application in engine industry if successful, but the author needs to address the following issue: (1) signal sensitivity to the sensor location and (2) signal sensitivity to the gap in bearing.

One reviewer remarked that this is a high risk/high reward element to support advanced combustion techniques. OBD2 has a direct application for misfire control for example – but there are other monitors as well. One final reviewer stated that, if this is durable and information beyond SOC can be determined, then this could be an enabler for alternative combustion regimes.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Multiple reviewers commented that this is a good use/great value of limited DOE funding, and that it is a very modestly funded project. One reviewer noted the very low funding level $55K, adding that this project shows good potential results in a high potential ROI. Another person suggested more resources for validation on a variety of conditions/engines.

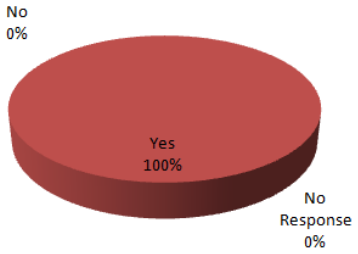
One reviewer asked if the knock sensor suppliers have been engaged. These sensors are not usually used in the crankcase and may need significant modification to be sufficiently durable. Another response indicated that this project needs additional experimental resources such as another engine or engines for evaluation. This project also needs some type of engine control element. One final reviewer stated that given the scope of the project, and if demonstration of other engines as described above is added and benchmarked against a similar project (such as the on-board engine exhaust particulate matter sensor project at University of Texas at Austin), a modest increase is justified.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

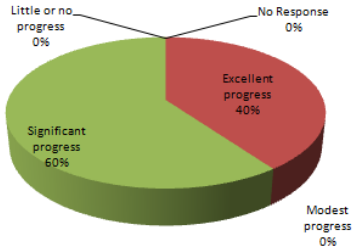
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development of a Robust Accelerometer- Based Start of Combustion-Sensing System

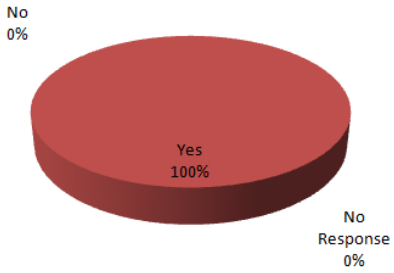
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



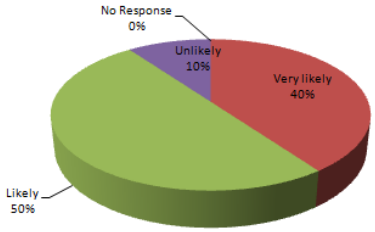
Question 3: Characterize the technical accomplishments and progress toward goals.



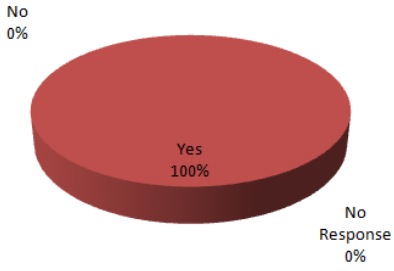
Question 2a: Are the goals of the project technically achievable?



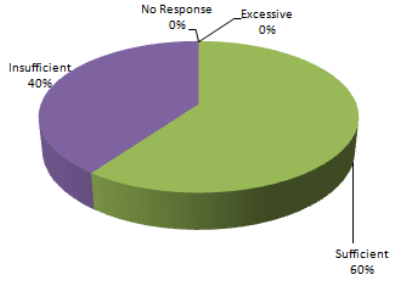
Question 4: How likely is the project team to move technologies into the marketplace?



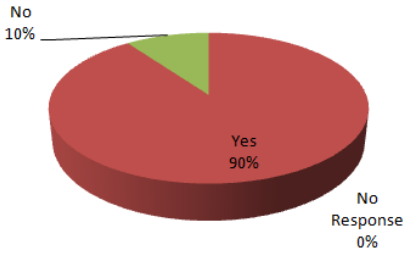
Question 2b: Have the technical barriers been identified and addressed?



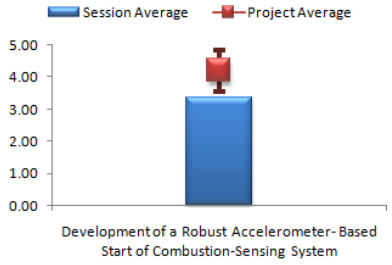
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Development of Enabling Technologies for High- Efficiency, Low-Emissions HCCI Engines (David Milam, of Caterpillar, Inc)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Multiple reviewers pointed to the resulting increased efficiency, with one reviewer adding that the group is moving forward with the development and demonstration of efficiency improvements in HD diesel engines. Another person commented that the work is well-aligned with objectives of improving fuel economy while satisfying emissions constraints. One response stated that the identified goal of achieving a 10% BTE improvement is in line with DOE objectives. One other reviewer remarked that a low emissions, high efficiency, production viable, low-temperature combustion engine system is the most effective way.

One reviewer commented that heavy truck users have a vested interest in technologies which improve fuel economy or reduce cost, as there is a direct impact on their business profitability. They tend to be early adaptors of new technologies, which then filter down to non-commercial consumers. Also, heavy trucks, almost by definition, consume a large portion of our energy. This consumption is skewed to the first few years of vehicle service, the period where the products are placed in heaviest service.

Another person remarked on the integrated approach to optimize engines for BSFC/NOx, adding that the overall roadmap was outlined, but no indication was given regarding where the project is on the roadmap itself. Some of the data presented did not look very fuel efficient (i.e. heat balance pie chart).

One final reviewer stated that the means to demonstrate compliance with emissions standards was not clear.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent indicated that Caterpillar's internal organization has the capability to bring the technology to the marketplace if and when appropriate. One reviewer stated that there is a good map forward leveraging a variety of external resources, while another person commented that there is a well balanced approach among metal and optical engine experiments and complementary simulation. This reviewer added that the partnership with ExxonMobil to explore fuels effects is a plus. One person remarked that they should get to waste heat recovery projects quickly, while another highlighted the high EGR %.

To contrast, one reviewer commented that it was not shown that the technological barriers could be overcome, and there was an insufficient quantification of improvements. Another reviewer agreed, stating that he or she was not sure if the goals are achievable technically - lots of "info" presented - but this reviewer didn't see any clear identification of where the target is and how close they are to achieving it. Heat balance brake power (thermal efficiency) does not look good. Why is this group taking a fuels approach? It is OK to check, but it makes deployment much harder. No info on fuels offered - is it practical? CAT didn't offer any information here, and there was no indication that the technical barriers are being overcome or that progress is being made.

One final reviewer indicated that achieving 0.2g/bhp-hr NOx without NOx A/T and 55% BTE seems unlikely. Gains in efficiency are assumed by getting rid of NOx A/T. However, it is unclear how HECC will enable thermal efficiency to be maintained throughout the engine map, especially at full load. It would also be useful to understand what the tradeoffs are and what will need to happen to achieve the elimination of NOx A/T, such as fuel changes. Is the approach to meet 2010 emissions without NOx A/T compatible, or with NOx A/T that will most likely be required to meet future emissions standards?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that progress is being made in increasing efficiency, while another noted the good results on the effects of fuel cetane on improving the power of HCCI. One other individual indicated that the advanced engine will most likely require operation in a mixed HCCI/conventional diesel mode. The work should be directed into controlling transitions, transients, and associated controls, particularly if the engine will employ two-stage boosting systems.

To contrast, one reviewer stated that a lot of work seems to have been done but is not reflected in the presentation. Another added that it was not shown that the technological barriers could be overcome, and there is an insufficient quantification of improvements. One person was not sure if the goals are achievable technically – there was lots of "info" presented but this reviewer didn't see any clear identification of where the target is and how close they are to achieving it. One final reviewer stated that gasoline blending is probably required for HCCI. This reviewer doesn't see a special fuel as being practical, at least for early introduction.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that an engine manufacturer is leading the project, ensuring a path to deployment. One person noted the good collaboration with Sandia, Exxon/Mobil, and IAV, while another added that Caterpillar is an OEM, so technology transfer can occur quickly.

One reviewer indicated that HCCI still has fundamental issues with stability and noise which must be overcome to bring the concept to production. This reviewer doesn't see a direct path to production, even on a limited scale, except at part load as discussed. This is a change from previous CAT presentations.

Another respondent stated that, without seeing technical status towards objectives, it is hard to imagine this work will be transferred to achieve DOE goals. If results are promising, CAT could be in a good position to implement except if it requires fuels changes, for example. One response indicated that, although it may not deliver as much efficiency as promised, the understanding gained will improve HD diesel efficiency. Dual fuel solutions are generally unacceptable to customers, and mixing gasoline and diesel in a gas tank is explosive. One final reviewer felt that very little information was shared on how the fuel was blended. It would be good to know the grades of commercial fuel, bulk property range tested, how they impact engine performance, etc. This would be interesting to hear about next year.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the funding was appropriate given the scope.

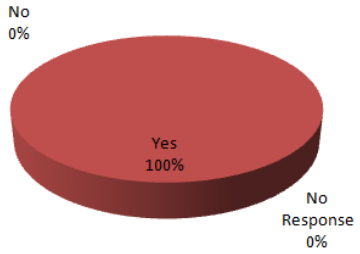
Others disagreed, with one response stated that the level of funding appears extremely high. Similarly, one reviewer began by asking if this project includes the Sandia activity. Historical program results from a few years ago have shown good technical insights and development strategies – but this reviewer didn't see the same quality of R&D here. This project seems to have too many resources considering the lack of deliverables/data/results. One final reviewer added that, although he or she can appreciate the good work shown and the accomplishments to date, this reviewer expected more progress with the given high funding level. Also, it was not clear how the work at Sandia was supported. Did it come from Caterpillar's DOE funds or was it funded directly from DOE to Sandia as a part of their own LTC programs?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

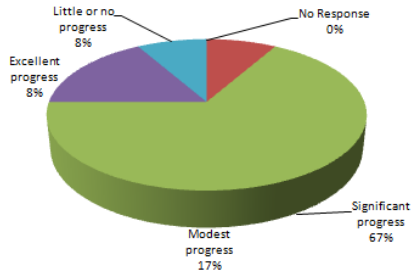
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development of Enabling Technologies for High- Efficiency, Low-Emissions HCCI Engines

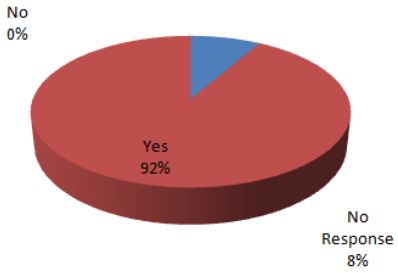
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



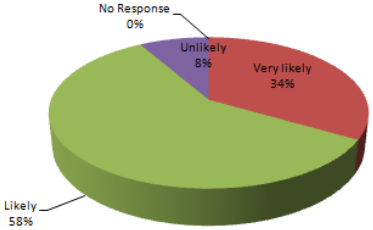
Question 3: Characterize the technical accomplishments and progress toward goals.



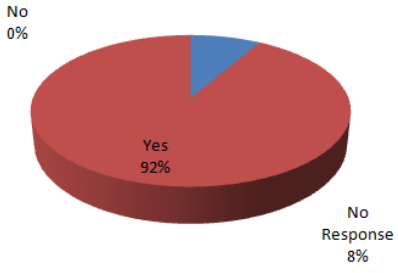
Question 2a: Are the goals of the project technically achievable?



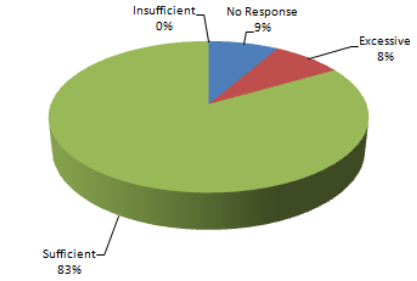
Question 4: How likely is the project team to move technologies into the marketplace?



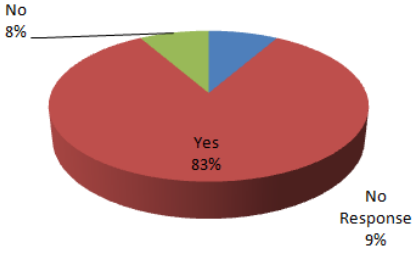
Question 2b: Have the technical barriers been identified and addressed?



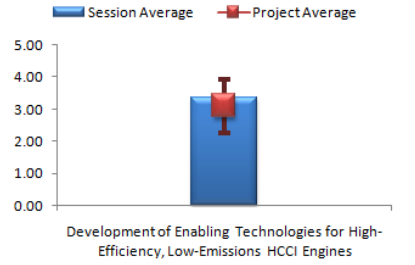
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Enabling High-Efficiency Clean Combustion (HECC) (Don Stanton, of Cummins Inc.)

Reviewer Sample Size
This project had a total of 14 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Multiple reviewers commented on the improved efficiency possibilities, with one reviewer stating that the project aims at improving heavy-duty diesel engine efficiency. Another wrote that the project is well-aligned with DOE's objectives to improve the fuel economy of both heavy-duty and light-duty engines, while satisfying 2010 emissions standards. One reviewer indicated that the efficiency goals are realistic and achievable, and will result in measurable improvements in light- and heavy-duty diesel fuel efficiency. Another said absolutely yes – both the light and heavy-duty projects are directly and intimately focused on reducing both engine-level and vehicle fuel consumption. This is a very good program.

One individual noted that the goal is to improve BTE of engine, while another added that a 10% BTE improvement at 2010 emissions levels meets the program objectives. One other person commented that the aim is to help efficiency in HD, but the project is not actually targeting 55% peak thermal efficiency.

One final reviewer stated that this is a good approach to heavy-duty vehicles, and medium-duty engines are being looked at. There are good interim results claimed – it is reasonable that ISX steady-state results are achieved, but the FTP transient is problematic. There is, however, no information regarding how the results are obtained.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Three reviewers stated that this is a well thought-out plan for development and demonstration, while another reviewer commented that the project involves the integration of many subsystems and components.

One person stated that the commercial viability aspects were positive – this reviewer likes that OBD is considered during the R&D phase - but he or she trusts only very advanced OBD approaches to the new DOE sponsored technologies would be examined. OBD development is a normal development requirement for certification and general OBD development may not be appropriate for this DOE program.

Another person commented that the PI fully understands the engine- and vehicle-level challenges associated with reducing engine-out NOx while meeting the targeted 55% brake thermal efficiency. One potential barrier that should be carefully addressed is the impact of the additional cooling requirements on vehicle-level fuel economy. The work to date does not appear to have addressed this matter in detail. One concern is that the steps taken to improve the current brake thermal efficiency may result in little if any (and hopefully not a decrease) improvement in vehicle level fuel economy. It would be helpful to understand all of the associated parasitic loads associated with increased air flow (charge air cooling) and higher EGR rates (another high cooling load).

One reviewer asked whether NOx aftertreatment is required to meet emissions restrictions. Adding to this, one other individual stated that achieving 0.2g/bhp-hr NOx without NOx A/T and 55% BTE is challenging. The group is assuming large gains in efficiency from getting rid of NOx A/T; however, it

is unclear how LTC will enable thermal efficiency throughout the engine map, especially at higher loads. It would be useful to understand what the tradeoffs are to achieving the elimination of NOx A/T and whether it is possible with various fuels. Is the approach to meet 2010 emissions without NOx A/T compatible, or with NOx A/T that will most likely be required to meet future emissions standards?

One response indicated that it was not shown that the technological barriers could be overcome, and there was an insufficient quantification of improvements. Another person commented that the presenter presents some general ideas in improving BTE, adding that maybe that is the way to reach the target. One final reviewer remarked that the selection of the material that was presented made it difficult to assess the modeling and diagnostics that have been used to support engine development.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Four reviewers stated that there was good or reasonable progress over last year, with one adding that exploring the expansion ratio path is good for the HD applications. Another reviewer added that the group is accomplishing regular milestones in overcoming technical barriers. Transient control and calibration will be one of the keys to meeting the stretch goals going from optimized steady operation to transient vehicle-like operation. One other person noted lifted flame diffusion control technology will be an interesting research area.

One individual commented that, to date, this project has shown a potential roadmap for meeting 2010 standards while considerably improving today's state-of-the-art engine peak thermal efficiency for both medium and heavy-duty sectors. As pointed out above, more vehicle level systems integration work needs to be performed to assess the real world impact on composite vehicle fuel economy. Another reviewer added that the project appears to have made considerable progress toward overcoming barriers. However, very few technical results were presented, thus reducing the impact that the project can have on the technical community. This reviewer finds quite unacceptable that the technical graphs were presented without having figures on the axes. This way it is impossible to assess, for instance, fuel economy and emissions trade-offs.

One reviewer stated that they would like to see more results, while another added that it was not shown that the technological barriers could be overcome, and there was an insufficient quantification of improvements. Another person stated that the group claimed that the results are impressive - but no info is presented on how the results are achieved. One final reviewer indicated that no detailed information was presented, for example, BTE or BSFC. And the approach of how to reach the 2010 emissions target is unclear.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer commented that some parts are likely to be commercialized, adding that the lift of technology is feasible with right FIE system, but the three-mode combustion is difficult to optimize. Another reviewer indicated that portions of this effort are likely to transition to the marketplace, such as electric assist turbocharging, variable valve timing, and two-stage turbocharging. Other portions of this effort may or may not find their way into production.

One person noted that a manufacturer leads the project, thus providing a direct path to deployment, while another reviewer stated that Cummins has a good track record of commercialization of its DOE-funded research and development. One individual felt that Cummins is in a good position to integrate

the results into the ISX and ISB - that is assuming that the approaches used are viable. No information was presented on what the actual approach being pursued is. One reviewer wrote that, although OEMs don't appear to be involved much in this program at this time, Cummins is well positioned to bring them in and being these technologies to market if/when it becomes appropriate. In slight contrast, another reviewer indicated that Cummins is an OEM and will be able to introduce technologies into the market relatively easily.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the budget looks well-matched to the tasks required, while another person commented that this is a nice program with sufficient resources to address the 55% peak thermal efficiency target for both light- and heavy-duty sectors. One other respondent stated that the resources appear appropriate for the type of work done. However, since details on the approaches used were not given, it makes it difficult to be conclusive about this issue.

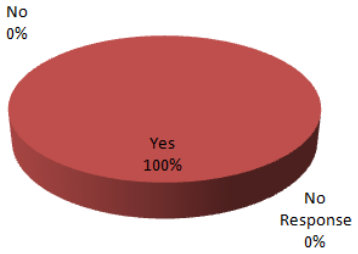
One reviewer commented that Cummins does a fine job of leveraging funding for product development activities. Another suggested that the presenters could highlight how the national labs were leveraged in these results.

One final reviewer stated that they would have expected to see more accomplishments for the given funding level this year.

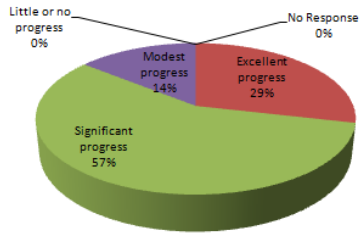
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Enabling High-Efficiency Clean Combustion (HECC)

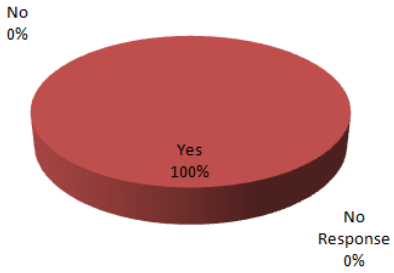
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



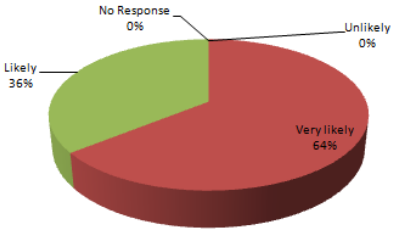
Question 3: Characterize the technical accomplishments and progress toward goals.



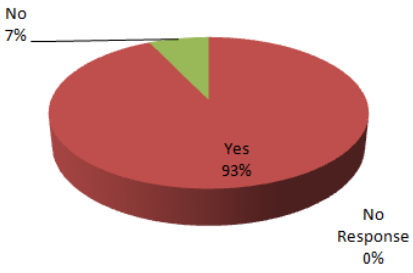
Question 2a: Are the goals of the project technically achievable?



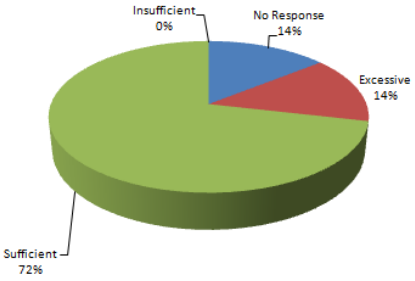
Question 4: How likely is the project team to move technologies into the marketplace?



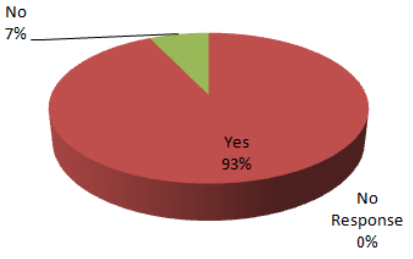
Question 2b: Have the technical barriers been identified and addressed?



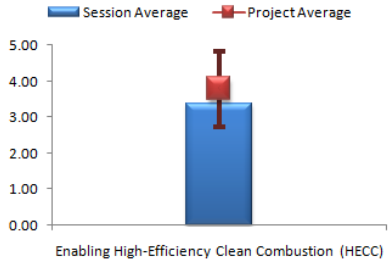
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Engine System Approach to Exhaust Energy Recovery (Rick Kruiswyk, of Caterpillar Inc.)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Two reviewers stated that the project supports meeting efficiency goals on HD diesel. Another person commented that it aims at achieving 10% efficiency gains via exhaust waste-heat recovery for heavy-duty trucks, a reasonable goal. One other reviewer said there is a very clearly defined path to reach the 10% goal, in line with DOE objectives.

One final reviewer stated that it seems that CAT is working hard on several fronts to achieve the program goals and therefore DOE objectives. This seems to be a good use of advanced analytical tools and results from other programs. This reviewer is not sure if CAT is in a position to deploy results from the analysis – it seems that a turbocharger partner may be advantageous to the program. For example, if the full turbo system does not work, minor advances may not be adopted into real hardware without a turbocharger partner. Additional barriers exist involved in the details of matching compressor/turbine – classical equations are not sufficient for this. Detailed flow effects and pulsation will have a large influence on the actual testing result.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that use of the second-law analysis to identify areas to attack for efficiency improvement lead to an approach is well thought out.

In contrast, one reviewer stated that this appears to be a difficult approach to apply to a series turbocharged engine, while another person added that the barriers for the defined path are significant to get this approach into a deployable solution. One respondent stated that CAT is considering the deployment barriers and applying analytical techniques. It seems that the turbo aerodynamics and the Brayton cycle packaging and heat exchanger packaging barriers would suggest including a turbo partner or a vehicle partner. But the cost barriers and vehicle packaging concerns still remain.

One reviewer commented that delivery of the 2% efficiency from the high pressure turbine will depend on the success of advanced turbocharger concepts, hence this is somewhat risky. Turbo compounding, being sensitive to the particulate filter back pressure, is somewhat risky. The penalty for regeneration of the DPF does not seem to be addressed. One final reviewer noted that the compound turbine is not newly proposed technology, but there still are some barriers to be identified and overcome: (1) TC transient response on engine performance, (2) friction effect, and (3) package and cost.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that plenty of results have been mentioned – but it is not clear that the approach is feasible considering that cost, vehicle packaging, and heat exchanger barriers were not addressed or at least mentioned. Another individual said that the path defined has been falling short of the predictions, but it appears that they are working to find new/alternate paths to reach the goal. One final reviewer noted that the GEN 1 mixed-flow turbine bench test has shown no improvement to baseline. GEN 2 turbine improvement is only predicted by simulation, and falls short of the ultimate target.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent noted that Caterpillar is an OEM, and so they can take the design and knowledge to production relatively quickly. Another reviewer stated that, given that the approach has many elements, the project is likely to lead to some areas of efficiency improvement in the marketplace. However, this reviewer added that the Brayton cycle work will only benefit HD and won't transfer to LD.

One reviewer indicated that there are plenty of results mentioned, but it is not clear that the approach is feasible considering that cost, vehicle packaging, and heat exchanger barriers were not addressed or at least mentioned. One final reviewer commented that patents are usually a hindrance to technology transfer, not an enabler. The likelihood of this complete system technology making it into the marketplace is probably not good. However, he or she can see some aspects (i.e. the turbocharger work) of this being very viable.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

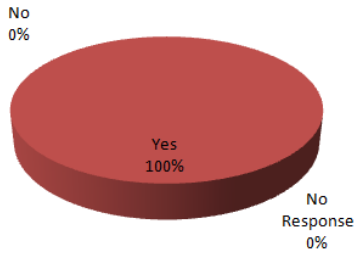
The lone respondent stated that the accomplishments seem to be appropriate for the funding level of this project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

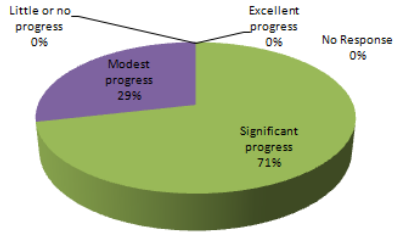
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Engine System Approach to Exhaust Energy Recovery

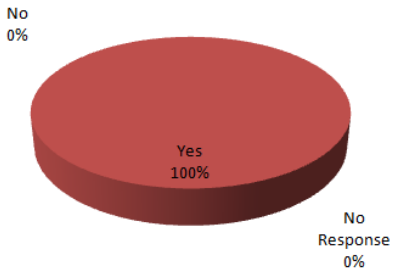
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



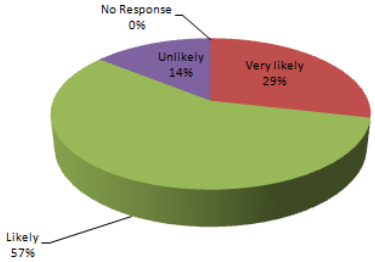
Question 3: Characterize the technical accomplishments and progress toward goals.



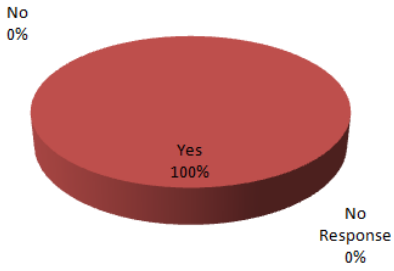
Question 2a: Are the goals of the project technically achievable?



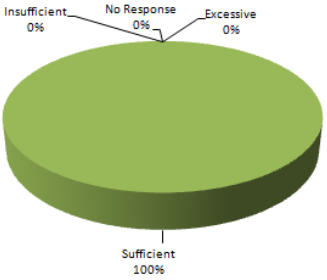
Question 4: How likely is the project team to move technologies into the marketplace?



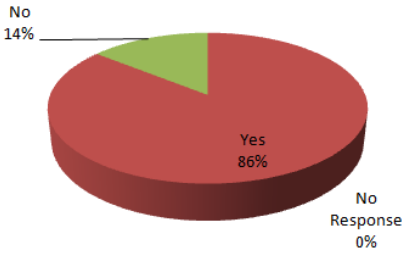
Question 2b: Have the technical barriers been identified and addressed?



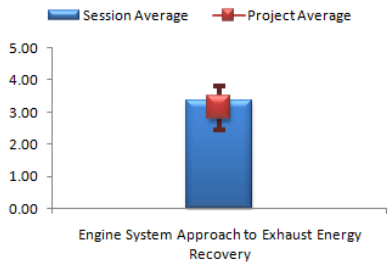
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Exhaust Energy Recovery (Chris Nelson, of Cummins Inc.)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the 10% overall improvement in efficiency meets the DOE objectives, while another stated that 10% efficiency improvement is anticipated for waste heat recovery, which is reasonable. Very similarly, one person commented that using waste heat recovery system can improve engine efficiency. One other respondent stated that the 10% technical improvement claimed is large. The cost requirement is also high, so this is a high risk/10% reward project.

One reviewer remarked that waste energy recovery will be an integral part of future high efficiency engines. WHR may be an important component of this (although lower hanging fruit like turbocompounding is here already). One final reviewer stated that improving efficiency through waste heat recovery is only applicable to heavy-duty vehicles.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated there is a good test plan in place, while another added that there is good analysis that will lead to decision making. This is a good approach to have go-no-go decisions in each phase and to prove out the concept analytically. One other reviewer complimented the idea to capture the EGR cooler heat rejection and use it for waste heat recovery – this is an advance over "historical" Rankine bottoming cycle ideas. It seems that intelligent compromises have been made to optimize the initial system prior to the start of development – this is important for deployment. Cost and additional complexity are probably the key barriers, and this reviewer did not see any new concepts to overcome these.

One reviewer wrote that HD application is only for the Rankine cycle due to the need for high quality exhaust for recovery. The expense of the system would probably be prohibitive for light-duty applications. Packaging has been addressed quite extensively. Another response stated that using the Rankine cycle is a good approach but needs to be demonstrated. One final reviewer noted that some results indicate the approach is feasible but cost and weight need be fully considered if the system should be used in light-duty vehicles.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated there is very good progress shown in all areas of this system, while another complimented that detailed design, adding that it is good to start with the vehicle application up front and concept design integration into the vehicle. It is good to see a lot of work up front on the Cyber Vehicle to plan out the available power/benefits.

One person noted that the schedule has slipped – no real reasons provided, but re-scheduled list of tasks seems reasonable. Another person stated that it is hard to be confident about this remark, but judging from the cumulative amount of work "completed" for Phase I and II (from pre-2005 to the end of 2007), the progress seems relatively slow.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent noted that Cummins is an OEM, and that all the work to demonstrate the concept is being done on prototype hardware on near-production engines. Another person commented that there are good collaboration with and relevant partners in Cummins/ITEC – integration to a low emission engine is an advantage over historical designs. One important issue is the strategy to overcome the implementation cost barrier. It is hard to imagine implementing a limited scope concept of this technology as a market transformation – so this reviewer believes the likelihood is low, although he or she does think the presentation/planning was good.

One response stated that it will be a brave company that commercializes this technology, but the first company that does so will not be the last. Another reviewer wrote that the analyses indicate that this will pay for itself in a couple of years; however, cost is likely to prevent implementation for some time.

One person remarked that the group is working with other companies on pumps and controllers for the Rankine cycle waster head recovery. The approach will have difficulty overcoming the negative cost and added weight aspects. This reviewer believes these constraints will likely keep this system from use in transportation applications. One final reviewer also indicated that the complexity of the system and its cost may prevent the technology from being applied into market. If these problems can be solved, it is possible that the system can be used in HD high power required vehicles.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

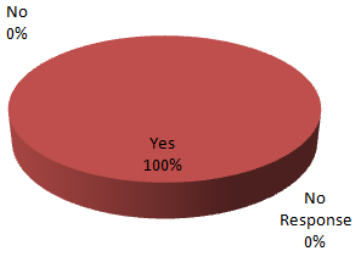
One reviewer stated that the support of Cummins seems to be generous in this and related projects, while another person added that $1.5 million seems high compared to the other projects in this Enabling Technologies category/session. Similarly, one final reviewed added that, although the progress was impressive, this project seems to be funded at a disproportionately high level compared with the others presented.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

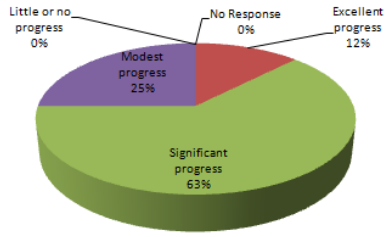
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Exhaust Energy Recovery

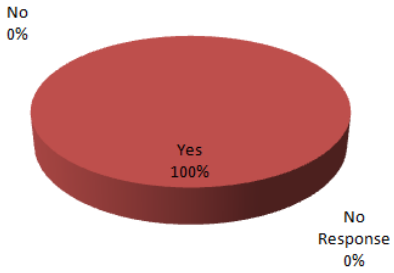
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



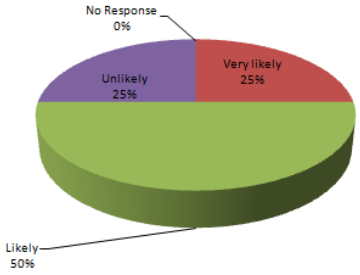
Question 3: Characterize the technical accomplishments and progress toward goals.



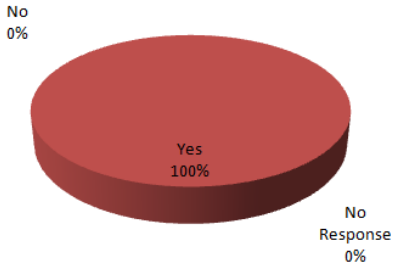
Question 2a: Are the goals of the project technically achievable?



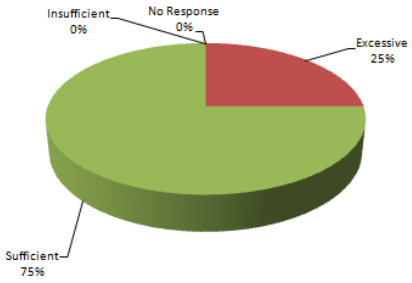
Question 4: How likely is the project team to move technologies into the marketplace?



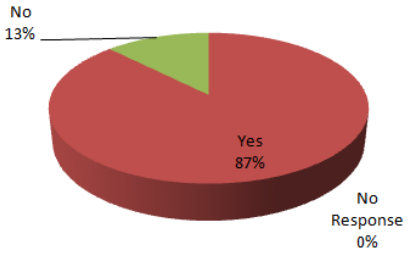
Question 2b: Have the technical barriers been identified and addressed?



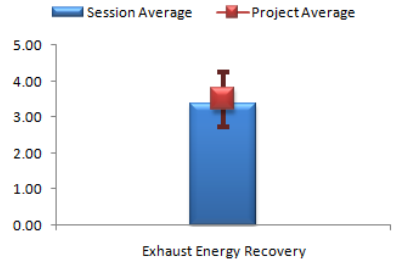
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Heavy Truck Engine Development and HECC (Houshun Zhang, of Detroit Diesel Corporation)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many reviewers commented on the efficiency improvement goals for HD diesel, with one reviewer adding that the project aims at improving efficiency while minimizing emissions via PCCI combustion. One reviewer stated that the project is well aligned with DOE's goals of reducing fuel consumption while satisfying 2010 emissions standards. Another person commented that the path toward 55% BTE appears well defined and thus is in line with DOE objectives. One respondent remarked that the evaluation of technology on transient cycle with multi-cylinder engine is a valuable tool.

One final reviewer wrote that it was refreshing that the strategy (urea SCR + turbo compound) and actual BSFC data/targets are shown. This reviewer added that it is good to clarify R&D project targets as well as production impact (45% in 2013); this is a big improvement over the previous two presentations.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the dual spray-angle injector is exciting, while another person added that it was not shown that the technological barriers could be overcome, but the Delphi FIE system seems promising.

A number of respondents offered suggestions. One person commented that there is a good balance between engine experiments and simulation methodologies. Some complementary optical diagnostics work would be desirable to shed light into performance of variable geometry injection system. Another reviewer remarked that is was impressive that combustion alone is close to achieving goals. This reviewer appreciates the quantitative data of the impacts at A25, A50, B100, etc. How realistic is the variable nozzle technology? Since it is employed over the transient FTP, it seems OK for R&D, but how about production? One other reviewer wrote that the project is only analytically done. There should be some data showing model validation because what the data presented seems too good to be true. What is the true source of the BSFC and emissions reduction?

One respondent felt that this is difficult to assess since so much depends on the proprietary fuel injection strategy. Is this a production viable technology, or only a lab scale demonstration? Another reviewer suggested that the investigators may want to elaborate more on how the efficiency targets are to be met. One final reviewer stated that no detail was shown on how simulation is used to help direct investigations and no fundamental analysis why dual-mode combustion strategy can improve combustion efficiency.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the project scope and organization is impressive. Many tools like CFD and design-of-experiments are being used in this project. Another commented that clear quantitative targets were shown, and the quantitative results provided show results that are in line with previous targets. It is encouraging that the results already show NOx and BSFC improvements in FTP transient

work. This reviewer looks forward to seeing if the same approach can be achieved with HECC over FTP.

One person remarked that the new fuel injection hardware with variable geometry is on its way. It could play a significant role towards the success of the project under dual combustion modes. The lack of detail provided about the hardware configurations and the intended strategies makes it difficult to assess its benefits at this time. More emphasis on controls of transients and mode transitions is highly desirable.

Adding to this, another reviewer commented that there was a significant amount of analytical data shown giving great results, but the models need to be validated. Nothing was shown indicating that the variable nozzle mechanism is on its way to being developed. Hardware demonstration is necessary to both prove the concept and to validate the models. Similarly, one person wrote that the reported numbers for efficiency improvements are quite impressive. However, this enthusiasm must be somewhat tempered until more can be revealed about the "novel" fuel injection strategy that leads to such dramatic improvements. This reviewer looks forward to DDC revealing that information next year when they have their IP issues resolved. One final reviewer stated that some interesting results were shown but the unreliability of a dual injection system and stability of the injection system have not been validated (this technology was used 20 years ago).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first response stated that the Delphi FIE system has great potential, while another person noted that a manufacturer leads the project, thus providing a direct path towards technology deployment. One reviewer indicated that DDC has sufficient resources to being these technologies to the marketplace if/when appropriate. One other person stated DDC should be in a good position to implement into the marketplace, and it is encouraging that the program has goals for R&D as well as the production engine implementation.

One reviewer stated that the likelihood of deployed depends on if the injection system reliability can be improved in the future and the control system can work well. Another person felt that the injector's likelihood of success was unknown, and that this area of explanation needs to be expanded. One final reviewer stated that it is unclear whether the variable nozzle concept being assumed for this project can be manufactured.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the current resources are appropriate for the goals of the investigation, while another remarked there was good progress with the funding provided.

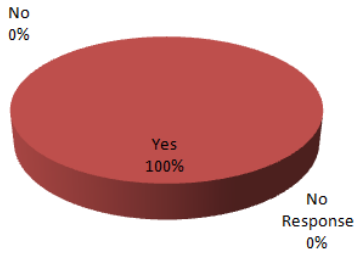
On the other hand, one final respondent indicated that, for the level of funding received, he or she would have expected more than analytical results.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

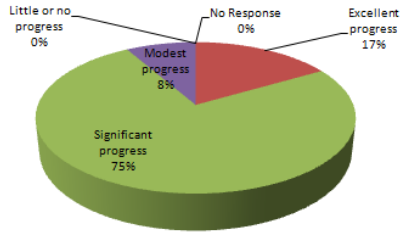
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Heavy Truck Engine Development and HECC

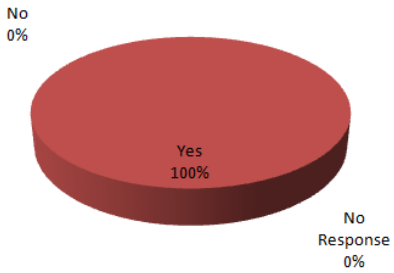
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



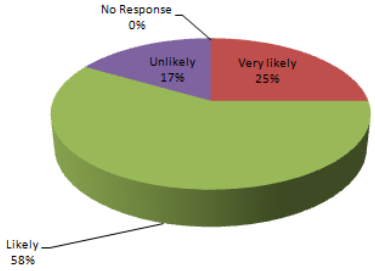
Question 3: Characterize the technical accomplishments and progress toward goals.



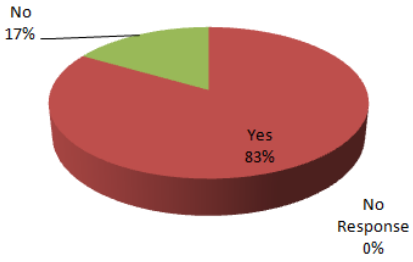
Question 2a: Are the goals of the project technically achievable?



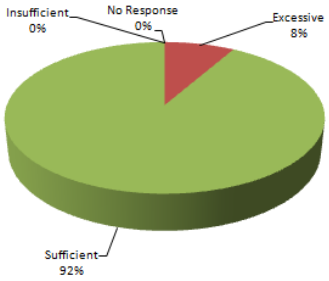
Question 4: How likely is the project team to move technologies into the marketplace?



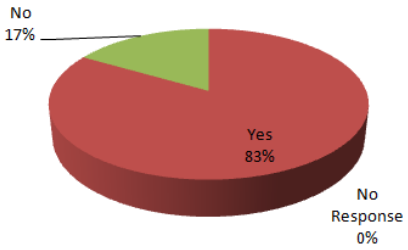
Question 2b: Have the technical barriers been identified and addressed?



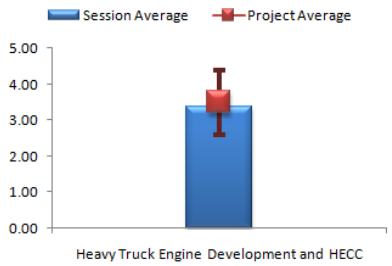
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines (Ken Patton, of General Motors Corporation)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that the group is working on hardware development to enable LTC and HCCI for diesel and gasoline, while another person stated that the goal to improve engine efficiency at constant emissions level is in line with DOE objectives. One reviewer added that the project supports well the DOE objectives of developing hardware for LTC engine designs that support DOE's objectives to improve fuel economy while satisfying Tier 2 Bin 5 emissions. Another individual remarked that gasoline HCCI is potentially an important fuel reduction technology, as well as the diesel HCCI work performed here. One person noted the 2.2L engine demo car was done in 2007.

One final reviewer noted that HCCI in the vehicle has high potential, although it is not clear what the quantitative objectives are. This reviewer asks, can DOE have each program adopt quantitative targets and present these numbers?

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented on the plain good engineering of the project, while another reviewer stated that the project harnesses HCCI R&D efforts internal to GM, as well as those available through the scientific community. It applies the knowledge and understanding to development and packaging of components and sensors required for an actual product. There appear to be good synergies between the gasoline and diesel foci of the project. One other person stated that the two-stage and VVA are the most effective ways to improve BSFC.

One reviewer noted that the program is a little different than others in that it is a design exercise and specifically directed at gasoline engines. Another individual felt that the strategy for deployment was difficult to assess. The in-cylinder pressure sensing on the LD program shows a good opportunity for deployment on either LD or HD engines, but this reviewer does find the admitted lack of interaction between the LD and HD programs at GM a bit disturbing.

One response felt that GM's goals in the project were not clear, while another reviewer indicated that GM has shown a willingness to deploy their advanced technologies in practice, as well as a good sense of realism in their project goals and assessments of potential pitfalls and barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that there is a realistic approach, while another person noted the good, steady progress in this project (on both the diesel and gasoline fronts). One response stated that the LIVC work on the HD program is showing good progress. This reviewer would like to see this continued. Another person stated that the project has already demonstrated the benefits of implementing fully flexible and production-intended VVA systems (alongside the associated HCCI control and transition strategies) in a vehicle. One other reviewer remarked that a lot of the issues with technology commercialization (e.g., camless and cylinder pressure sensors) have been well understood within the industry. This program seems to be set up to address those issues.

One reviewer noted that a 2.2L demo car was presented in 2007, adding that the VVA system may have system stability problems based on the schematic diagram presented. One final reviewer commented that the vehicle demonstration of HCCI seems impressive – but what is the emission level? Is this consideration part of the DOE program?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent indicated that there is a realistic approach, while another reviewer stated that this project has an excellent path towards demonstration, deployment and commercialization. It is an exemplar of transition from basic R&D (GM internal and leveraged from academia such as the GM-CRLs) to development of hardware components and their integration into product deployment. The project will also provide an excellent assessment of HCCI enabling technologies and sensors.

One person remarked that technology transfer must also include the transfer of information from the company to the rest of the (interested) world, such as academic institutions – and not just within GM. Another reviewer added that the presentations did not cover anything other than internal GM interactions (although not between LD and HD!). One SAE publication on the LIVC portion is good to see for some technology transfer. One final reviewer stated that it is not clear that the approaches being looked at are viable – there is no transient control of VVA.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the resources are appropriate for the project's objectives, while another person added that there is a good use of DOE funding to leverage company resources. One respondent added that GM has the technical potential to support the project (based on what was stated in the presentation).

One reviewer indicated that this looks like this is a supporting program. One person asked about how the university and labs were utilized in this project.

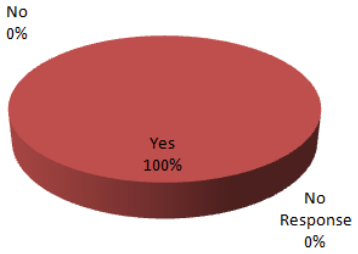
Another response indicated that the level of funding seems low to be spread out over two separate programs for gasoline and diesel. One final reviewer stated the FY08 funding looks small relative to other projects. Does this have carryover from previous years?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

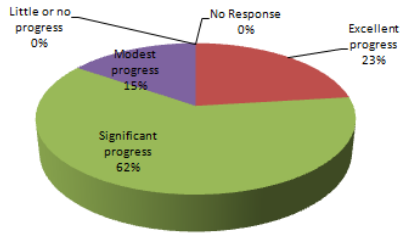
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines

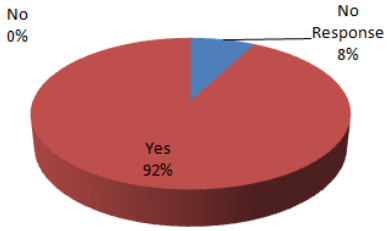
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



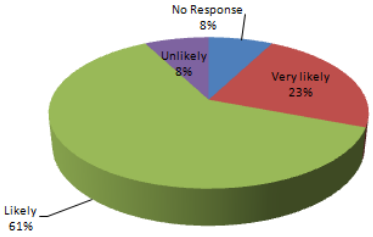
Question 3: Characterize the technical accomplishments and progress toward goals.



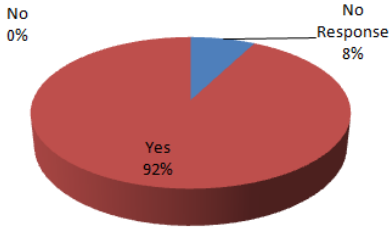
Question 2a: Are the goals of the project technically achievable?



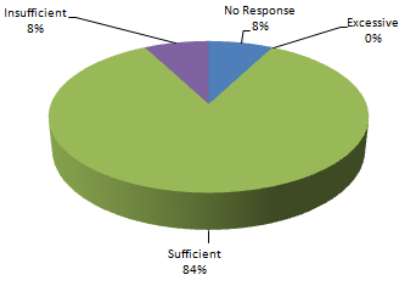
Question 4: How likely is the project team to move technologies into the marketplace?



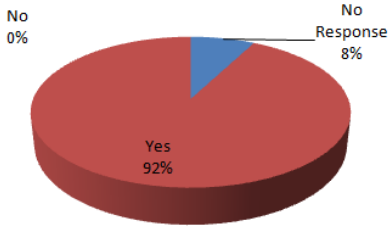
Question 2b: Have the technical barriers been identified and addressed?



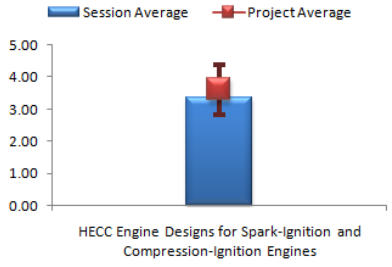
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Light-Duty Efficient Clean Combustion (Tim Frazier, of Cummins Inc.)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive to this prompt, with multiple reviewers commenting that the goal of 10.5% improvement in diesel engine thermal efficiency is in line with DOE objectives and will help to reduce future fuel consumption in the US. One of these reviewers added that the evaluation of biodiesel's impact is important to help make it clear what the introduction of biofuels will mean. Another person stated that, if achieved, it will support the DOE objectives. One other response indicated absolutely yes. This is a very aggressive program that attacks current fuel efficiency penalties associated with meeting future emission standards, and also will look at extending fuel efficiency beyond the penalties imposed by emissions compliance on today's engines.

One reviewer commented that this project is a light-duty diesel enabler – 10% improved city fuel economy (FTP-75) is a key step. This is a multi-pronged technical approach to expand the state of the art. There should be good synergy with the HECC program (high load emphasis) and this program (low load emphasis project) – all programs have good emphasis on controls. One final reviewer stated that many aspects of state-of-the-art HECC technology are being brought to bear on the project.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Multiple reviewers commented that there is a good, thorough plan for project progression. One reviewer added that the project has many items that will be examined, all of which appear reasonable to pursue for light-duty diesel. Another added that there are no results as of yet, since the project just started up, but noted that the fuel sensing capability is a good element of the program. One other reviewer stated that it will be interesting to see how this program progresses.

Similarly, another person indicated that the program has just started – there is only a plan, with no results so far. It seems to have a detailed multi-pronged approach to achieving the goals, and there should be good synergy with the HECC program (high load emphasis) and this program (low load emphasis project) – all of these programs have a good emphasis on controls. One individual stated that the proposed technologies and components to enable meeting fuel economy and emissions deliverables are right on target, and it shows good knowledge of state-of-the-art. He or she is looking forward to see what they can achieve.

To contrast, one reviewer commented that this is a very aggressive project and it will be difficult to attain the 10% peak thermal efficiency improvement. The combination of NOx aftertreatment elimination and advanced wide range turbocharging will improve upon peak thermal efficiency of today's diesel engines. To meet the 10% goal, the contractor will have to meet or exceed efficiency improvement targets in the controls area, LTC area, and air handling system while considering final vehicle integration – this will be difficult. One final reviewer added that fuel injection systems, air handling system, and controls and sensing system of the engine are the current technologies to improve BTE. The last one will be challenging and hard to realize in a production engine.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Most of the reviewers indicated that the program has not really gotten started yet or is a new project. One person stated that this is still in the analysis stage, while another noted the previous questions were not applicable, as this is a new project. Another reviewer remarked that this project is just getting started, and hence the low scores should be disregarded. The proposed plan is impressive, almost too optimistic – e.g. the hope of eliminating the NOx aftertreatment system (especially with turbocharger). This reviewer added that solving the air-plus-EGR handling system may not be done easily.

One final reviewer also stated that the project is in its initial stages. Elimination of NOx aftertreatment is a worthy goal, but needs to be better motivated, as this represents a large portion of the fuel efficiency improvement gain that the researchers anticipate.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer indicated that achievements have a clear path to commercialization for light-duty diesel. One respondent noted that Cummins has a good track record of commercialization, but this project is still in its early days as of yet. Another reviewer added that Chrysler is the partner of Cummins, and the engine developed will be applied in a Chrysler vehicle. Similarly, one reviewer said that Cummins is an OEM and technology transfer will be natural. Mule engines for this technology development can be easily made into product. One person commented that various portions of the technologies targeted for further development within an engine system are likely to find their way into the marketplace given that the lead company is also the manufacturer of the engine system under consideration. At a minimum, it is anticipated that work in the advanced turbocharging and fuel injection system areas will evolve into future engine products. Another person felt the partnership with Daimler-Chrysler is good for helping move results to the marketplace. Is this relationship the same now under the new Chrysler ownership?

One reviewer commented that this program is planning to utilize a number of modest 'stretch' technologies that should be coming available in the next few years. This reviewer added that this is an ambitious goal to eliminate aftertreatment.

One final reviewer expressed some doubt regarding whether or not eliminating NOx aftertreatment is actually viable with US06 requirements and possible LEVIII emissions requirements, even with all of the areas they plan to examine.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that there is good leveraging of DOE funding with industry contribution. Another stated that resources seem to be consistent with HECC program – so there seems to be enough funding and supporting programs available to support this work. One individual remarked that, according to the presentation, it appears that the contractor has adequate overall engineering and financial resources to efficiently address program goals.

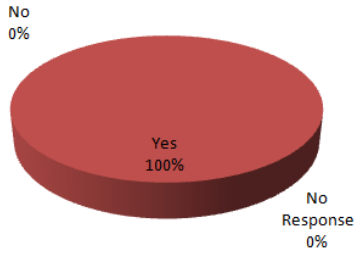
To contrast, one respondent stated that the work plan for FY08 looks a little aggressive for the moderate funding level in the first year. Another commented that there are no visible links to other labs/universities, etc. One final reviewer indicated that, among the technologies mentioned, robust combustion control will be challenging to realize within the expected time period.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

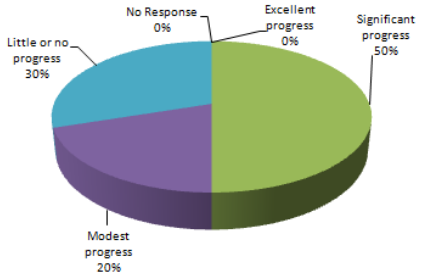
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Light-Duty Efficient Clean Combustion

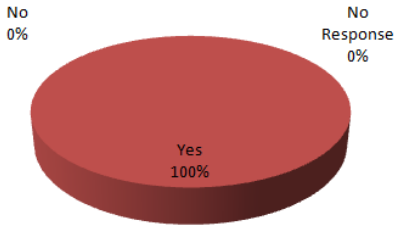
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



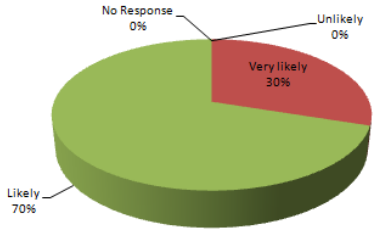
Question 3: Characterize the technical accomplishments and progress toward goals.



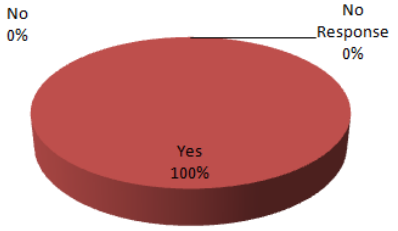
Question 2a: Are the goals of the project technically achievable?



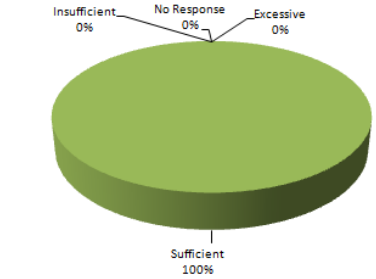
Question 4: How likely is the project team to move technologies into the marketplace?



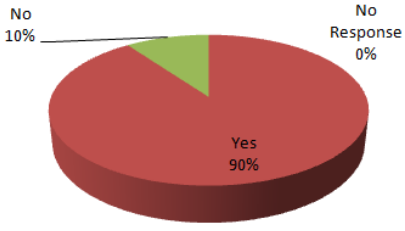
Question 2b: Have the technical barriers been identified and addressed?



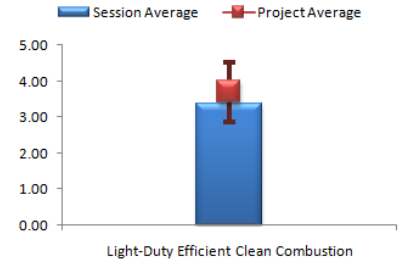
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Cost, Fast Response Actuator (Charles Mendler, of Envera LLC)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that there is a high efficiency improvement potential, while one person commented that this is an enabling technology to support HCCI. Another reviewer indicated that the variable compression ratio has a high potential for fuel efficiency. One individual stated that VCR is supposed to improve engine BTE, while another response said that VCR engine operation is an important potential enabler for both fuel efficiency improvement and for the use of alternative fuels such as higher efficiency octane bio-derived fuels. One other reviewer stated that variable compression ratio hardware that is practical and affordable would make a significant contribution to supporting DOE's fuel economy goals.

To contrast, another reviewer stated that the benefits were indirect. VCR does have benefits for new combustion regimes, but they may not yet be fully developed yet. One other reviewer added that a cost benefit analysis is needed before value can be assessed. One final reviewer remarked that it seems that no one knows if there are any benefits. This VCR concept should be modeled as part of the engine system – cycle-simulation modeling should show the projected benefits first over steady state, and then over a transient excursion. All VCR methods are not created equal, and this reviewer asks what the system technical capabilities are to modify VCR over the engine transient. This reviewer thinks it is good for DOE to invest in a distributed portfolio with high risk/high reward concepts included to some extent – however, high risk projects should be fully evaluated to understand the technical objectives and benefits before building hardware.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the project goals seem reasonable and feasible. Good luck. Another respondent commented that VCR has been demonstrated as a viable tool for advanced combustion. This reviewer would like to see several more competitive concepts like this funded.

One person stated that this is an interesting development of the FEV technology, adding that the movement of the crankshaft and coupling to transmission was not addressed. Another reviewer commented that the objective seems to be to build the system and test it – why not ask a NL or an engine consultant to do some modeling to check this system out? One other respondent stated that the project needs a Ford / GM / Chrysler connection. A project like this needs critical mass or else it is doomed to fail.

Another reviewer stated that full engine testing should address the performance potential of this concept. Similarly, one response indicated the need to demonstrate the ambitious objectives of the new technology in an integrated system. While the hardware is built, its ability to overcome the technical barriers in an integrated fashion has yet to be demonstrated. The project needs to use modeling and simulation tools more to guide hardware development, including multi-body dynamic system simulations. One final reviewer remarked that this concept has a significant number of barriers to clear. It is likely that many of these have probably not even been identified yet until a hardware demonstration has been built and tested.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Responses were generally mixed for this prompt. One reviewer commented on the clever development of the FEV technology with hydraulics and offloaded endpoints, adding that the efficiency potential of 30 % is realistic. Another stated there has been good progress on this project.

One person commented that all of the devices aimed at providing VCR capability are complex and subject to variability / tolerance stack ups, strength and wear, but if successful are enablers for HCCI. This is a good example of high risk and high potential payoff technology. Another reviewer noted that the emphasis looked like it focused on CAD, with no testing – FMEA type work shown. Another person reviewer suggested the technology needs an OEM to prove its ability to reduce fuel consumption.

One respondent felt that it is difficult to assess the technical accomplishments based on the very limited information disclosed. The project has developed hardware, but it is hard to assess if it has the potential to meet the project's ambitious goals. One final reviewer stated that, from the presentation, it was difficult to tell which accomplishments were from this last year. This reviewer is not sure this project is making progress at a rate that will overcome the major technical challenges ahead of it in the near future (less than 5 years).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses were generally negative to this prompt. One reviewer simply commented that he or she has been waiting for someone to advance this technology, while another said that technology transfer will increase the closer to production feasibility this technology comes. One reviewer suggested that Envera needs to work more closely with engine OEMs to enhance the commercialization prospects of the system. There does not appear to be any current interest from US manufacturers. Similarly, one person stated that the lack of any industrial partnerships is going to make this difficult to get into the marketplace, while another felt that, without commitment by an OEM, a project like this does not have a chance to demonstrate its potential. One other person stated the concept is potentially an enabler for HCCI but the hardware needs to be proven on a running engine.

Other reviewers expressed cost / manufacturing concerns. One respondent indicated that, based on currently available data, there is no reason to expect any real advantage. Another person thought that this would take a long time to develop because of the high risk. One reviewer stated that the cost, weight and increased package space will make this technology unattractive. One final reviewer stated that this technology may have applications in niche vehicles, but large market penetration will be difficult.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that there was good leveraging of DOE funds in this project. Another person commented that, although this project is modestly funded, it needs a manufacturer to join in the effort, which looks like it may come from Mercedes in the future. One other reviewer noted the project needs full involvement and commitment from an OEM.

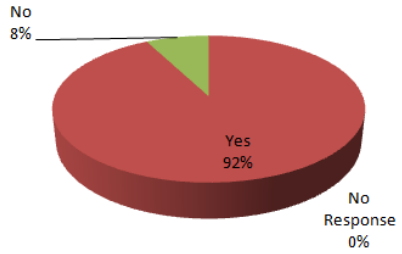
One person felt that not enough information has been presented on the total funding of the project, so it makes any assessment difficult. Generally, the development, control, and demonstration of a practical VCR system require a significant investment. One final reviewer asked if detailed stress analysis has been done on a multicylinder arrangement.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

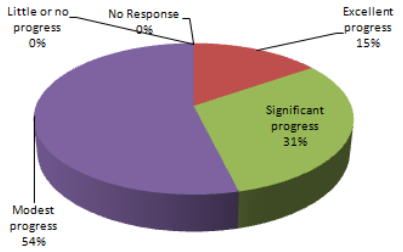
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Cost, Fast Response Actuator

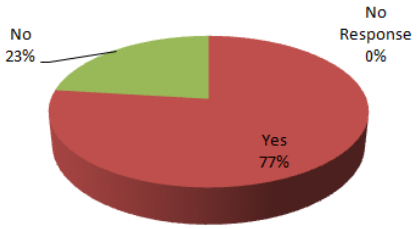
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



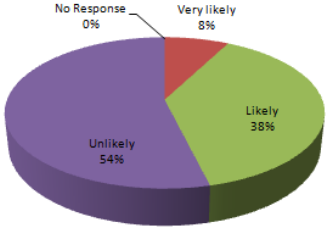
Question 3: Characterize the technical accomplishments and progress toward goals.



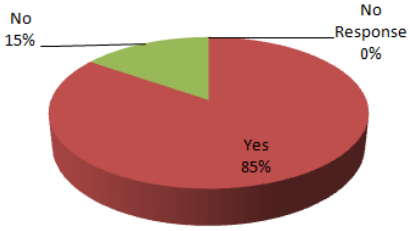
Question 2a: Are the goals of the project technically achievable?



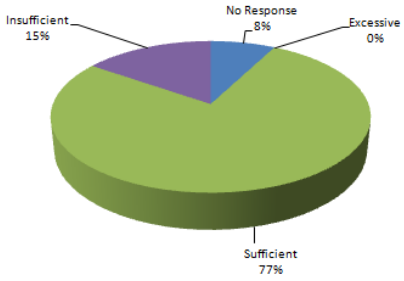
Question 4: How likely is the project team to move technologies into the marketplace?



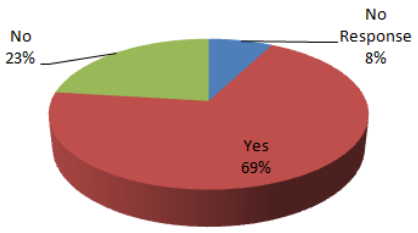
Question 2b: Have the technical barriers been identified and addressed?



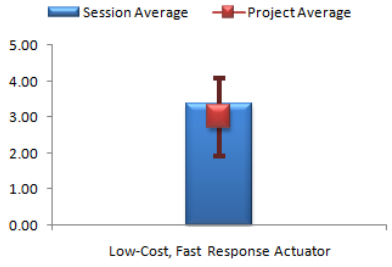
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low-Temperature Combustion Demonstrator for High-Efficiency Clean Combustion (Willy Ojeda, of Navistar Inc.)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer highlighted the improved efficiency, while another person indicated that the goal of the project is to improve fuel economy and reduce emissions. One individual commented that this is an extremely low-cost, high-return project that will result in appreciable fuel consumption reductions in next generation engines. Another reviewer remarked that the LTC project supports DOE objectives of improving fuel economy while satisfying emissions constraints.

One response said there is good work on pushing the upward load limit on a medium-duty operating in HECC mode. This project does address DOE's fuel economy improvement goals, but does not appear to be as aggressive as other engine OEMs. This could be based on the fact that the presentation was shortened and this reviewer did not participate last year.

To contrast, one reviewer remarked that there is nothing new being done. This seems like a standard development project – what are the quantitative targets/objectives? One final respondent felt there was not much info presented about the achieved or expected BTE on this program. This reviewer assumes since it is LTC work that it is there, if not explicitly.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that this is nice application work with a focus on known problems, while another felt that there was a good balance among modeling/simulation and experiments, adding that the involvement of Conoco/Phillips on the fuels side is a plus. One person indicated that the program looks to be on a good path to keep the work production viable, which will enable deployment. Another reviewer stated that the project goals are well established, and technical barriers are laid out. The project team seems to have a good idea of the problems facing them, and the approach is realistic.

One reviewer commented that it is not clear on what the quantitative goals are. The technologies chosen appear to be production viable - new technology is added (in-cylinder pressure sensing and VCR?) but what is the benefit to BSFC? What is the NOx reduction potential? Some barriers were presented – EGR distribution, combustion tradeoffs – but these are normal development tasks – not advanced R&D. Another individual remarked that the goals are nebulous, and it would be nice to see performance targets. One technical barrier is focused on wide range diesel fuel with a cetane number that varies from 42 to 58. The presentation did not directly address this variance though maybe this work was done in the past? Another possible barrier that was not mentioned is the volatility variances - does this PI believe this fuel property variance is an issue? One final reviewer stated that the presenter presents solid steps and plans how to reach the target through modeling and simulation, injector hardware optimization, and control supervisor. But they have not mentioned how to improve the charge system to improve thermal efficiency.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer stated that this is nice application work with a focus on known problems. Another commented that the project has made excellent progress and has a good path laid out for the future. This seems to be excellent leveraging of DOE funding for a well-run project that has a good chance of technical success. One other reviewer remarked that achieving 11 bar BMEP at 3000 rpm is great. This reviewer is looking forward to the publishing of the fuel effects results, adding that there is good collaboration with LLNL on the chemical kinetics.

One person commented that the data on the alternative sensor for in-cylinder pressure sensor was slim but sounds like it is an interesting technology. More data and analysis next year would be informative. Another reviewer indicated that this project seems to still be in an early stage. For example, the variable compression ratio hardware appears to be still under development and its ability to enable HECC still has to be explored in much more detail. The presentation did not show systems integration issues for a medium-duty application; such analysis would be beneficial in assessing the actual impact of engine control/hardware changes on vehicle fuel economy. For example, it appears the engine under investigation is utilizing more and more EGR; what is the impact on cooling and parasitic losses?

One final reviewer stated very low resources are allocated – so results have been shown, but the results look like traditional development type of work. The reviewer heard that the funding level $125K is not indicative of the total funding – if the funding level is really higher, then the results shown would be disappointing. What are the results toward BSFC improvement?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer felt that this was nice application work with a focus on known problems. Another person indicated that International has a good track record of commercialization of DOE-funded results, and the company seems eager to incorporate technologies developed in projects such as this. Similarly, one reviewer stated that International appears to be on a focused path to keep the technologies they are exploring on a production viable path.

One respondent stated that portions of this overall HECC technology are likely to move into the marketplace such as variable valve timing and advanced fuel injection strategies. Other portions of the hardware development such as the variable compression ratio hardware will require much additional development beyond this program.

One final reviewer indicated that the benefits or the expectations from the project technologies shown were uncluear. This reviewer does not see any real advantages to the market as a result of the work presented.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One of the reviewers indicated that this project seems to be severely limited by the constraints of its budget. Its results far outweigh the limited DOE investment involved. Another person added that there are very low resources allocated, but almost no results toward the objectives either. It was not clear, but seems like it may be rather low.

One person commented that this is a good program that appears to have the necessary funding, human resources, experimental, and computational resources to execution of the proposed work scope.

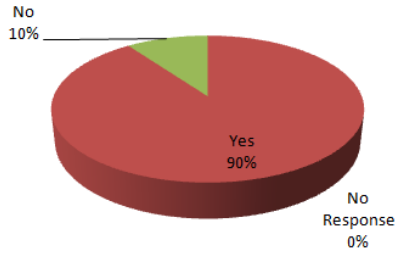
One final reviewer said that this was difficult to assess with the number reported for FY08.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

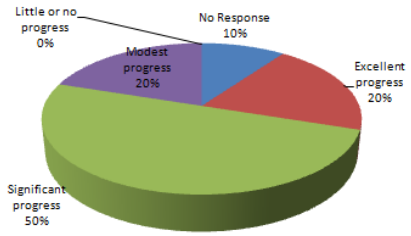
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low-Temperature Combustion Demonstrator for High-Efficiency Clean Combustion

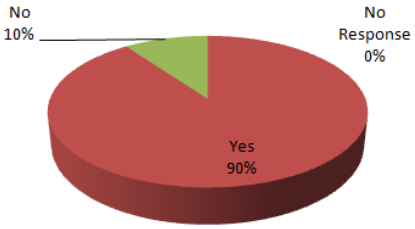
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



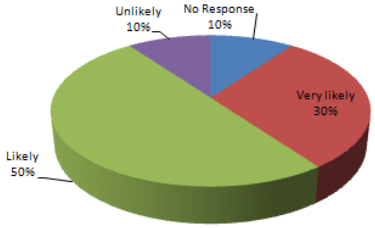
Question 3: Characterize the technical accomplishments and progress toward goals.



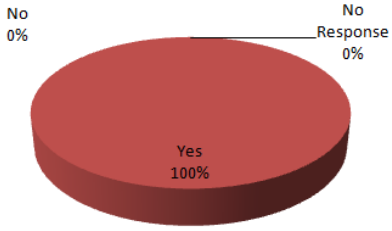
Question 2a: Are the goals of the project technically achievable?



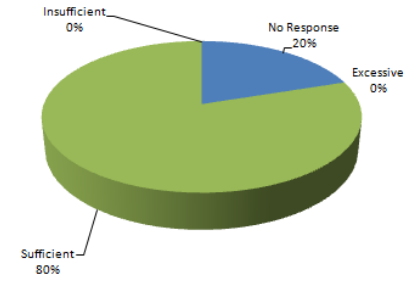
Question 4: How likely is the project team to move technologies into the marketplace?



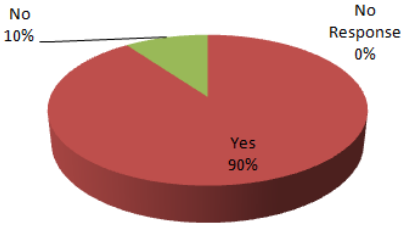
Question 2b: Have the technical barriers been identified and addressed?



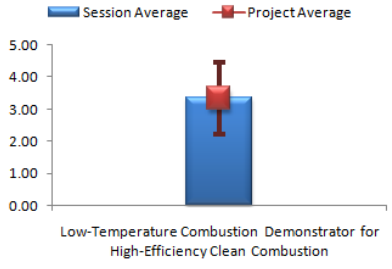
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Narrow-Band Engine and a CVT to Optimize Performance (Bahman Habibzadeh, of Mack Trucks Inc.)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this will increase efficiency in diesel, while another person stated that it is an interesting approach to reaching the 10% goal. Adding to this, one reviewer commented that optimized vehicle fuel efficiency will reduce future fuel use in truck-based transportation, so looking at the vehicle as a whole is important. Another person remarked that this is a good analysis of the up-front benefits to the technology and implementation on the vehicle. This person added that a simple cost analysis is included, but no information on the whole package (CVT and vehicle integration, for example).

One reviewer indicated that, yes, this high risk concept has to be viewed from a vehicle-level perspective which, if the CVT is as efficient as advertised, should lead toward vehicle-level fuel efficiency gains without consideration of a narrow band engine. One final respondent noted that compound TC is not a new technology used in diesel engines, but it does improve engine efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the goals and strategies are sound, adding that the CVT development is the responsibility of a third party and is a critical path item, especially for a late 2008-early 2009 deadline. One reviewer indicated that the compound turbine is not newly proposed technology, but there still are some barriers to be overcome / identified, such as (1) TC transient response on engine performance and (2) friction effect.

Multiple reviewers commented on proving the CVT technology. One person stated there was no info on CVT design – without the CVT's ability to keep the engine speed range narrow, this reviewer is not sure if the deployment of the technology is feasible. It seems that the concept must be integrated into a vehicle to make it work – this reviewer is not sure why this is not shown. One reviewer stated that the CVT torque limit concerns need to be addressed, while another expects the torque capability to be an issue, and a third person felt that there need to be more details on the CVT design for such high torque levels. One reviewer said the risk on the CVT is an unknown and it is not indicated as a potential risk at all. Since this approach relies on the CVT to reach the goal, it would be good to give more information about that system to understand how production-ready it really is.

One respondent said the CVT is a key part of this concept. The CVT enables narrow speed operation, which in turn enables efficiency optimizations in the engine-turbo and waste-heat-recovery turbo. But the CVT seems high risk, yet it was not included in the list of barriers. What stage of development is the Eaton CVT? Is it even possible to develop such a high-torque CVT? No information was presented on the CVT technology. Without more details, this seems like an Achilles heel of the program, and therefore there should be more focused initially on this component. At the next review opportunity, the risk involved with the Eaton CVT should be presented and discussed. In fact, why not invite Eaton to present their progress?

One final reviewer wrote that this targeted CVT duty cycle efficiency of 95% is very optimistic. Overall program goals are contingent on the CVT itself, but work on the turbocompound device could be valuable in the future without consideration of the overall powertrain concept.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer noted that good progress shown on the turbo compounding, while another respondent stated the real value of this project is yet to come. We need to see the real-world CVT device to assess if the fuel economy gains are real. Simulations are valuable to assess limits on fuel economy gains, but overall integration will answer this question.

One reviewer specifically commented that the current progress is based on simulation, while another person remarked that, due to the CVT, this project has a dark cloud hanging over it and this will affect the perception of progress. One individual felt that the project has shown only modest progress – a lot of simulation and slippage of deadlines, but not much else. The efficiency improvements due to the CVT seem minimal – idle reduction gets a 5%+ improvement with minimal hardware modification. One final reviewer stated it was perhaps too early for this determination, but the preliminary work has been completed – the fully assembled engine will be more interesting.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that turbocompounding seems a shoo-in for implementation (low risk); however, the widespread use of CVTs in HD applications seems unlikely (high risk). This project seems to marry two completely different technologies of two widely different risk levels – is one dependent on the other, in terms of implementation? One reviewer said that Mack and Volvo have sufficient internal resources to bring these technologies to the marketplace if/when appropriate, while another person added that, if the project succeeds, since Volvo is an OEM it will be relatively easy to take it to production.

One response stated that Volvo is in a good position to commercialize the technology, adding that the big unknowns are the CVT and the turbo matching to the engine. Cost is the ultimate barrier to integration and market introduction. Another reviewer stated that torque limitations are likely to make this technology hard to adapt to HD diesel. One final reviewer commented that CVT for heavy-duty use could find its way into the heavy-duty sector in the future if its wide operating range efficiency can exceed today's finite gear range transmission technology. This program has too aggressive fuel economy goals that hinge on a narrow band engine and a very efficient CVT. Both the engine and CVT are high risk from a performance perspective viewpoint.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the budget seems suitable and matches the progress so far. One person added that it appears the contractor has sufficient experimental and analytical resources. They may need additional money to develop the CVT to meet the 95% plus efficiency goal. Another reviewed commented that it was stated during the presentation that 4-5 engineers were working at four Volvo centers. A total of 16-20 engineers (along with usual support staff and infrastructure) seems like a lot of work-in-kind. On the other hand, the handout did not include a dollar figure for the funding for this project, so it is really difficult to accurately rate the resource level.

Following up on this last point, one reviewer stated that no resource information was provided, and another person said that funding wasn't shown to merit reviewers for this project. Similarly, one final

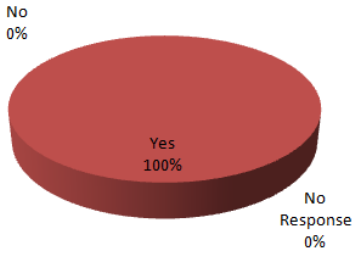
reviewer stated that no dollar amount given for this year, so he or she is not sure how to evaluate this. The reviewer assumed that it is sufficient, for lack of any supporting information.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

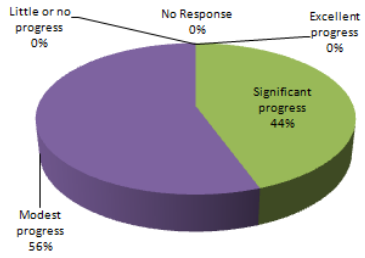
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Narrow-Band Engine and a CVT to Optimize Performance

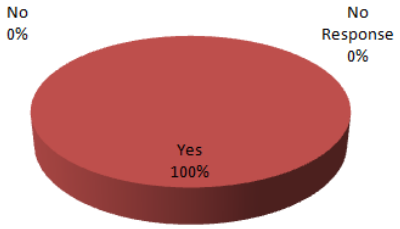
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



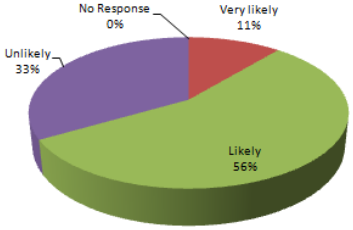
Question 3: Characterize the technical accomplishments and progress toward goals.



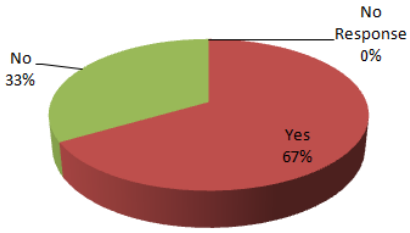
Question 2a: Are the goals of the project technically achievable?



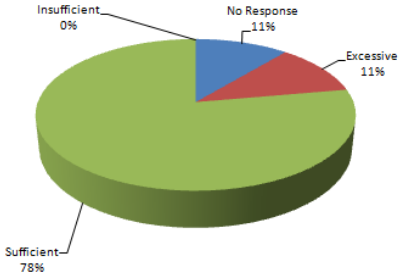
Question 4: How likely is the project team to move technologies into the marketplace?



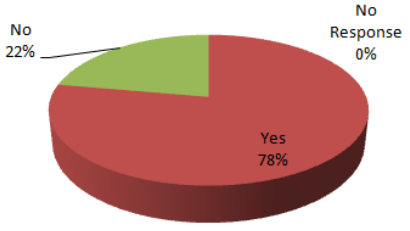
Question 2b: Have the technical barriers been identified and addressed?



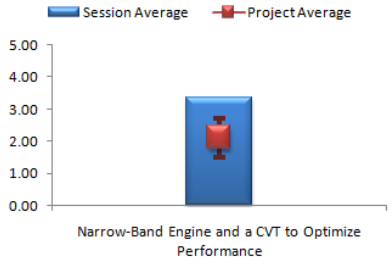
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



On-Board Engine Exhaust Particulate Matter Sensor (Matt Hall, of University of Texas at Austin)

Reviewer Sample Size
This project had a total of 12 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Results to this prompt were generally positive. One reviewer stated that it supports an enabling technology for diesel, while another believes that a real-time PM sensor can be important in mixed-mode combustion, adding that this could be an enabling technology. One person stated that it helps in the monitoring and feedback control of LTC engines to minimize PM emissions. Another commented that a PM sensor is an auxiliary for HECC/HCCI and diesel engines. One response stated that there are very promising results for not just LTC, but also conventional direct-injection gasoline development. One other reviewer commented that an on-board PM sensor would be useful in developing control strategies to meet PM emissions from diesel engines.

One respondent stated yes, but only indirectly – it is an enabling technology that may or may not be of interest to OEMs (how many OEMs plan to use NOx sensors in near-term production, for example?).

One final reviewer asked: Why is there no correlation of the PM sensor to opacity or PM measurements or smoke? What is the potential of the technology? Why does it support DOE objectives? Since the developers are not sure how the technology works – why not study this and make sure the concept is understood and proper correlations are made to avoid wasting time and resources?

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that the approach proposed is feasible, while another noted that this sensor is of interest for advanced combustion technologies. One other reviewer commented that various designs of sensors are being constructed and tested. One person remarked that good progress has been made with the design improvements made from the original concept. It is good to see a sensor manufacturer show some interest in this and contribute their expertise to this project.

Another reviewer commented that the need for good sensors is vast. The vehicle manufacturers are responsible for maintaining and diagnosing emissions. Filter regeneration is difficult and this will help. One response stated that it will be critical for the success of the project to develop a better understanding of the underlying physics of the sensor; otherwise a cut-and-dry approach is unlikely to overcome the significant technical challenges. Similarly, one reviewer said it is still not clear that the physics are well understood. Further investigation here may result in a more robust product.

One respondent wrote that it is not clear what is different and better about this sensor over other sensors being developed. One final reviewer asked: why is there no correlation of the PM sensor to opacity or PM measurements or smoke? What is the potential of the technology? Why does it support DOE objectives? Since the developers are not sure how the technology works – why not study this and make sure the concept is understood and proper correlation is made to avoid wasting time and resources?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer stated that the results have shown linear volt-soot mass behavior, adding that this is impressive work. Another person commented that the design has evolved considerably since the last review.

One other response indicated that the design improvements for reliability look to be on target. It would be nice to see better correlation with some standardized PM sampling method. One reviewer added that more improvement in design is still desired to capture PM signal constantly, adding that the project has lot of works to do before calibration.

Another response stated that greater fundamental understanding of the electromagnetic aspects of this technology is essential to overcome issues of reliability, drift and potential degradation. Foil electrodes sound too fragile for commercial use – what about thick, curved stainless steel electrodes set in a ceramic rod? Similarly, one reviewer asked, since the developers are not sure how the technology works – why not study this and make sure the concept is understood and proper correlation is made to avoid wasting time and resources? Why is there no correlation of the PM sensor to opacity or PM measurements or smoke? What is the potential of the technology? Why does it support DOE objectives?

One final reviewer noted that the project is still in the start-up phase, which is understandably slower. Setting up a multi-cylinder engine and controlling it under multi-mode (diesel/HCCI) operation are substantial tasks that will require time. Unfortunately, this will take away time and resources from the development of the sensor. This reviewer asks: would it be possible to focus the project on sensor development and collaborate with another academic group and/or industrial partner to evaluate the sensor in a multi-cylinder engine? This should include consideration of the effects of engine vibration on sensor life, as well as an exploration of sensor performance in transients.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that this project addresses a big need and seems inexpensive, while another reviewer commented that an operating, reliable, low cost sensor will provide its own marketing.

One respondent remarked that deployment is likely, provided that strong partnerships with OEMs are developed. Cummins' early involvement in the project and the recent interest by Ceramatek are encouraging. Another indicated that work is being done in collaboration with Cummins. One person commented on the need to increase the activity with a sensor manufacturer, while (in contrast) one person stated that the strong interest apparently from both an engine OEM and sensor manufacturer makes this already a reality. With more reservation, one response indicated that, at the very least, this type of sensor would be useful for the development of DI engines, both gas and diesel.

One final reviewer asked: why is there no correlation of the PM sensor to opacity or PM measurements or smoke? What is the potential of the technology? Why does it support DOE objectives?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated there that has been good progress for a small program, while another similarly remarked that there has been good progress on a limited budget. One person stated that the resources are appropriate for the project's objectives related to sensor development. Leveraged funds will be

required for the setup of a modern multi-cylinder diesel engine facility, or the latter should be pursued through collaboration with a partner.

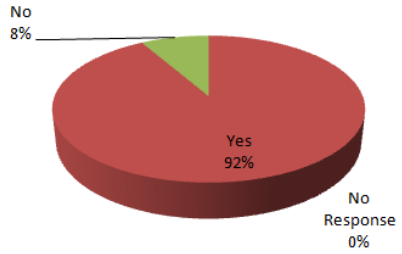
One final reviewer commented on that very limited funding – the presenter mentioned correlation data would be included in the upcoming SAE meeting. In this DOE review, several presenters mentioned the data would be published in SAE papers – why not present technical results at these DOE sessions? The lack of technical data is disappointing.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

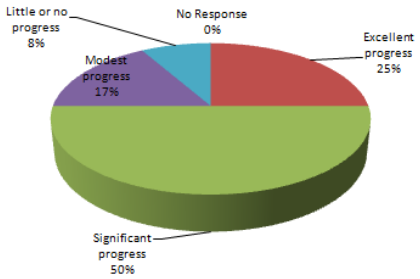
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: On-Board Engine Exhaust Particulate Matter Sensor

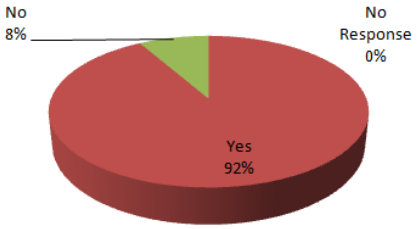
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



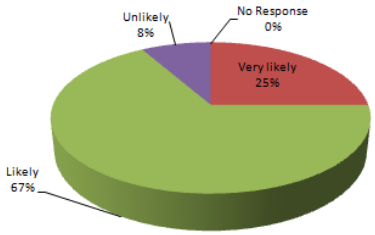
Question 3: Characterize the technical accomplishments and progress toward goals.



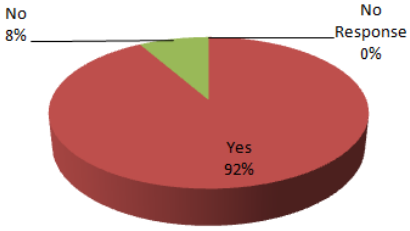
Question 2a: Are the goals of the project technically achievable?



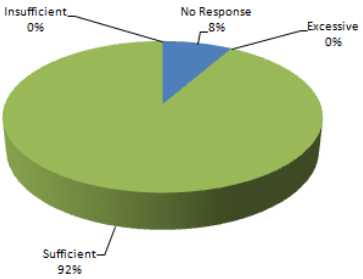
Question 4: How likely is the project team to move technologies into the marketplace?



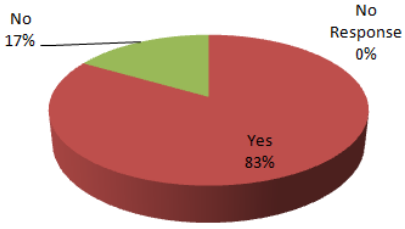
Question 2b: Have the technical barriers been identified and addressed?



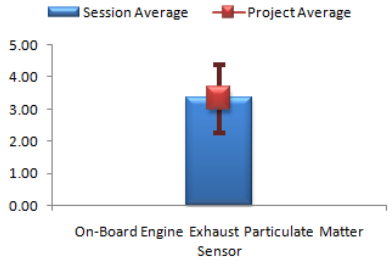
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Variable Valve Actuation (Jeff Gutterman, of Delphi Automotive Systems)

Reviewer Sample Size
This project had a total of 13 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that the group is working on VVA hardware development to enable LTC and HCCI, while another person stated they are working on a mechanism to enable VVA to enable LTC combustion. One respondent commented that VVA is one of the "holy grail" quests for advanced combustion. Another response stated that the benefits of VVA on opening up opportunities for efficiency improvement are well documented. One other reviewer remarked that the project is developing critical to VVA hardware for production-intent LTC/HCCI engines, thus supporting the DOE fuel economy objectives. Another person commented that VVA is potentially important technology for enabling LTC or mixed mode operation, as well as improving the fuel efficiency of conventional engines. Applications to CI and SI engines are equally applicable. One reviewer noted that the VVA project was initiated to support VT High Efficiency, Clean Combustion Enabling Technologies. The group is working to develop a practical, production-worthy VVA system that will have widespread use across many engine platforms.

To contrast, one reviewer stated yes, but specific designs can be difficult to incorporate into the existing OEM architecture. One final reviewer didn't know – slides claim that the VVA advantages are well known – but also that a compromised VVA system that is feasible is better than an idealistic VVA system that is never produced commercially – but the compromised VVA design should outline specific advantages and objectives. This reviewer added that in the future DOE should have each presentation outline specific quantitative targets/goals/metrics for clarification purposes.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Multiple reviewers commented that this project is a realistic and practical approach to get an affordable system for use in IC engines. Another reviewer commented that the project is using an appropriate balance of simulation tools and hardware development. One person stated that production feasibility seems close.

One reviewer noted that the technology is being designed into a GM engine – this is good. It is also being designed into a cradle that can be tuned to other engines easily – this makes sense. How does this compare to other commercially available VVA (lift and timing) systems (BMW, Nissan, Toyota…)? Another reviewer indicated that Delphi has made excellent progress on making this technology viable for a production engine. One final reviewer noted this could be used for a variety of purposes on both exhaust and intake cams.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the program appears to be on schedule and meeting its goals for providing a viable VVA enabling technology for OEMs. Another person indicated that this is a relatively low cost idea that seems to have some potential, while one other person stated that the flexibility looks good and consistent with Russ' presentation on IVC techniques from GM. One reviewer remarked that multicylinder engine operation is the next important step in this development program.

One response noted that the product is being used in dynamometer testing, while another stated that the project seems to have come to a conclusion.

One final reviewer commented that the project has benefited from the collaboration with GM. Collaboration with more OEMs would be desirable to develop hardware that could support a range of VVA strategies contemplated by various OEMs. Exploration of benefits on the diesel side has yet to be done. This reviewer added that the project should report on benchmarking against other production-intent systems reported in the literature and articulate its advantages/limitations.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that this is a realistic approach. Another respondent commented that this is a cost effective mechanism compared to full camless. One person felt that this technology can be deployed and if the mechanism is cost effective and can be packaged. Another reviewer stated production feasibility was designed in from the start.

One reviewer noted that Delphi is working directly with one of the OEMs (GM) to support its programs. Similarly, another felt that Delphi seems to be keen on commercialization, and so we can conclude that technology transfer and market introduction is only a matter of time. One person stated that this looks to be a very viable option for doing VVA in a production environment. More specific information on interactions with OEMs would be helpful to know how close this really is to commercial production.

One individual commented that the cost/package/complexity looks very high. Another person added that the key issue is cost – every diesel engine already has significant cost issues, and VVA increases the complexity and cost. This reviewer added that other aspects of the program seem well-suited for commercialization. One final reviewer stated that the benefit of the system does not appear to be worth the cost, weight, and packaging space issues that come with it.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

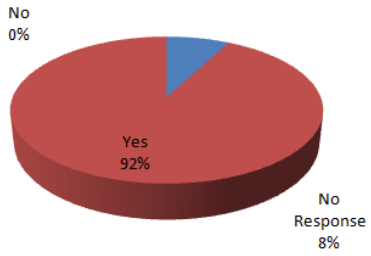
One reviewer stated that the resources are appropriate for the project's objectives over the duration of the program. Another person stated that the DOE funding seems to be well-leveraged and well used. One final reviewer added that the accomplishments look good for the modest funding level (at least in FY08).

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

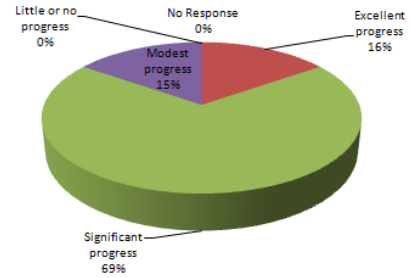
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Variable Valve Actuation

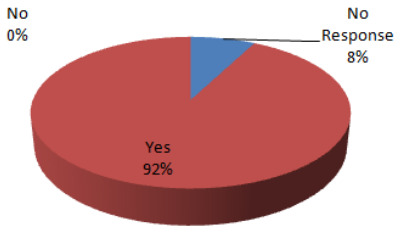
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



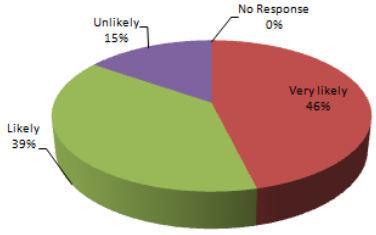
Question 3: Characterize the technical accomplishments and progress toward goals.



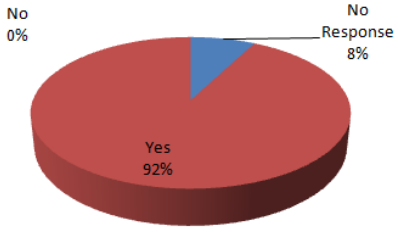
Question 2a: Are the goals of the project technically achievable?



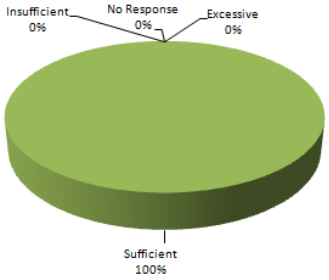
Question 4: How likely is the project team to move technologies into the marketplace?



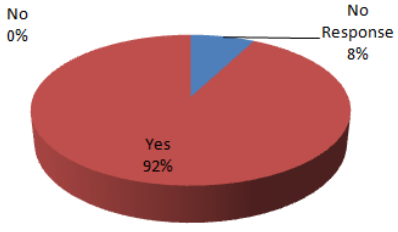
Question 2b: Have the technical barriers been identified and addressed?



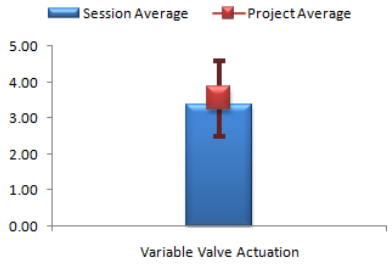
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



9. Emission Control and Aftertreatment

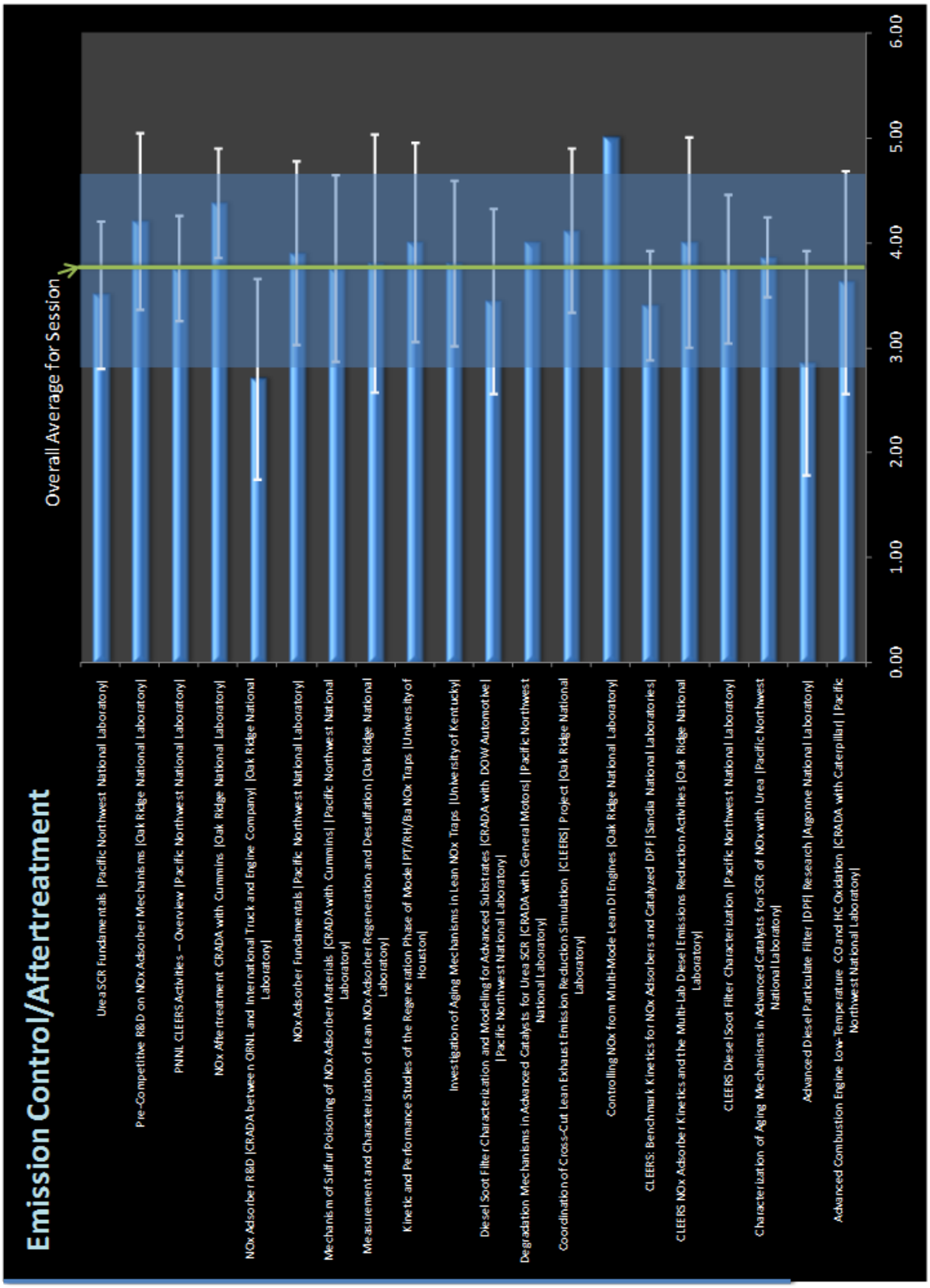
Introduction

Increased use of advanced combustion engines in light-duty vehicles requires compliance with the U.S. Environmental Protection Agency's (EPA's) Tier 2 regulations which are phasing in from 2004-2009. The Tier 2 regulations require all light-duty vehicles to meet the same emissions standards, regardless of the powertrain. Compliance can be achieved with advanced combustion engines through the addition of emission control technologies, though these technologies are much less mature than gasoline engine catalysts and are severely affected by sulfur from the fuel and lubricant. Even the recent reduction of diesel fuel sulfur content to below 15 ppm does not assure that catalytic emission control devices will be durable and cost-effective. This work seeks to improve the effectiveness, efficiency, and durability of engine emission control devices to enable these engines to achieve significant penetration in the light-duty market and maintain their application in heavy-duty vehicles.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
9-4	Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) (Jonathan Male, Pacific Northwest National Laboratory)	3.63	1.06
9-7	Advanced Diesel Particulate Filter (DPF) Research (Kyeong Lee, Argonne National Laboratory)	2.86	1.07
9-10	Characterization of Aging Mechanisms in Advanced Catalysts for SCR of NOx with Urea (Charles Peden, Pacific Northwest National Laboratory)	3.86	0.38
9-13	CLEERS Diesel Soot Filter Characterization (Charles Peden, Pacific Northwest National Laboratory)	3.75	0.71
9-16	CLEERS NOx Adsorber Kinetics and the Multi-Lab Diesel Emissions Reduction Activities (Jae-Soon Choi, Oak Ridge National Laboratory)	4.00	1.00
9-21	CLEERS: Benchmark Kinetics for NOx Adsorbers and Catalyzed DPF (Richard Larson, Sandia National Laboratories)	3.40	0.52
9-25	Controlling NOx from Multi-Mode Lean DI Engines (Jim Parks, Oak Ridge National Laboratory)	5.00	0.00
9-28	Coordination of Cross-Cut Lean Exhaust Emission Reduction Simulation (CLEERS) Project (Stuart Daw, Oak Ridge National Laboratory)	4.11	0.78

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
9-32	Degradation Mechanisms in Advanced Catalysts for Urea SCR (CRADA with General Motors) (Charles Peden, Pacific Northwest National Laboratory)	4.00	
9-34	Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive) (Darrell Herling, Pacific Northwest National Laboratory)	3.44	0.88
9-37	Investigation of Aging Mechanisms in Lean NOx Traps (Mark Crocker, University of Kentucky)	3.80	0.79
9-41	Kinetic and Performance Studies of the Regeneration Phase of Model PT/RH/Ba NOx Traps (Mike Harold, University of Houston)	4.00	0.94
9-45	Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation (Jim Parks, Oak Ridge National Laboratory)	3.80	1.23
9-50	Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) (Charles Peden, Pacific Northwest National Laboratory)	3.75	0.89
9-53	NOx Adsorber Fundamentals (Charles Peden, Pacific Northwest National Laboratory)	3.90	0.88
9-57	NOx Adsorber R&D (CRADA between ORNL and International Truck and Engine Company) (Todd Toops, Oak Ridge National Laboratory)	2.70	0.95
9-61	NOx Aftertreatment CRADA with Cummins (Bill Partridge, Oak Ridge National Laboratory)	4.38	0.52
9-64	PNNL CLEERS Activities – Overview (Darrell Herling, Pacific Northwest National Laboratory)	3.75	0.50
9-67	Pre-Competitive R&D on NOx Adsorber Mechanisms (Jae-Soon Choi, Oak Ridge National Laboratory)	4.20	0.84
9-70	Urea SCR Fundamentals (Jonathan Male, Pacific Northwest National Laboratory)	3.50	0.71
	Overall Session Average and Standard Deviation	**3.73**	**0.92**


Emission Control/Aftertreatment
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Urea SCR Fundamentals |Pacific Northwest National Laboratory|
Pre-Competitive R&D on NOx Adsorber Mechanisms |Oak Ridge National Laboratory|
PNNL CLEERS Activities – Overview |Pacific Northwest National Laboratory|
NOx Aftertreatment CRADA with Cummins |Oak Ridge National Laboratory|
NOx Adsorber R&D |CRADA between ORNL and International Truck and Engine Company| |Oak Ridge National Laboratory|
NOx Adsorber Fundamentals |Pacific Northwest National Laboratory|
Mechanism of Sulfur Poisoning of NOx Adsorber Materials |CRADA with Cummins| |Pacific Northwest National Laboratory|
Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation |Oak Ridge National Laboratory|
Kinetic and Performance Studies of the Regeneration Phase of Model Pt/Rh/Ba NOx Traps |University of Houston|
Investigation of Aging Mechanisms in Lean NOx Traps |University of Kentucky|
Diesel Soot Filter Characterization and Modeling for Advanced Substrates |CRADA with DOW Automotive| |Pacific Northwest National Laboratory|
Degradation Mechanisms in Advanced Catalysts for Urea SCR |CRADA with General Motors| |Pacific Northwest National Laboratory|
Coordination of Cross-Cut Lean Exhaust Emission Reduction Simulation |CLEERS| Project |Oak Ridge National Laboratory|
Controlling NOx from Multi-Mode Lean DI Engines |Oak Ridge National Laboratory|
CLEERS: Benchmark Kinetics for NOx Adsorbers and Catalyzed DPF |Sandia National Laboratories|
CLEERS NOx Adsorber Kinetics and the Multi-Lab Diesel Emissions Reduction Activities |Oak Ridge National Laboratory|
CLEERS Diesel Soot Filter Characterization |Pacific Northwest National Laboratory|
Characterization of Aging Mechanisms in Advanced Catalysts for SCR of NOx with Urea |Pacific Northwest National Laboratory|
Advanced Diesel Particulate Filter (DPF) Research |Argonne National Laboratory|
Advanced Combustion Engine Low-Temperature CO and HC Oxidation |CRADA with Caterpillar| |Pacific Northwest National Laboratory|

Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) (Jonathan Male, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that HCCI offers potential to significantly reduce engine-out NOx - furthermore this topic is essentially developing a scheme to design a new oxidation catalyst chemistry - very cool if it works. Another reviewer cited this was an excellent CRADA dealing with low temperature combustion. One reviewer commented that low temperature DOC function is critical for HCCI, and also for idle and low load diesel engines.

One reviewer commented that improved low temperature performance of oxidation catalysts will reduce petroleum use by reducing the need for low efficiency operation of diesel engines during active regeneration. Another reviewer believes that HCCI technology should be central in the VT menu. It was stated by a reviewer that low temperature CO and HC oxidation catalysts enable HCCI to reduce gaseous emissions. HCCI is a high fuel efficiency operation mode. A reviewer felt that the program was in line with the DOE formulation.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented on an encouraging approach and robust plan. Another stated that the answers above are yes/no: here, the reviewer felt a need for a confidence level. The reviewer adds that this is a very difficult task, and that the project has made useful progress, but it remains uncertain whether the 50% HC conversion at 150°C can be achieved. The reviewer continues that even if not, it seems useful progress has been made.

One reviewer stated that mostly experimental tools have been applied to evaluation of novel substrates and catalysts. Another reviewer stated that adding praseodymium into the CeO_2 system appeared to have a promising effect by increasing oxygen storage capacity, which promotes low temperature oxidation activity. The praseodymium addition also maintains pore volume and pore size and optimal dispersion of Pd catalyst.

A reviewer stated that it was a good discovery project, but wondered if the cost of praseodymium was cheaper than the catalysts with the higher PM content. Another reviewer was unsure that the technical barriers will be overcome. One reviewer believed that a fundamental understanding will lead to invention of new catalyst support material composition to enhance catalyst performance at low temperature.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer comments that there has been good progress on a difficult task. Another reviewer said that there were interesting and useful findings with respect to influence of substrate chemistry and catalyst selection on oxidation efficiency. Another reviewer felt the findings would be useful to a catalyst designer.

One reviewer commented that competition with catalyst suppliers is useful, and that the partnership with Caterpillar should be helpful. Another stated that the CRADA is using an array of tools to redesign a catalyst from scratch to allow HCCI to be applied. The reviewer continues that the application of this approach can be applied to any engine system - this CRADA shows the advantages to collaborative development. A reviewer believed that activity after aging was lacking and that quick results on aging are crucial.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that the project will transfer the knowledge to catalyst suppliers. One reviewer felt that competition with catalyst suppliers is useful. Partnership with Caterpillar should be helpful. Another reviewer cited activity with Caterpillar and presumably its suppliers. One reviewer commented that since the project is a CRADA with an industrial partner (Caterpillar), it is very likely for any useful results to be commercialized. A different reviewer wondered if the suppliers already know most of this, believing that if not, this material should be very useful. It was said, by a reviewer, that the catalyst showed promising performance, although aging and durability needs to be carried out next year.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

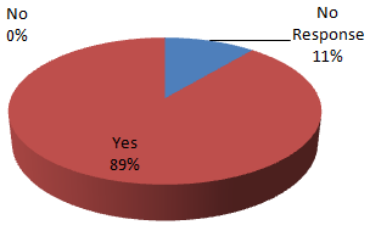
A reviewer suggested the project should not run its "own engine testing" at PNNL, but rather should leave that to Caterpillar. Another reviewer felt that collaborative research with Caterpillar should be enough on aging testing and durability testing. Another reviewer felt that funding of $250,000 seems adequate considering that there is an equal amount spent by the industry partner under CRADA.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

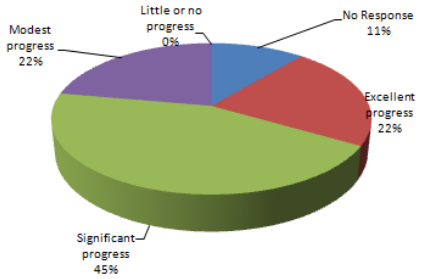
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar)

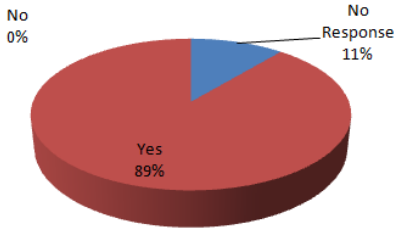
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



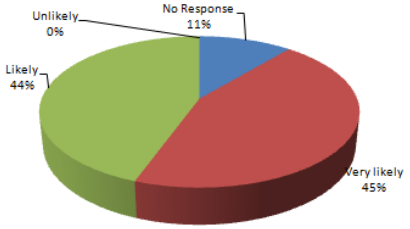
Question 3: Characterize the technical accomplishments and progress toward goals.



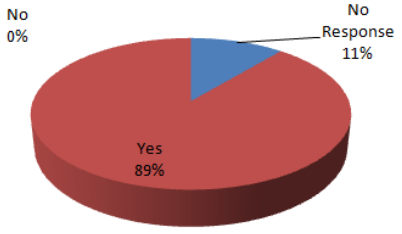
Question 2a: Are the goals of the project technically achievable?



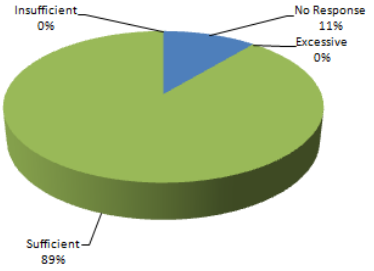
Question 4: How likely is the project team to move technologies into the marketplace?



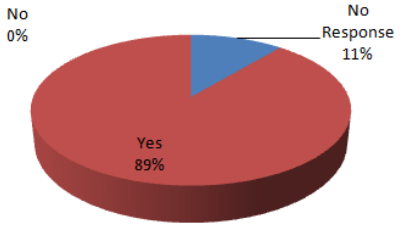
Question 2b: Have the technical barriers been identified and addressed?



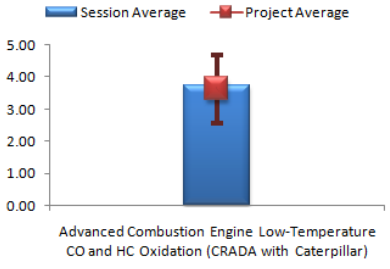
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Diesel Particulate Filter (DPF) Research (Kyeong Lee, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that theoretically DPF advanced developments have a minor impact on BSFC, but the tools and methods to design aftertreatment without the normal "cut and try" approach allows for intelligent integration and a real potential to advance the state of the art that could deliver significant BSFC and cost advantages that may open the door for light-duty diesel. Another reviewer said that DPFs are essential for dieselization, and they cost fuel efficiency. One reviewer cited improved understanding of DPF filtration and regeneration as having a high potential of reduced diesel fuel use (both due to higher efficiency associated with lower pressure drop and fuel use during regeneration if it occurs at lower temperatures or less frequently). A reviewer felt that the DPF is a major stumbling block to future diesel usage. The reviewer adds more work is welcome; there is a need to better understand the particles, to prevent them. One reviewer felt that optimization of DPF systems and their application would contribute to their improved fuel efficiency. Another reviewer stated that it was a unique study of soot structure and the oxidation properties of each type of structure are interesting. Another reviewer adds that VT emissions can't be dealt with until emissions control is addressed. The reviewer adds that emissions control has an associated energy penalty.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer comments that the technology is mandated, industry struggles with the best implementation methods, and deployment should be readily achieved. Another reviewer states that this project applies our latest understanding of soot morphology to the design of DPF, but the advantage of this additional detail is not well described, and it is easy to say - So what? The reviewer asks what is lacking from the simplifications that previous projects have made. The reviewer continues that fuel additives should not really be a major focus – this is OK to look at, but not clear why this is presented.

A reviewer states that it is important to explain more details of the washcoat used. Another reviewer comments that other institutes have done similar work, as stated in slide 4. The reviewer goes on to ask why this cannot be done elsewhere and what national lab core competency it requires.

A reviewer states that the objectives seem loose and perhaps overambitious. The reviewer suggests concentrating on how soot collects in and burns off the pores; regeneration strategies and runaway control seem beyond the scope of this lab setup. The reviewer continues that it may be appropriate to wait for firm objectives until we see what the system can do. This system may be useful to gather data for verification of various DPF models.

Another reviewer comments that the experimental setup seems to be state-of-the-art, especially translation imaging system. One reviewer sees images as the key to better design direction. The reviewer adds that it is still in the early phase but there is an expectation that the results will be very useful and powerful. The results will help validate models.

Another reviewer suggests that the controlled microreactor will provide valuable insights into the mechanisms of soot collection and regeneration.

One reviewer felt that the objectives and overall strategy for this project were not clearly defined in the presentation. The reviewer adds that there is no doubt that very substantial technical challenges exist with the DPF technology and that better understanding of these would be lead to more robust and fuel-efficient DPF systems, but it is not clear which specific aspects of the DPF technology this program is planning to address and how the information from this program is intended to be applied.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer commented that there were lots of descriptions of equipment and sensors, but video results could not be shown. The reviewer felt that the purpose behind the work was not communicated. The reviewer wondered why this work is important. The reviewer felt the research did not communicate this. Another reviewer stated that it is merely an exercise that does not really address technical barriers. One reviewer said that although not stated, it seems like this project is very early and there are not real research results yet. One assumes more results will come when the system is set up and in use. Another reviewer commented that the project just started last year, and while there are no significant results yet, the engine dynamometer setup and reactor bench/imaging system have been completed. A reviewer commented on the micro imaging system as a wonderful contribution which should aid in understanding this complex system. Another felt that it was good to see the use of visual technology. Another reviewer said that impressive experimental capabilities were established during the first year of the project, consistent with the fairly high level of funding.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reviewers commented on the participation of industry, and that the industrial partners would be able to make direct use of learning when it comes. Another reviewer commented that the use of visual technology is a very effective means of technology transfer. One reviewer wonders how Corning was going to develop a higher thermally stable material. The reviewer questioned which data from this project helps them to design an improved substrate, and adds that the high resolution images shows that the Corning material is not very uniform. Another reviewer felt that this was work for others.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

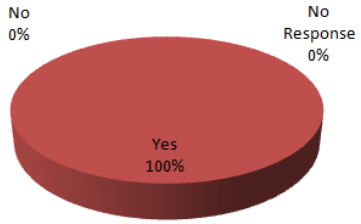
A reviewer felt that funding of $400,000 seems sufficient, considering the similar spending from the CRADA partners. Another reviewer wonder why fund it at all?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

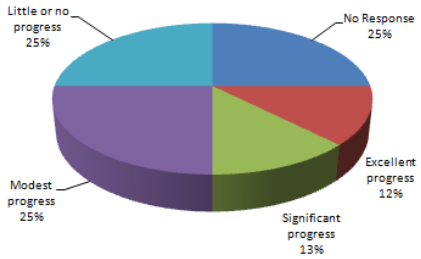
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Diesel Particulate Filter (DPF) Research

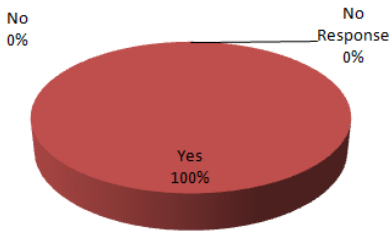
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



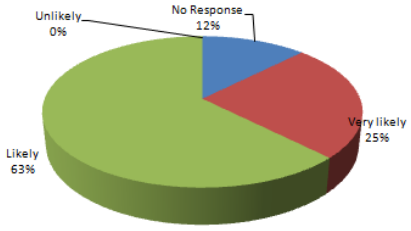
Question 3: Characterize the technical accomplishments and progress toward goals.



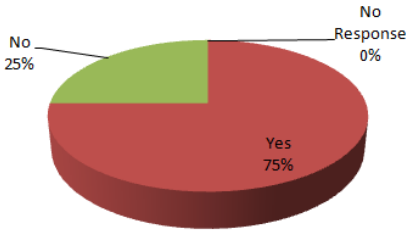
Question 2a: Are the goals of the project technically achievable?



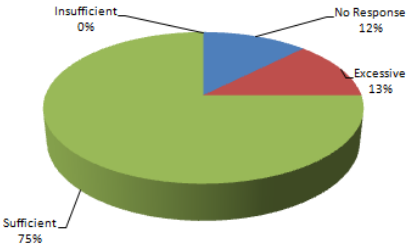
Question 4: How likely is the project team to move technologies into the marketplace?



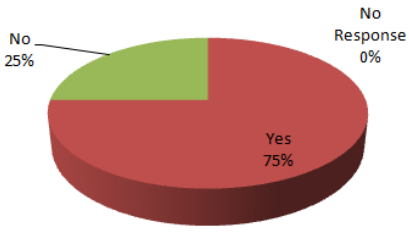
Question 2b: Have the technical barriers been identified and addressed?



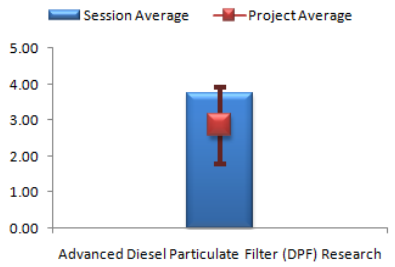
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Characterization of Aging Mechanisms in Advanced Catalysts for SCR of NOx with Urea (Charles Peden, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that active NOx catalysts have tremendous potential to improve BSFC. A reviewer mentioned that better understanding of selective catalytic reduction aging is critical in improving the performance of urea selective catalytic reduction, which is the only NOx reduction approach with the potential of actually reducing use of diesel fuel, while meeting future emission regulations. It was also said by another reviewer that selective catalytic reduction technology is a leading solution for the lean deNOx, while another felt that implementation of the SCR aftertreatment system is expected to lead to improved fuel efficiency.

Another reviewer commented on the CRADA with Ford having kicked off in February 2007. The reviewer felt it definitely was a viable technology in the medium and heavy duty diesel markets, assuming the urea infrastructure is viable and the cost of the second fluid is minimal. One other reviewer mentioned it being a Ford CRADA. A reviewer felt the project was certainly consistent with the desire for DOE to emphasize short term commercialization.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer mentioned realistic aging protocols for time/cost savings. The reviewer added that barriers are well-recognized in terms of durability in the absence of field history. The reviewer continued that urea-induced deactivation of zeolite (alumina or copper based) and that it was not apparent how this will be overcome. One reviewer said that laboratory aging protocols are very important. Another reviewer stated that the goal of the program is to learn the fundamentals of catalyst aging and durability, so that the engine and vehicle testing protocol can be formulated.

A reviewer commented that the technical approach makes the optimum use of the strengths of CRADA partners - Ford and PNNL. Another reviewer stated that the project was aiming at a Ford development need.

One reviewer felt that this was exactly the type of program which can help industry and also help the OEM's synergize. The reviewer add that this is an excellent model program for how our national labs through CRADA can work and supply useful research to the private sector.

Another reviewer stated that the project objectives/scope are very clearly defined and are based on a well-documented case of catalyst failure (SAE papers and DEER presentation); the tools employed by PNNL are uniquely useful for the task and not available to the industry (e.g. NMR)

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that aging, in the presence of urea, revealed previously unknown effects such as large deposits upstream and/or on monolith catalysts (urea decomposition) polymerization of cyanuric acid, and wondered how this can be overcome.

A reviewer stated that the project had found unexpected aging results, and was still learning. Another commented that after only one year of work, some important technical accomplishments have already been achieved.

One reviewer commented that new deposits are identified during the aging as unreactive urea and crystalline cyanuric acid and urea-cyanate. The reviewer adds that aging of catalyst supported on monolith showed the catalyst at entrance was deactivated, from chemical species from fuel and lubrication. The reviewer felt that urea induced de-alumination is another part of deactivation mechanism, and added that a new copper species was identified.

Another reviewer commented that Al27 NMR measurements, along with other material characterization techniques, provided clear evidence of the zeolite material changes underpinning the observed performance changes.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer found that there had been good collaboration and sharing of tasks based on capabilities. Another mentioned that there was already an industrial partner involved.

One reviewer felt that since the CRADA seems to have been formed in response to specific issues identified by the industry partner (Ford), it is very likely that any useful technical results will be used and implemented. The close involvement with an industrial partner was commented on by other reviewers as well.

A reviewer noted that the results will help the complete system design, and added that fundamental understanding on SCR catalyst aging will help to solve the aging issues.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

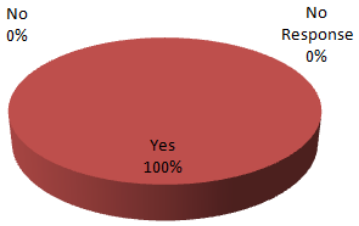
A reviewer stated that $100,000 was used for the first year, and wondered if this increased over the life of the CRADA. A reviewer commented that the funding can only cover 0.4 FTE of a junior scientist. The reviewer adds that this seems inadequate to the magnitude of the technical challenge and to the potential influence of the project success on the reduction of diesel fuel use in advanced engines. Another reviewer felt that the current level of funding limits this CRADA to a quite narrow focus on diagnosing a specific failed selective catalytic reduction system. One reviewer felt that the cost per technical person at PNNL (and all national labs) is excessive. This comment applies to ALL projects. The reviewer adds that the work can't and shouldn't be exported to China and India, but must be competitive globally!

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

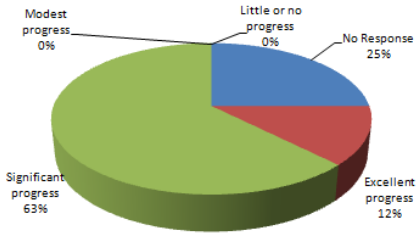
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Characterization of Aging Mechanisms in Advanced Catalysts for SCR of NOx with Urea

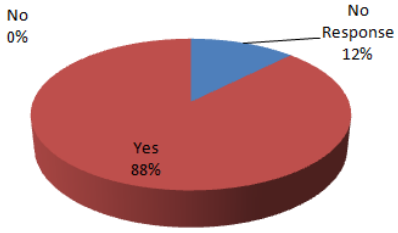
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



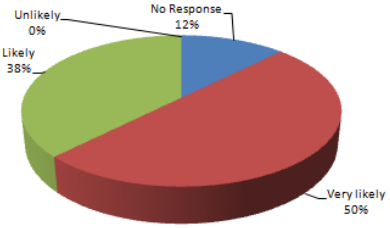
Question 3: Characterize the technical accomplishments and progress toward goals.



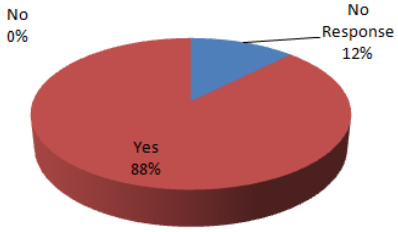
Question 2a: Are the goals of the project technically achievable?



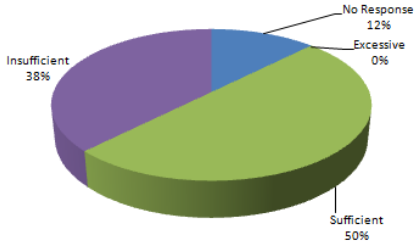
Question 4: How likely is the project team to move technologies into the marketplace?



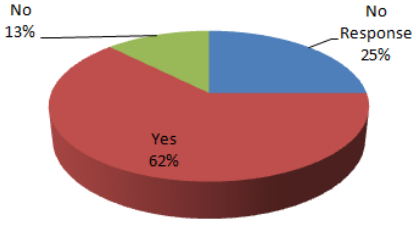
Question 2b: Have the technical barriers been identified and addressed?



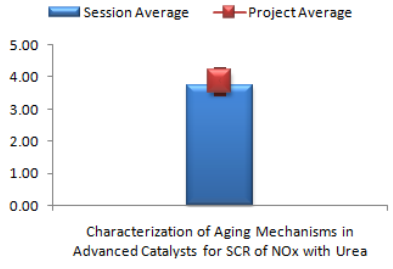
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



CLEERS Diesel Soot Filter Characterization (Charles Peden, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that the project is promoting net fuel efficiency through experimental data combined with micro modeling. Another reviewer said that diesels need NOx catalysts. One reviewer mentioned deeper understanding of DPF mechanisms is very likely to result in devices with lower pressure drop, better filtration efficiency, less frequent active regeneration events, all leading to reduced use of petroleum. The reviewer went on that better understanding of urea-SCR mechanisms is very likely to result in devices with lower pressure drop, lower urea consumption, better catalytic efficiency, all leading to reduced petroleum use. A reviewer felt that this was directly related to the DOE focus. One reviewer commented that aftertreatment is very important to diesels becoming a commercial reality. Another reviewer mentioned optimization of DPF systems and their application would contribute to their improved fuel efficiency. It was stated by a reviewer that fundamental understanding on DPF systems with collection efficiency, regeneration and back pressure is highly industry relevant.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that the project was comparing cordierite with other substrates e.g., SiC. The reviewer added that particulate size effects had been examined. The reviewer continued that there was a good test strategy to build/verify understanding from aerosol surrogates (salts) to controlled combustion aerosol (MiniCAST) to diesel engine test. The reviewer also noted the conducting of regeneration studies.

A reviewer stated that guidance from industry members of the CLEERS consortium creates a high probability of the deployment of technologies and utilization of fundamental understanding developed in this project. Another reviewer expected that understanding on the molecular level should translate to successful modeling.

One reviewer felt that the report was not risky. Another reviewer commented on the unique experimental approach employing a single-channel system which provides an opportunity for controlled loading of particulate matter and subsequent non-disruptive evaluation due to particulate matter layer being exposed.

The project was also commented on, by a reviewer, as having used synthetic nanoparticles with monodispersion and a single wall filtration apparatus to simulate the soot collection process on DPF. The reviewer added that the cake formation process was monitored through the filtration efficiency and backpressure.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that this was good fundamental work, but that the need to correlate to results with filter physical parameters is poorly defined. The reviewer adds that DPF characteristics have more impact on the performance and insights to it are highly valuable for better designed DPF system. One reviewer felt that more needs to be done on soot regeneration events, as well as measurement of

particle sizes during regeneration events. Another reviewer stated that things were good so far, but that there were still many questions to be answered. A reviewer commented on transition from depth filtration to cake filtration as a function of loading for different materials; correlation/validation with salt particle penetration (ammonium sulfate). One reviewer believed the project closely parallels commercial supplier work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer believes that any improvement in DPF and SCR performance derived from this research is very likely to enter the marketplace immediately due to its direct impact on efficiency and emissions. Another reviewer stated that this was solid and fundamental.

Another reviewer commented that the use of ammonia sulfate may not be representative to be filtration behavior in the filter due to surface interactions with DPF materials, although provided nice particle size range. The user added that more detailed work is needed to clear this argument.

Two reviewers commented on the close work with industry, and another mentioned good networking with the CLEERS system. One reviewer talked of efficient information dissemination being ensured by the CLEERS structure.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer felt that the project focus needs to address the fundamental of DPF microstructure, pore size and its distribution on filtration efficiency, backpressure, if DPF manufacturers allow the disclosure of this information.

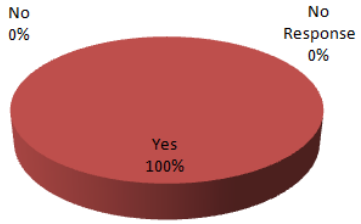
Another reviewer stated that it was their understanding that this project (10048), in spite of its title, actually covers two areas of research - DPF and urea SCR. The reviewer added that as such, resources seem inadequate, especially since this seems to be the only project under CLEERS dedicated to technologies other than a NOx adsorber. The reviewer would recommend moving more of the CLEERS resources from NOx adsorber projects to DPF and SCR projects. The reviewer lists specific areas of research that could be covered with more funding as ash deposition and migration in the DPF, oxidation of biodiesel derived soot, compared to soot from petroleum diesel fuel, and ways to reduce urea consumption of SCR.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

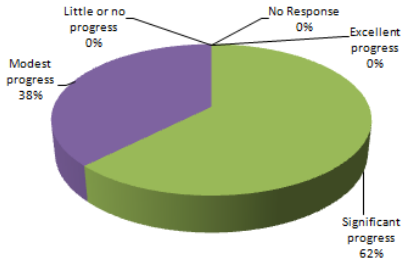
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: CLEERS Diesel Soot Filter Characterization

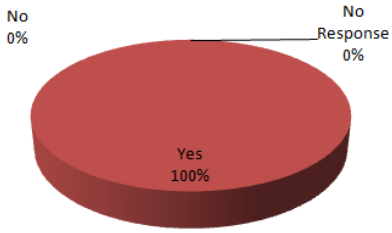
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



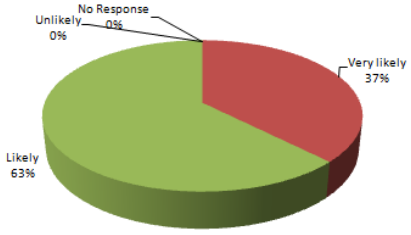
Question 3: Characterize the technical accomplishments and progress toward goals.



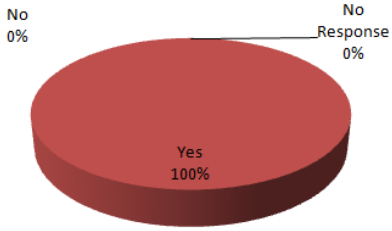
Question 2a: Are the goals of the project technically achievable?



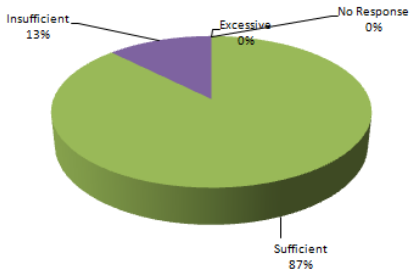
Question 4: How likely is the project team to move technologies into the marketplace?



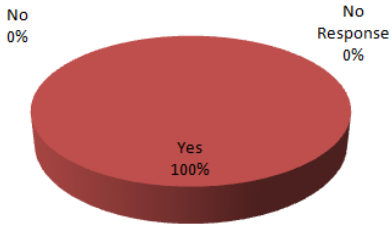
Question 2b: Have the technical barriers been identified and addressed?



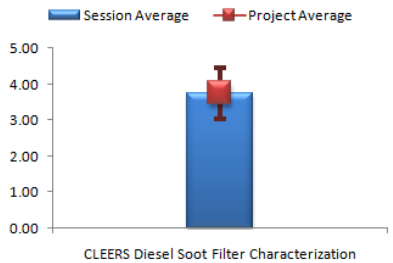
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



CLEERS NOx Adsorber Kinetics and the Multi-Lab Diesel Emissions Reduction Activities (Jae-Soon Choi, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that any reduction in NOx emissions via active aftertreatment provides potential to break the traditional BSFC - NOx tradeoff. The reviewer adds the consortia-based, non-competitive based approach moves the industry/academia forward in a collaborative way - the end result is better thermal efficiency. Another reviewer felt that the program was valuable for coordination, adding that various companies cannot communicate easily and that CLEERS creates a forum where communication can occur. A second reviewer also felt that it is important to keep interacting with all cross sections of the emission industry.

One reviewer stated agreement that the sulfation and deSOx is the most important issue facing LNT implementation. The reviewer adds that lowering the DeSOx temperature is the key barrier. Another reviewer stated that understanding of NOx adsorber kinetics and sulfur poisoning process can help the development of lean-burn gasoline engines, which can reduce petroleum use. A reviewer says that the LNT chemistry and kinetics for NOx control are highly desirable. The reviewer adds that analytical/numerical tools and models are useful for fundamental understanding and data collections. The reviewer continues that the tools and models will help identify the system level energy inefficiency, provides potential solution to resolve emission control bottlenecks. The reviewer concludes that sulfation and desulfation are critical to LNT performance in real world.

A reviewer stated that the early NOx adsorber systems on the market are quite non-optimal and better understanding of this technology should lead to improved fuel efficiency. Another reviewer said that dieselization critically depends on NOx catalysts. The reviewer adds that current LNT technology is loosely understood, and both very expensive and not very robust.

One reviewer stated that the program was enabling technology for advanced diesels, and should result in improving the utilization of high efficiency diesels. The reviewer found the program completely in sync with the DOE mission. Another reviewer expressed concerns that the objectives of the research were not made very clear.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer believes that with this being a consortium-based program, deployment is essentially automatic. The reviewer adds that the steering committee has a heavy industry focus including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer continues that DOE may want to consider having a similar consortia operating for other research and development programs to enable or accelerate deployment

Another reviewer states that the project is building on the extensive technical capabilities established at FEERC, including equipment and experience of NOx adsorber catalysts operation, and in particular the capabilities of SpaciMS to evaluate spatially-resolved gas composition. One reviewer says that the nature of LNT sulfation and catalyst composition impact on sulfation have been addressed in this work, the reviewer adds that it also addressed the sulfation impact on NOx storage, oxygen storage

and reductant consumption for regeneration of the catalyst, with all the data available, the operation model is conceptualized.

One reviewer saw the program as a basic research project, and suggested bridging it to some possible application concepts at NTRC-ORNL. Another reviewer expressed doubts that it was likely sulfur poisoning issue to be resolved, even with deeper understanding of the physics behind the process.

One reviewer commented that the Umicore sample should not be the only LNT system investigated. The reviewer added that other materials should be characterized with a goal to lower the DeSOx temperature. High temperature DeSOx should not come at the price of poor low temperature NOx performance.

It was commented by a reviewer that the reference catalyst is very useful and interesting, but no one will make the most up-to-date catalysts available for such detailed study in a public forum. The reviewer suggested that, when possible, to look at another fully formulated catalyst. Another reviewer said that the technical barriers are identified at this point. A different reviewer commented that the key is to how this kinetic investigation translates to commercial proprietary systems which may or may not be similar to the model system.

One reviewer expressed his opinion that the project is mainly reporting results; this reviewer didn't understand barriers or difficulty references.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer stated that CLEERS is more focused on methodologies and deployment or these, rather than on specifically overcoming the identified technical barriers. The reviewer adds deployment aspects of coordinating National Lab and academia towards industry needs will continue to pay increasingly significant dividends over time. The reviewer thinks this approach deserves a spot in DOE strategy.

Another reviewer felt that there had been good progress on identifying mechanisms of sulfation. The reviewer felt that there needed to be clear alignments with variations in compositions due to processing of wash coat; i.e., was there adequate statistical sampling across the original full-size sample?

A reviewer commented that although this was a purely catalyst and materials research program, the researchers have taken some effort to relate their work and findings to real life issues/challenges. The reviewer continued that the researchers should expend more attention in this area. The reviewer saw the mention of tool development as a plus.

A reviewer felt that relevant and state-of-the art characterization techniques have been applied to the study of NOx adsorber kinetics and sulfur poisoning. The reviewer added that no routes to elimination of the sulfur poisoning have been identified so far. Another reviewer commented that the program certainly has the analytical and microreactor resources to accomplish their tasks.

One reviewer commented that sulfur sensitivity to Ba is not a surprise. 700°C TPR is not high enough. The reviewer added that some of the sulfur may need higher temperature. Another reviewer commented on good clarification of sulfur storage sites. A reviewer commented that NSR and OSC affected by sulfur were determined to have two different mechanisms, verified by NOx reduction and ammonia forming.

It was commented by a reviewer that there was an outstanding job bringing together a number of significant aspects of the catalyst operation into a single physical model, such as NOx performance, OSC, WGS, and sulfur impact. The reviewer adds that this appears to be an excellent example of long-term work on a complex, multi-faceted subject coming together into a single coherent picture. The reviewer continues that the results were clearly underpinned by a very large volume of high quality experimental work/data.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that with this being a consortium-based program, deployment is essentially automatic on all levels (from what we learn of the hardware, to the diagnostic methods, to the cross-fertilization of the different technical discussions, to other insights into the underlying physics). The reviewer adds that the steering committee has a heavy industry focus - including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer suggests that DOE may want to consider having similar consortia operating for other R&D programs to enable or accelerate deployment. The reviewer felt that CLEERS is not really developing specific aftertreatment technologies that would apply to an engine; rather it is using standard commercially available catalysts to develop better understanding and methodologies, in DOE's diverse portfolio, and that this is an excellent program. The reviewer suggests that more opportunities for this approach should be applied to other programs if possible to further enhance deployment.

Another reviewer suggests that DeSOxing the LNT at the lowest temperature possible to avoid thermal deactivation should be the key emphasis. The reviewer suggests that other materials besides the Umicore sample should be investigated. Another reviewer comments that fundamental understanding on sulfation of LNT catalyst system is critical information for catalyst formulation and design.

A reviewer notes that industrial partners seem closely involved. Another reviewer says that it is imperative that the LNT producers are plugged into this work, if not the researchers will be studying things not relevant or, worse yet, been done by the Johnson Matthey's/Engelhard's etc. A reviewer felt the program could be enhanced if a specific industrial entity "owned" the project rather than the pool involved in CLEERS. Another reviewer commented that the team cooperates closely with industry via CLEERS and several CRADAs.

A reviewer doubts that sulfation of NOx adsorbers would be resolved. Another reviewer concluded that the translation to industry will be burdened by real world application issues associated with flow distribution and species concentration distribution. That reviewer also commented that the flow appeared to be steady state, creating plug-like poisoning--not the real world situation.

One reviewer felt that since the study is precompetitive, there is a likelihood of a follow up program to apply and transfer the technology.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer wondered why DOE was sponsoring this project at Oak Ridge National Laboratory, and if the project was completely awarded. The reviewer also wonder if there was a rationale for review of the CLEERS charter and funding level since the focus now is on more deployment rather than basic research?

Another reviewer commented that the project had a talented staff and the equipment to study this system. One reviewer saw the project as so vital to diesel eventual success eventually, and didn't think the resources are adequate. Another reviewer felt the funding was adequate, but wondered about overlap with other national labs.

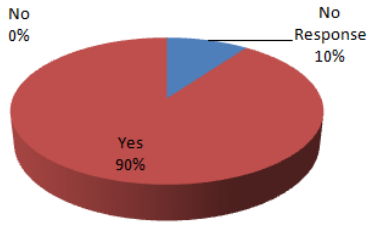
A reviewer believes the CLEERS return on investment is very good due to the collaborative approach and the focus on methodologies and base understanding over developing new hardware.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

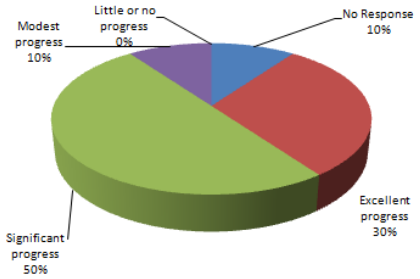
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: CLEERS NOx Adsorber Kinetics and the Multi-Lab Diesel Emissions Reduction Activities

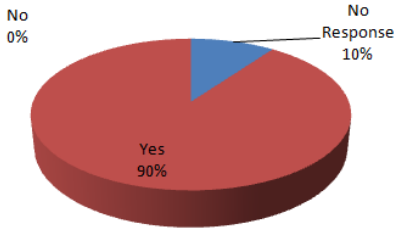
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



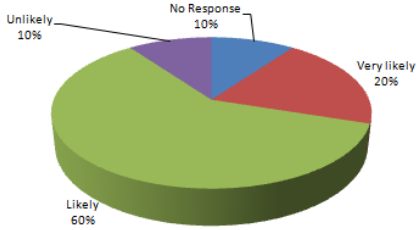
Question 3: Characterize the technical accomplishments and progress toward goals.



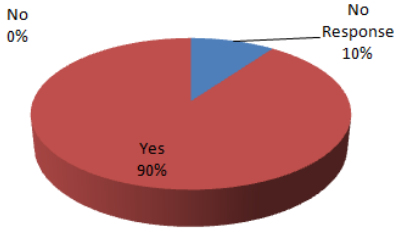
Question 2a: Are the goals of the project technically achievable?



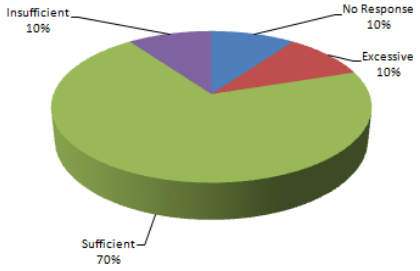
Question 4: How likely is the project team to move technologies into the marketplace?



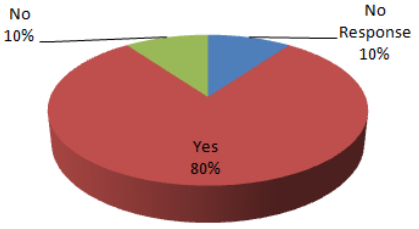
Question 2b: Have the technical barriers been identified and addressed?



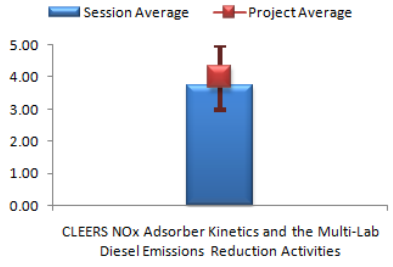
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



CLEERS: Benchmark Kinetics for NOx Adsorbers and Catalyzed DPF (Richard Larson, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that any reduction in NOx emissions via active aftertreatment provides potential to break the traditional BSFC - NOx tradeoff. The reviewer adds the consortia based, non-competitive based approach moves the industry/academia forward in a collaborative way - the end result is better thermal efficiency. The reviewer also stated that there were quantified targets, so they were definitely achievable. A reviewer stated that these were basic studies to understand the underlying mechanisms.

One reviewer commented that these were wide temperature ranges to a minimum fuel penalty. Another reviewer commented that these were the right subject area to enable diesel engines. A reviewer stated that better fundamental understanding of NOx adsorbers and DPF will lead to more efficient emission control devices and ultimately reduced petroleum consumption. Another reviewer commented that the fundamental elemental reaction mechanism will help to speed up LNT technology adoption in industry.

A reviewer commented that NOx catalysts are essential to dieselization. The reviewer continued that details of LNT storage/release are still uncertain. The reviewer requested that the program please emphasize what it is doing that is not being done at other places doing LNT models (Lund, University of Michigan, industrial partners, etc.) Also, the reviewer suggested, full reductants like diesel HCs should be added. Another reviewer felt that the activity must be high after appropriate aging. The LNT durability changes significantly. The reviewer added therefore, the kinetics must adapt with aging conditions (thermal and/or sulfated).

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer believes that with this being a consortium-based program, deployment is essentially automatic. The reviewer adds that the steering committee has a heavy industry focus including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer continues that DOE may want to consider having a similar consortia operating for other research and development programs to enable or accelerate deployment.

A reviewer commented that the technical knowledge gaps have been identified. The right tools are being applied to closing the gaps. Another reviewer commented that it will be useful to study a newer catalyst if/when it is available. Another reviewer saw correlation to experimental data from ORNL. The reviewer added that the Umicore GDI is now on market; the model was transferred to CLEERS members. The reviewer adds that the tool is capable for use in “what if” scenarios and those activities for the upcoming year are focused on appropriate barriers for LNT.

One reviewer stated that ignoring the reality of the application severely limits the eventual usage of the technology. The reviewer commented that flow distribution and local inlet chemistry is important. The reviewer also cautioned that the fundamentals also need to be done here, but added that they felt the pseudo-state technique is very applicable, at least insightful.

A reviewer felt that the questions are not directly applicable but the implied answers are given. One reviewer commented that it was not clear from the presentation how this effort is differentiated from or is taking advantage of the other micro-kinetic modeling efforts and similar experimental work reported in the literature.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer stated that they thought this topic and collaboration of detailed kinetics to the measured data from ORNL is one of the original ideas of CLEERS and expectations. The reviewer added that it took a long time to generate this result, but the results have been published and disseminated. The reviewer continues that from the presentations it is hard to gauge how effective the results are, but it appears from the slides that the original expectations were met. The coordination of the different sciences, national laboratories, and industry is the key technical accomplishment. The reviewer continues that the results appear to be preliminary, with some basic comparison data still showing differences, but the work should continue. The reviewer comments that meanwhile the technologies have hit the market, so there is a time gap between generating the knowledge and having to apply the knowledge, just another reason to keep the collaborative work going.

One reviewer felt the need for fundamental understanding is helpful. Another reviewer commented that the model showed reaction species on catalyst surface for 100-500°C and showed reaction kinetics semi quantitatively. The reviewer added that the model generally gave a good picture of reaction and products; however, the details with the adsorber present needs more resource or time to work it through.

A reviewer stated that they did not catch the capability of the model to predict the extent of the DeNOx event, to determine the remaining NOx storage capacity and subsequent NOx adsorption event.

It was said by a reviewer, that the sulfur effects need to be added along with thermal degradation issues. The reviewer added that timely results are needed, or other organizations will do it. One reviewer noted that while the project title is "Benchmarking kinetics for NOx adsorbers and catalyzed DPF", all activities so far and upcoming plans seem to focus on the NOx adsorber. The reviewer added that shifting the focus to the catalyzed DPF may improve the likelihood of technology transfer and market transformation resulting from this project.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that with this being a consortium-based program, deployment is essentially automatic on all levels (from what we learn of the hardware, to the diagnostic methods, to the cross-fertilization of the different technical discussions, to other insights into the underlying physics). The reviewer adds that the steering committee has a heavy industry focus - including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer suggests that DOE may want to consider having a similar consortia operating for other R&D programs to enable or accelerate deployment. The reviewer felt that CLEERS is not really developing specific aftertreatment technologies that would apply to an engine, rather it is using standard commercially available catalysts to develop better understanding and methodologies, in DOE's diverse portfolio, and that this is an excellent program. The reviewer suggests that more opportunities for this approach should be applied to other programs if possible to further enhance deployment.

A reviewer felt that this was a good evaluation for such a basic research effort. Another reviewer stated that the preliminary results are already transferred to industry. One reviewer stated that this will eventually be integrated into better actual application models.

It was commented, by a reviewer, that LNT is one of the lean deNOx technologies, especially for gasoline engines or light duty diesel engines. One reviewer felt that resolution of NOx adsorber issues is not very likely.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that funding appears to be close to the minimum running level of a National Lab researcher, so it would seem that collaborative synergy is being achieved between the National Labs. The reviewer cites running tests at ORNL, combined simulation/testing at PNNL and detailed kinetics at SNL. The reviewer believes that the return on investment is good, as long as the data/methods are being disseminated.

It was stated by a reviewer that funding of $250,000 seems to be at the right level, especially if focus shifts to catalyzed DPFs. Another reviewer felt that this project has a good sense of practical application, and the reviewer believed the project should see increased funding.

A reviewer felt that more experiments need to generate enough evidence for elucidating the reaction mechanisms, the reviewer felt that more resources or time required. Another reviewer would like to see the addition of aging, and other reductants. The reviewer believed this could be useful if funded.

One reviewer added what they described as a general comment that applies to the funding and projects carried out by the National Laboratories. The reviewer adds that there seems to be a tendency to duplicate the core competency at more than one site. The reviewer gives the example of catalyst modeling possibly duplicating work between ORNL, PNNL and SNL. The reviewer believes it would be beneficial to have a clear core competency portfolio.

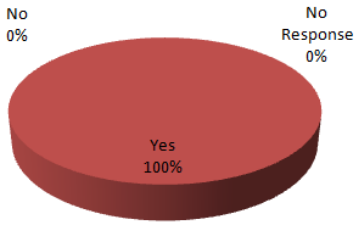
Another comment made by a reviewer was that this is a general comment database for the National Laboratories with distinct differentiation of respective core competencies. The reviewer continues that ensuring complementary suits of core competencies and minimizing duplications will enhance DOE, VT and NL mission and improved the efficiency of funding utilization!

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

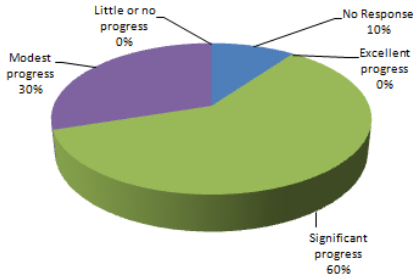
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: CLEERS: Benchmark Kinetics for NOx Adsorbers and Catalyzed DPF

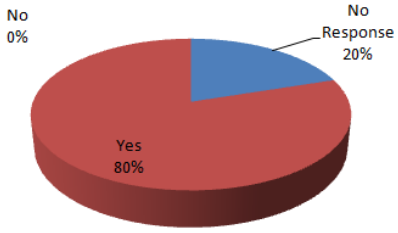
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



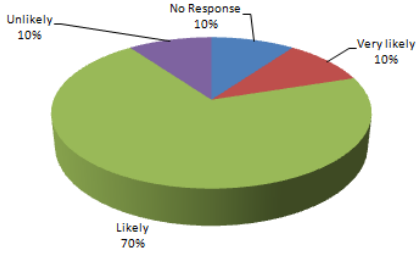
Question 3: Characterize the technical accomplishments and progress toward goals.



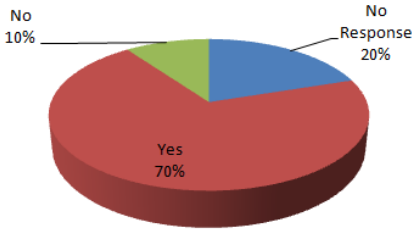
Question 2a: Are the goals of the project technically achievable?



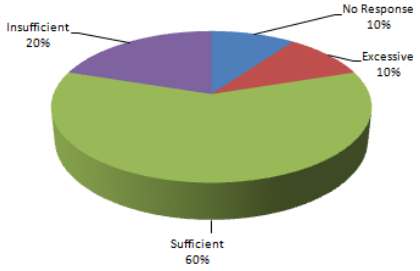
Question 4: How likely is the project team to move technologies into the marketplace?



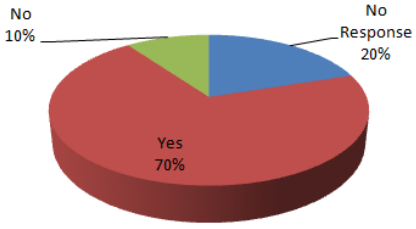
Question 2b: Have the technical barriers been identified and addressed?



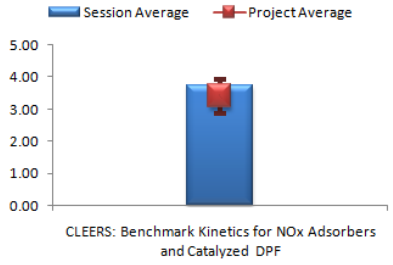
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Controlling NOx from Multi-Mode Lean DI Engines (Jim Parks, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer states that NOx aftertreatment and combustion work, especially as integrated in this project, serves the DOE goals. The reviewer adds that the integration may be best suited to an OEM with more control of ECM, FIE, LNT controls and hardware. The reviewer continues that ORNL is covering a lot of basic development (EGR/combustion/engine hardware) and believes that this is really what OEMs do best - this is not a good topic for ORNL activity. The reviewer found the LNT activity very interesting, and stated that it was valuable to show the basic characteristics. The reviewer adds that they believe this is what national labs do best. One reviewer says that both projects address important needs. Another reviewer said the project focus on the light duty diesels, which assume the system costs, will be acceptable for this market sector. Another reviewer states that the objective is directly related to VT and nicely fits into core charter. The reviewer continues that technology deployment aspects are in focus as the research work covers fundamental characterization to engine testing with HECC. A reviewer says optimized integration of novel combustion regimes with various aftertreatment devices can have a significant effect of reduction of petroleum fuel use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Another reviewer comments that there was excellent bridging of fundamental/basic research all the way to real-life applications. A reviewer suggests that there seem to be so many possible avenues that the objectives and goals are not clear. The reviewer continues that many good things can be done, and cites a need to focus on what the funding can cover. The reviewer ends by stating that desulfation and durability were not mentioned very much. One reviewer mentions a broad look at various emerging HECC approaches as combined with a gamut of aftertreatment devices. One reviewer states that this program is building up on several key strengths of FEERC, including extensive experience with laboratory testing of NOx adsorber materials, engine combustion expertise and advanced gas analytics.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that it seems a lot of activity is on hardware/EGR tuning/development/deposits. The reviewer sees a reliance on obsolete hardware as a problem, and states the move to GM engine is good. One reviewer mentions that technology deployment aspects are in focus as the research work covers fundamental characterization to engine testing with HECC. A reviewer says that many useful results characterizing engine operating points (mostly low-speed low-load) under conventional and HECC combustion regimes. One reviewer felt that it was good work, but wondered whether OEMs have similar data internally. The reviewer still felt that the public and published data is very valuable. Another reviewer adds that an outstanding volume/quality of complementary experimental data related to the impact of various combustion modes/strategies on the operation of a NOx adsorber catalyst. The reviewer continues that the project includes a healthy mix of applied research (on-engine evaluation supported by the advanced gas analytics), in-depth lab research (bench-scale tests) and even some exploratory work (testing of some advanced concept catalysts from University of Kentucky).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that development is probably behind the OEMs, so either the project must accelerate the activity and use more sophisticated methods or alter the focus to specialize on a more specific aspect of controls integration or LNT/HECC optimization. The reviewer adds that the scope of activities may be too broad. A reviewer states that this project provides an important addition to the set of HECC combustion projects, by looking at the implications for the selection of appropriate emission control technologies.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

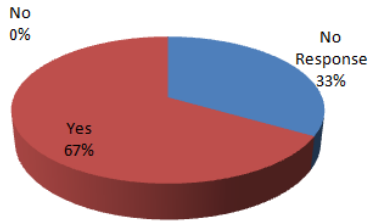
A reviewer states that funding seems insufficient. The reviewer suggests additional funding, if provided, should be used for accelerating introduction of SCR and DOC devices to the test matrix.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

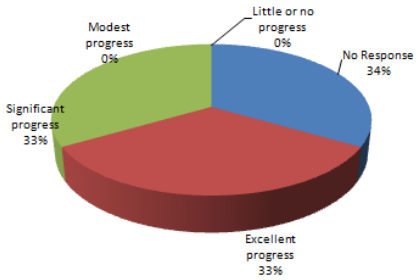
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Controlling NOx from Multi-Mode Lean DI Engines

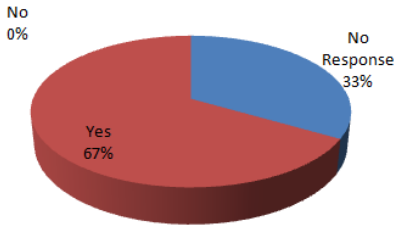
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



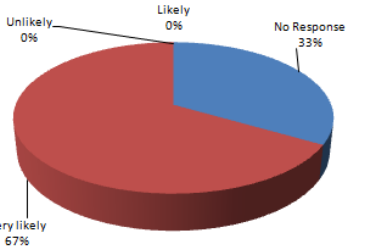
Question 3: Characterize the technical accomplishments and progress toward goals.



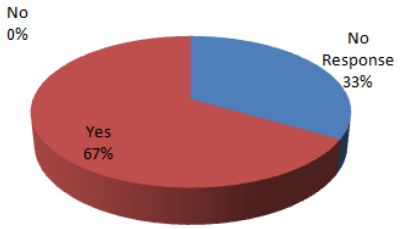
Question 2a: Are the goals of the project technically achievable?



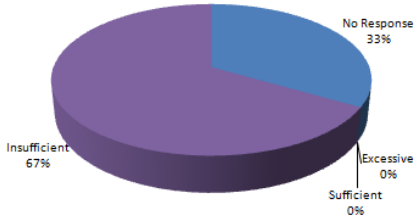
Question 4: How likely is the project team to move technologies into the marketplace?



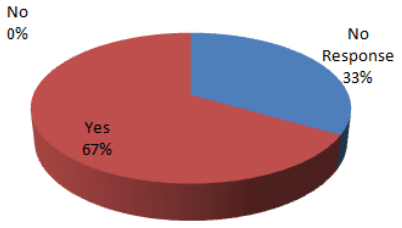
Question 2b: Have the technical barriers been identified and addressed?



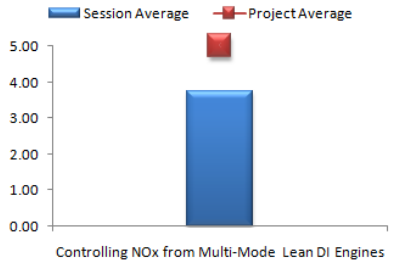
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Coordination of Cross-Cut Lean Exhaust Emission Reduction Simulation (CLEERS) Project (Stuart Daw, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that any reduction in NOx emissions via active aftertreatment provides potential to break the traditional BSFC - NOx tradeoff. The reviewer adds the consortia based, non-competitive based approach moves the industry/academia forward in a collaborative way - the end result is better thermal efficiency. Another reviewer felt that the program was valuable for coordination, adding that various companies cannot communicate easily and that CLEERS creates a forum where communication can occur. A second reviewer also felt that it is important to keep interacting with all cross sections of the emission industry.

A reviewer commented that the diesel engine is one of most promising options to boost fuel efficiency. The reviewer continues that the key issue is emission control for diesel engines to meet Tier 2 Bin 5 standards. The reviewer believes that the program has identified and addressed two big emitters (PM and Lean NOx). As the program moved on, lean deNOx has been identified to be most critical. The reviewer sees the setting up of an industry-wide network to address the technical issues.

Another reviewer says that the program is focused on system cost management and fuel consumption effects while meeting emissions regulations. The reviewer adds that the LNT model adapted for hybrid powertrain systems (Mercedes 1.7L diesel) demonstrates good system integration with another future technology set. R&D survey results were used effectively help align objectives.

A reviewer states that VT cannot be done with its work without addressing emission control and adds that emissions have an associated energy penalty. Another reviewer states that the influence of emission control technologies on transportation fuel use is significant and growing, due to continually tightening emission regulations.

One reviewer comments that the mathematical modeling of the aftertreatment system is a key to their optimization for improved fuel efficiency. Another reviewer states that there is a clear line of sight with DOE's vision of emission reduction with the key advantage of fuel reduction.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer believes that with this being a consortium-based program, deployment is essentially automatic. The reviewer adds that the steering committee has a heavy industry focus including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer continues that DOE may want to consider having a similar consortia operating for other research and development programs to enable or accelerate deployment.

A reviewer believes that the broad industry-government nature of the CLEERS organization should ensure rapid deployment of useful results. Another reviewer states that confidentiality is always a barrier, but CLEERS has done a good job balancing this. Another reviewer saw great team work and partnering of talents with industry and government talent. A reviewer states that the overview provided clear strategy and roles of the participating labs.

One reviewer felt that this was a continuous crosscut activity and that some question elements are not applicable to the project. The reviewer wondered is there a rationale for review of the CLEERS charter since the focus is now on more deployment rather than basic research. Another reviewer stated that the small focused group with monthly meetings is the optimal way to address the technical issues, coupled with annual technical reviews.

A reviewer felt that the overall CLEERS program is addressing several aspects of the aftertreatment technology. The reviewer listed mathematical models of aftertreatment devices, in the pre-competitive form, experimental information critical for developing such models or discriminating different modeling approaches, and that it serves as a channel for technical discussions among the participants and as a conduit for delivering select best external research information to the CLEERS participants. The reviewer added that CLEERS represents a very good example of complementary collaborative work between different National Labs, especially ORNL (FEERC) and PNNL.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer stated that CLEERS is more focused on methodologies and deployment, rather than on specifically overcoming the identified technical barriers. The reviewer adds the opinion that deployment aspects of coordinating National Lab and academia towards industry needs will continue to pay increasingly significant dividends over time. The reviewer thinks this approach deserves a spot in DOE strategy.

A reviewer also says that it seems the CLEERS collaborative process works but believes it also slows down the rate of progress for the initial iterations. The reviewer theorizes that perhaps over time the speed will also increase. This is one disadvantage of collaboration, but the results are released over a broad spectrum of industry/groups. The reviewer thinks this more than offsets the time related disadvantage.

One reviewer states that CLEERS activities tend to over-emphasize gasoline technologies over diesel technologies, specifically, the results of the survey showed DPF and SCR related issues as top diesel priorities, and LNT issues as top gasoline priorities. Yet, four out of five presented projects (8746, 8744, 10049, 14766) are devoted to LNT, only one to DPF (10048) and none to SCR.

Another reviewer comments that overall, CLEERS has substantially outgrown its original role and scope and evolved into a collaborative technical research team (as witnessed by the individual CLEERS presentations ranked separately) and also a focused technical forum.

One reviewer lists LNT modeling progress and R&D priorities survey incorporated into PNNL, ORNL, and SNL operating plans. A reviewer states that simulation is an extremely robust and useful tool when used properly. Another reviewer states that the program has the necessary talent and group to accomplish the goals by a rigorous incorporation of a large group.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that with this being a consortium-based program, deployment is essentially automatic on all levels (from what we learn of the hardware, to the diagnostic methods, to the cross-fertilization of the different technical discussions, to other insights into the underlying physics). The reviewer adds that the steering committee has a heavy industry focus - including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer suggests that DOE may want to consider having a similar consortia operating for other R&D programs to enable or accelerate

deployment. The reviewer felt that CLEERS is not really developing specific aftertreatment technologies that would apply to an engine, rather it is using standard commercially available catalysts to develop better understanding and methodologies, in DOE's diverse portfolio, and that this is an excellent program. The reviewer suggests that more opportunities for this approach should be applied to other programs if possible to further enhance deployment.

A reviewer felt that the CLEERS format ensures close industrial involvement and participation at all stages, from determining the research direction (e.g. via industry surveys) to information dissemination via monthly teleconferences and an annual workshop.

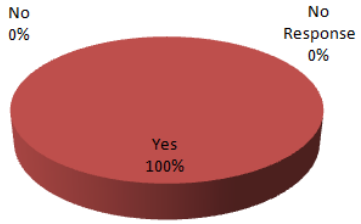
A reviewer felt that industry and academic people are active in the group. Another reviewer saw good connection to research and development throughout the survey. One reviewer felt that teaming and information dumps are critical and being addressed well in this program. One reviewer felt that the CLEERS projects would prove useful to the gasoline technologies of automotive companies, but not very useful for diesel (especially heavy duty).

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Reviewers suggested keeping the government-sponsored staff at the same level, or reduce it. The reviewer also felt that industry should continue to pitch in. The reviewer added that administrative overhead should be reduced and the tendency to increase the home grown staff assignments at ORNL, PNNL, etc. should be resisted. One reviewer felt that some LNT activities at ORNL, PNNL and SNL seem overlapping. A reviewer believes the CLEERS return on investment is very good due to the collaborative approach and the focus on methodologies and base understanding over developing new hardware.

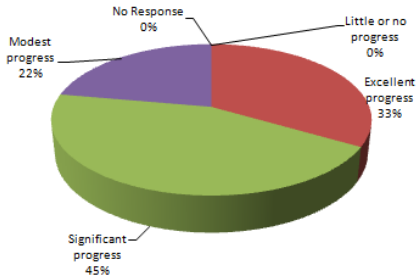
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Coordination of Cross-Cut Lean Exhaust Emission Reduction Simulation (CLEERS) Project

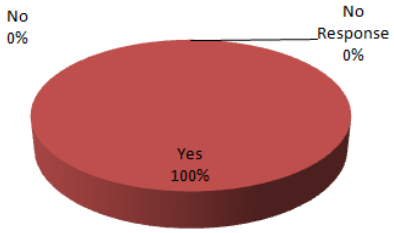
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



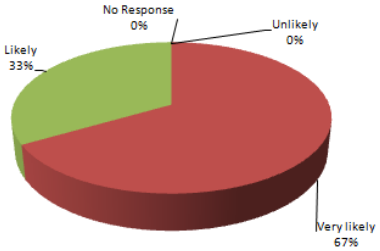
Question 3: Characterize the technical accomplishments and progress toward goals.



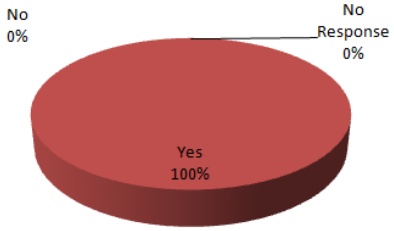
Question 2a: Are the goals of the project technically achievable?



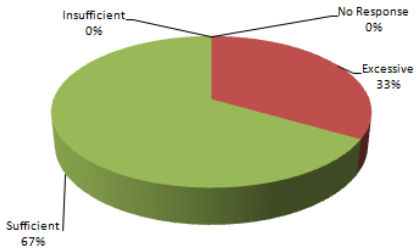
Question 4: How likely is the project team to move technologies into the marketplace?



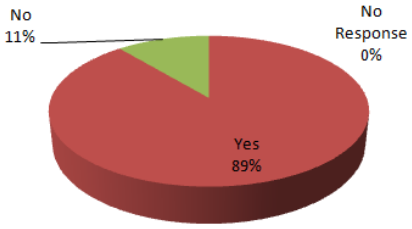
Question 2b: Have the technical barriers been identified and addressed?



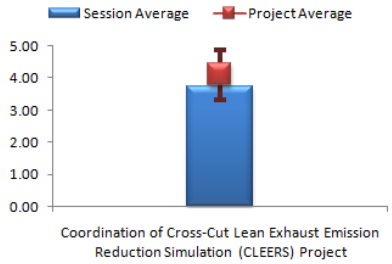
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Degradation Mechanisms in Advanced Catalysts for Urea SCR (CRADA with General Motors) (Charles Peden, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer states that selective catalytic reduction is a key issue in applications.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
No comments were received for this query.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
No comments were received for this query.

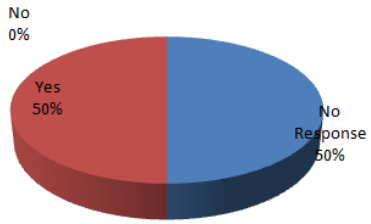
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
No comments were received for this query.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
No comments were received for this query.

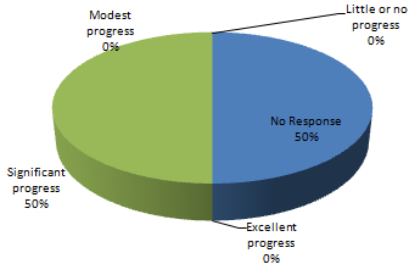
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Degradation Mechanisms in Advanced Catalysts for Urea SCR (CRADA with General Motors)

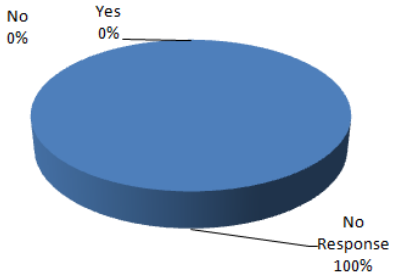
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



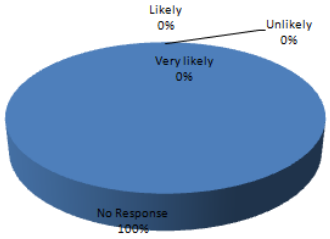
Question 3: Characterize the technical accomplishments and progress toward goals.



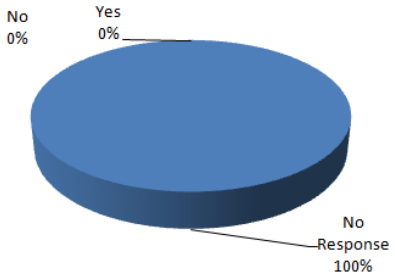
Question 2a: Are the goals of the project technically achievable?



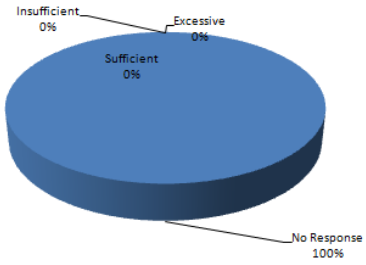
Question 4: How likely is the project team to move technologies into the marketplace?



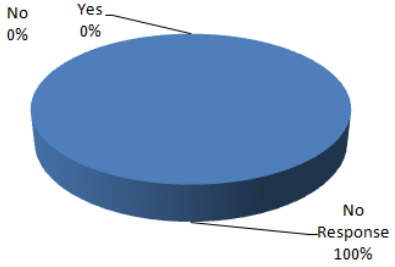
Question 2b: Have the technical barriers been identified and addressed?



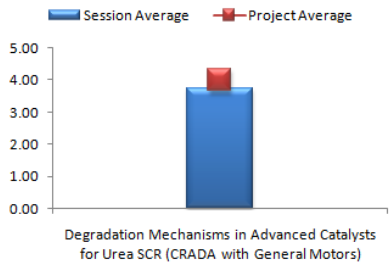
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive) (Darrell Herling, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented on the minor impact on BSFC/MPG by advancing that substrate state of the art. Another reviewer stated the project helps enable automotive diesel technology, and one reviewer added that DPFs are needed for diesel engines. One reviewer felt that this was a technology transfer of CLEERS technology, and seems to be capable of catalyst design to potentially improve the DPF technology state of the art. The reviewer continues by noting that successful application and refinement over time could have a more significant impact. A reviewer commented that this was a nice technical CRADA with Dow. One reviewer stated that alternative materials provide low backpressure characteristics compared to other types of filters. It was also said, by a reviewer that advanced DPF substrates can deliver lower pressure drop across the device, and/or improved filtration efficiency, thereby reducing petroleum use by modern diesel engines. Another reviewer wondered why this material (Dow ACM) was chosen (lower back pressure). The reviewer also wondered about durability.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that there were no quantitative targets, so R&D will generally move the project forward. The reviewer felt it is not really possible to gauge success. Another reviewer stated that there was the right mix of analytical (modeling) and experimental tools applied to characterization of advanced filter substrates. Another reviewer stated that the concentration of catalyst is very extreme on the leading edge. One reviewer said that using this different, not a monolithic DPF, is very important in order to understand the breadth of technologies that might be in the marketplace.

A reviewer commented that Dow acicular mullite micromodeling was used to make higher level models more robust by understanding fundamentals. The reviewer added that digitized re-construction was based on 2D images and a stochastic approach, and that this was building upon single channel understanding. The reviewer stated that it was difficult to account for needles/soot interactions, but is trend correct; i.e., filtration efficiency benefit? The reviewer continued that little known/presented on cost of ACM and control of mictrostructure uniformity (extrusion effects on needle morphology).

One reviewer stated that it was within the confines of CRADA, while another stated that this was results reporting, but that the technique to describe the needles is very interesting.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that there were no quantitative targets so R&D will generally move the project forward, but it is not really possible to gauge success. The reviewer added that the results presented included 2006 results, but that results for 2007 seemed limited.

Another reviewer wondered about durability after active soot regeneration events. The reviewer was also interested in knowing the maximum temperature limit of the material. The reviewer questioned

what the limitations of this filter were compared to others in the market. The reviewer showed concern about durability and wondered what happens when large amounts of HC enter the filter during active filter regeneration.

A reviewer saw a good correlation of simulations under the CLEERS programs on cordierite. The reviewer felt that tailored microstructures show promise. Another reviewer felt that there was good advancement in a uniquely-tailored CRADA for Dow's material. Another reviewer felt that the preliminary modeling results seem to be validating fairly well against available data. One reviewer stated that the talent and the tools are in place in order to achieve the goal.

One reviewer felt the project had not shown a lot of insight yet, while another stated the project has come to a close.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that this CRAD seems to be applying the technology PNNL developed within the CLEERS DPF project, so this project is in itself a technology transfer/market transformation. Another reviewer stated that Dow Automotive is a partner; communication also through CLEERS, while another stated that Dow will evaluate the technical feasibility and market potential. One reviewer stated that, considering that the project is a CRADA with an industrial partner (Dow), it is very likely that useful results of this research will be commercialized.

One reviewer felt that the mullite material has great potential, and studying it in detail is the correct thing to do. A different reviewer stated that the needle-like structure provides good back pressure behavior, however, lower on filtration efficiency is a big concern as well as the material's safety issue. Another reviewer thought the project assumes ACM cost can be competitive.

A reviewer believed there was way too much Pt loading (120g/ft^3), and suggested the project try <15g/ft^3.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

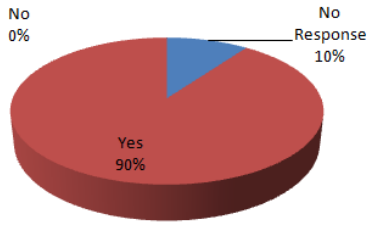
One reviewer stated that is was the final year of the CRADA. Another reviewer felt Dow should be matching the funding. A reviewer believed that funding of $150,000 seemed sufficient, considering the CRADA partner is funding the same amount. A reviewer suggested exploring the possibility of using the filters for 4-way applications.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

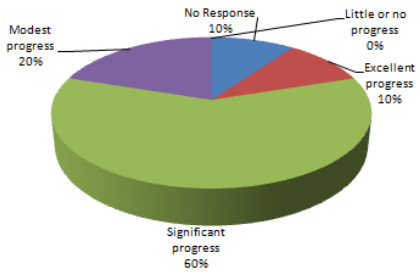
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive)

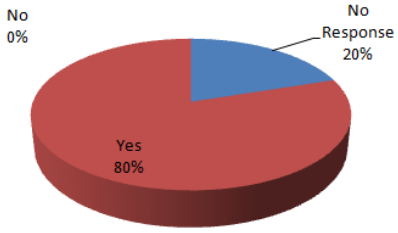
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



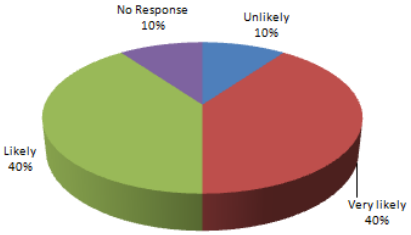
Question 3: Characterize the technical accomplishments and progress toward goals.



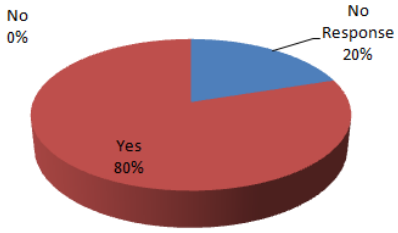
Question 2a: Are the goals of the project technically achievable?



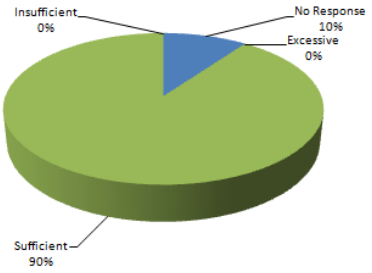
Question 4: How likely is the project team to move technologies into the marketplace?



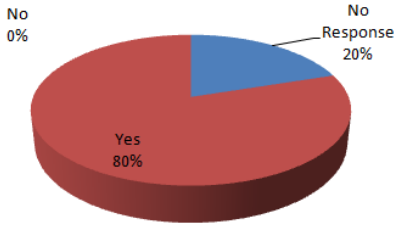
Question 2b: Have the technical barriers been identified and addressed?



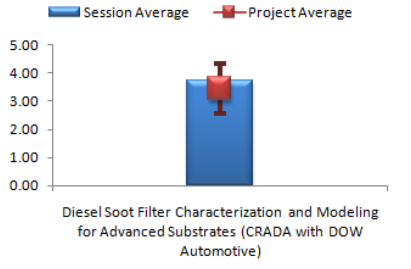
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Investigation of Aging Mechanisms in Lean NOx Traps (Mark Crocker, of University of Kentucky)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer cited a nice parametric look at Ce LNT washcoats and felt it would be advantageous to target higher benefit washcoats for subsequent work. Other reviewers cited an improved understanding of LNT chemistry that may lead to reduced petroleum use by the engines that will use LNT for NOx aftertreatment.

Another reviewer mentioned that the project was aimed at durability improvements and optimized catalyst performance over aging history via compositional changes. One reviewer believed that LNT aging has been identified to be a major barrier before commercialization. The reviewer adds that a fundamental LNT catalyst study at chemical and physical processes level to study aging effect is highly desirable. The reviewer continued that for a real catalyst, the function of each component for catalyst performance as well as durability and their synergic interactions are highly sought after for better design catalysts and engine operation. The reviewer said that this project squarely addresses the key issues regarding to the LNT catalysts.

One reviewer said that the work is worthy of support. The reviewer asked is there a rationale for continued funding of this program by VT since the focus now is on more deployment rather than basic research. The reviewer wondered should it be funded from Basic Science instead. Another reviewer felt the work was somewhat repetitive of earlier work by other authors.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that for the first review the data presented looks very good. The reviewer felt the next step is aging of LNT catalysts. The reviewer found the approach to be sound, and saw good collaboration with OEM. A reviewer felt that testing aged catalysts is important. The reviewer was glad the work respects this. The reviewer also noted that varying the LNT formulation composition is different than everyone else which tend to treat the catalysts as black boxes.

A reviewer noted good progress with ceria additions showing multiple benefits including low temp conversion efficiencies, storage capacity, and desulfation. The reviewer notes progress with LNT aging on a bench reactor to optimize catalyst performance over aging cycle.

A reviewer commented that the project addresses a real-life issue and a product development hurdle. The reviewer adds that the project seems to capitalize on a specific core competency to help industrial partners. Another reviewer felt that these model catalysts are much more representative than past (simpler) model catalysts.

A reviewer stated that the project plan, experimental facility and selection of research areas, is complementing work done in the National Labs. Another reviewer saw this as an excellent comprehensive study of the effects cerium has on LNT performance, the reviewer added that this was a “beautiful study.”

Another reviewer states that with knowledge of commercial catalyst components, the project addresses the role of each individual components and effects on aging characteristics by using bench top reactor in simulated gas stream, and DRIFTS and oxygen storage capacity measurements. The reviewer continues that after aging, the catalysts were studied again. The reviewer states that the current work appeared to focus on OSC impact to LNT and on aging.

A reviewer comments that the program is focused on one aspect of NOx adsorber technology which has not been well characterized (at least that knowledge is not available in the public domain) - the relationship between the catalyst formulation and various aspects of its performance. The reviewer continues that the program systematically explores key formulation variables and uses solid experimental protocols to evaluate these.

A reviewer wonders how this project is fundamentally different than the CRADA work at PNNL on LNT degradation. PNNL was also getting into fully formulated catalysts. The reviewer adds that the SpaciMS continues to show usefulness.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer comments that this is the first review for this work, but already a lot of good conclusions/findings are being communicated. The reviewer adds that there is excellent return on investment. One reviewer stated that many useful results were already obtained, specifically in the area of catalyst selection and desulfation mechanisms. A third reviewer stated that the project, in its first year, already had substantial numbers of formulations prepared at University of Kentucky and characterized at ORNL and Ford. A reviewer felt that there had been excellent progress for a first review, but would like more information on cost impact (i.e. the reduction of precious metal content).

One reviewer cited the work with fully formulated catalysts and the realistic lab simulations. Another commented on the interesting data for a useful range of formulations. The reviewer added that data on aged pieces will be very interesting. Another reviewer commented that studying composition changes helps identify formulations that may remove the technical barriers.

Reviewers focused on the Ce addition into the catalyst improving catalyst performance, selectivity to N_2, aging and regeneration. A reviewer adds catalyst characterization tools appeared to be more OSC specific. The reviewer said its other synergistic catalyst function needs are to be emphasized as desired. The reviewer felt it was desirable to see more spectroscopic study on the catalysts, to see where sulfur is stored, what surface interaction with Ce is seen, and how much OSC is affected by stored sulfur before and after aging. The reviewer would like to see more microscale study on the catalysts as the project is carried by academia. Reviewers believed that Ford had an internal aging protocol 4-5 years ago, and why do it again. The reviewer also wondered if real exhaust was used.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Progress was seen to be good for a first year project. Good ties to Ford and Umicore were also cited, and it was believed this would lead to technology transfer. A reviewer added that the fundamental study will have direct impact on catalyst formulation. The reviewer continues that with an OEM as a partner, the learning from the study will likely to be implemented if a commercial value is proven.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

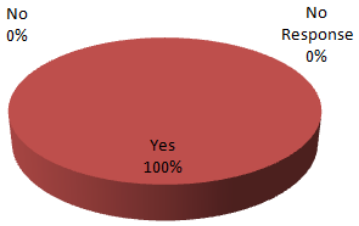
A reviewer felt that additional funding would be made available based on the successes of the first year. The reviewer added that it seems commensurate if most of the work is performed at UK. A reviewer wondered what the total budget of this excellent effort was, including the partners contribution. Another reviewer felt the funding seemed adequate considering the project's complimentary nature to many other LNT research projects funded by VT. One reviewer felt that current funding was insufficient.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

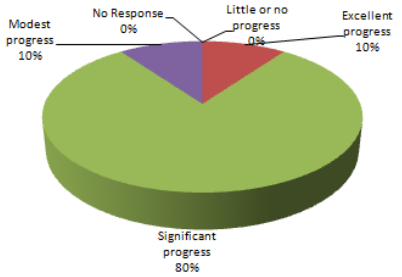
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Investigation of Aging Mechanisms in Lean NOx Traps

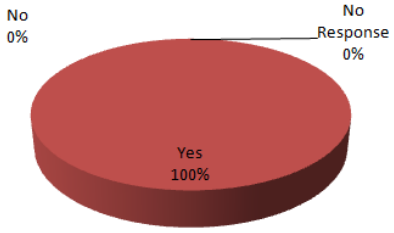
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



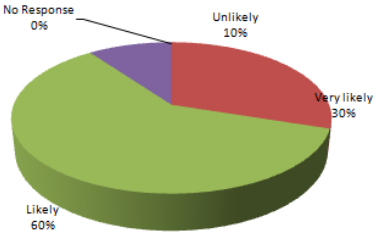
Question 3: Characterize the technical accomplishments and progress toward goals.



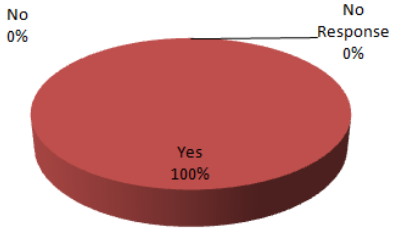
Question 2a: Are the goals of the project technically achievable?



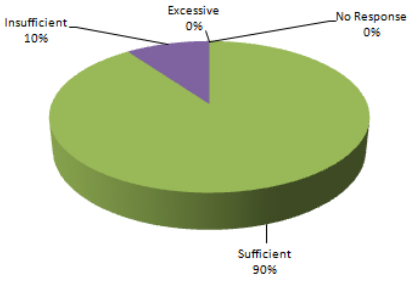
Question 4: How likely is the project team to move technologies into the marketplace?



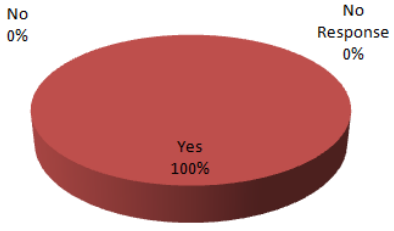
Question 2b: Have the technical barriers been identified and addressed?



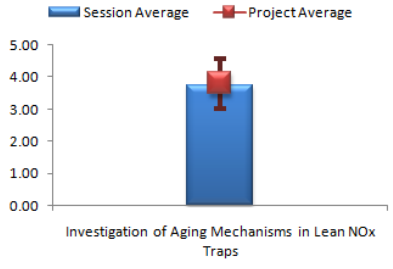
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Kinetic and Performance Studies of the Regeneration Phase of Model PT/RH/Ba NOx Traps (Mike Harold, of University of Houston)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer felt that an advantage seems to be a unique approach toward looking at LNT washcoat chemistry and kinetics. The reviewer is not sure how effective the modeling data is (kinetics) but it would seem that the data developed makes a good database for follow-up investigation. The reviewer wondered if there were follow-up investigations underway. A reviewer commented on diesel engine market penetration and fuel efficiency. The reviewer also noted an excellent graphic on the Houston skyline which emphasized the impact of the project.

A reviewer stated that the work is worthy of support, but wondered if there is a rationale for continued funding of this program by VT since the focus now is on more deployment rather than basic research. The reviewer also wondered whether the project should be funded from Basic Science instead, since it is in the third year of a four-year program.

A reviewer stated that LNT catalysts are necessary for diesel and probably mixed-mode gasoline engines. A commenter noted that better understanding of LNT processes, including better modeling tools for LNT design optimization, can lead to lower petroleum use by the engine that will use such devices.

One reviewer said that this program is far more rigorous in molecular modeling and fundamental than any of the CLEERS-related programs.

One reviewer said that a predictive LNT reactor model is required to have main chemistry and transport processes for fundamental understanding, and suggest design the catalysts and operate engine to fit catalyst requirement. The reviewer suggests fundamental studies on transient kinetics and LNT regeneration, evaluating and compare the reductant performance, design and optimize predictive model based on experimental data, and test the newly designed LNT on a HDD dynamometer. The reviewer states that the project systematically studies fundamental to design practical catalyst system supports the DOE objective for fuel efficiency enhancement.

One reviewer states that early NOx adsorber systems on the market are quite non-optimal and better understanding of this technology should lead to improved fuel efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer found the approach to be unique. Another reviewer felt the project addresses a real-life issue and a product development hurdle. The reviewer adds that the project seems to capitalize on a specific core competency to help industrial partners.

Another reviewer comments that a symbiotic relationship between experimental studies and modeling efforts creates a good basis for reaching better understanding of LNT performance, allowing better design and integration of LNTs.

One reviewer considers this to be the most promising of all the other LNT modeling programs which are too phenomenological and empirical. The reviewer adds that this program is excellent and sets the bar much higher than the other CLEERS programs.

The microkinetic approach was seen as approaching incorporation into reactor models in a joint project with Ford and BASF catalysts. TAP reactor seems very sophisticated to get fundamental understanding of reactions using actual monoliths rather than powders; provides excellent path to correlate with engine samples. Another reviewer found the work on microkeinetics of LNT useful.

One reviewer commented on the bench-scale reactor system that provides atmospheric pressure reaction in simulated gas exhaust system; the reviewer added that the TAP reactor provides ultra-high vacuum flow transient study for the catalyst and monolith; the reviewer continues that separated catalyst characterization provides information on microscale information over the catalyst surface and the reviewer mentioned the computer for microkinetics and LNT model. The reviewer ended that the computer for dynamometer system provides a testing facility for designed catalyst for evaluation and further improvements.

A reviewer stated that this program addresses several aspects of the NOx adsorber technology which are not covered by any other program in the reviewed portfolio; in particular, it targets to quantitatively de-couple the reaction engineering aspects of the NOx storage and regeneration process from the chemical mechanisms. The reviewer continued that the involved set of experimental tools and expertise at UH (including modeling) appears to match well the project objectives.

One reviewer described the project as a great education exercise and wondered if SpaciMS would be of use here.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer said that it was hard to judge technical progress: it could be that barriers have been overcome, but the reviewer was not certain. The reviewer looks forward to seeing modeling next year.

A reviewer states that the reactor results are very encouraging, but 'fundamental' studies can often impede progress toward deployment. The reviewer adds that, for example, the study of the effects of monolith length on ammonia formation was interesting, but the impact on objectives was not clear. The reviewer believes that modeling should focus on clear reduction of costs through formulation optimization.

A reviewer comments that some of the findings made by the program during its first year were very interesting and of practical significance, for example the finding of the difference in the reactivity of NH_3 and H_2 as reductants for NOx regeneration. Another reviewer cites good bridging of fundamental/basic research to real-life product developments.

A reviewer says that the TAP reactor system was applied on model catalysts and provided detailed reaction sequences and separation between diffusion and surface reaction, so that work provided information on intrinsic reaction kinetics. In addition, the temperature of the catalyst is well controlled. The reviewer continues that it is desirable to see the study on real LNT catalysts which has other components for promoting catalyst performance. The reviewer says the TAP study will define the synergy effect of the additive to the LNT model catalysts, which will provide insights to develop new catalysts or new chemistry. The reviewer continues that the benchtop reactor provided information

on catalyst performance in simulated exhaust gas. The reviewer concludes that the fundamental study is hopefully (funding availability) extended to catalyst durability, which is major concern after desulphurization many times for the industrial applications.

A reviewer felt that the project seems to get at the difficult question of the importance of Ba-Pt "intimacy", among other data. Another reviewer feels that this program will yield more useful information then all the previous reviewed CLEERS modeling programs. A different reviewer noted that the modeling had begun.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer needed to see the modeling results to really understand. A number of reviewers cited a strong partnering with Ford and BASF and that this would lead to information dissemination from the project to the marketplace. A reviewer added that there was a strong history of publication, citing both DEER and SAE. A different reviewer also listed the 'synergistic studies' with State of Texas for retrofit, Houston; pull from HD side of market. The project was described as relevant work by a reviewer. One reviewer commented that by working closely with a catalyst coater and an OEM, the knowledge developed from this fundamental study is readily transferred to the commercial side for new products and applications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

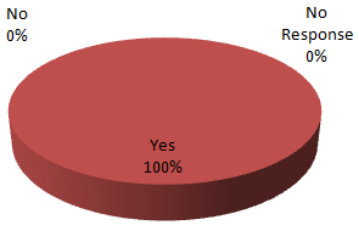
A reviewer stated that more effort is justified for determining the kinetics of various LNT formulation compositions. The reviewer recommends the project team talk with Mike Crocker and obtain his samples that have different Ba, Ce, and precious metals. The reviewer gave the examples of which composition avoids NH_3 and which make more NH_3. A reviewer described the project as university-based research with good support from Ford and BASF. One reviewer wondered what the total budget, including partners contributions were. Another reviewer felt the funding was sufficient, considering the leverage of other funding from the state of Texas.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

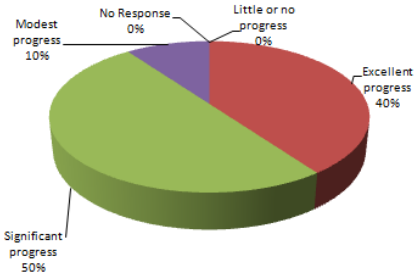
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Kinetic and Performance Studies of the Regeneration Phase of Model PT/RH/Ba NOx Traps

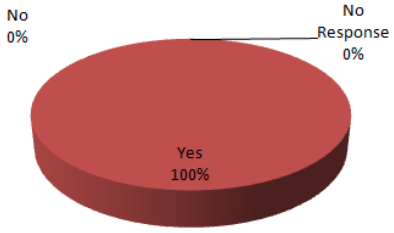
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



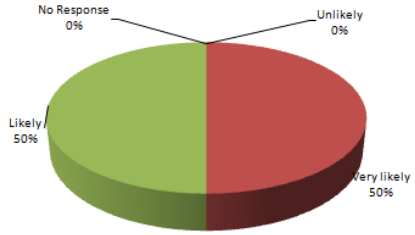
Question 3: Characterize the technical accomplishments and progress toward goals.



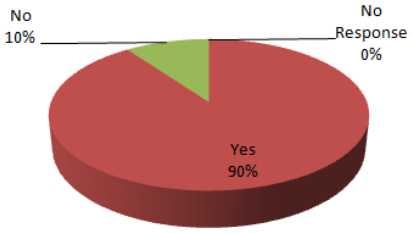
Question 2a: Are the goals of the project technically achievable?



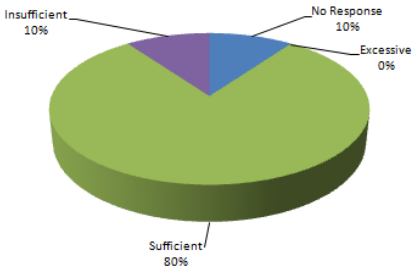
Question 4: How likely is the project team to move technologies into the marketplace?



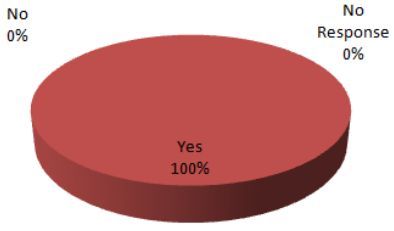
Question 2b: Have the technical barriers been identified and addressed?



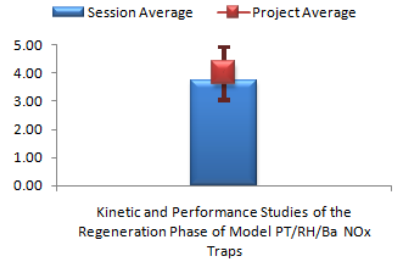
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation (Jim Parks, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer states that NOx aftertreatment and combustion work, especially as integrated in this project, serves the DOE goals. The reviewer adds that the integration may be best suited to an OEM with more control of ECM, FIE, LNT controls and hardware. The reviewer continues that ORNL is covering a lot of basic development (EGR/combustion/engine hardware) and believes that this is really what OEMs do best - this is not a good topic for ORNL activity. The reviewer found the LNT activity very interesting, and stated that it was valuable to show the basic characteristics. The reviewer adds that they believe this is what national labs do best.

Another reviewer said the project focus on the light-duty diesels, which assume the system costs, will be acceptable for this market sector. Another reviewer states that the objective is directly related to VT and nicely fits into the core charter. The reviewer continues that technology deployment aspects are in focus as the research work covers fundamental characterization to engine testing with HECC.

One reviewer says that both projects address important needs. Another reviewer answers that the work fits the DOE goals by enabling diesel technology introduction that will lower our dependence on oil via higher mpg. The reviewer adds generally this is diesel enabling, and fits the mission of DOE. Another reviewer comments on a better understanding of LNT regeneration and desulfation will help reduce diesel fuel use.

One reviewer mentions the regeneration chemistry and performance of the LNT system and the system performance under multimode engine operation condition is highly relevant to lean deNOx. Multimode operation further improves fuel efficiency for a diesel engine.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that there are no quantitative goals so it is easy to say that the "directional" objectives will be attained. The reviewer suggests that DOE may want to consider requiring quantitative goals to clarify objectives - this is a global comment - not specifically for this work. The reviewer continues that a clear quantitative goal in this project would allow an easier optimization of control strategies between the different combustion modes - the goal would allow a translation between NOx emission and BSFC.

The same reviewer continues that the ORNL project may want to consider modeling the LNT around each combustion point to select the optimal point considering engine-out and LNT efficiency conditions - the LNT activity may alter the optimal point selection and could improve the efficiency level. This reviewer said it was good to note the space velocity impact and advantage of advanced combustion modes - this is an advantage, and adds that it is hard to imagine deployment for the advanced combustion activity. The Ce LNT activity has good potential.

Another reviewer suggests detailing the regeneration events for each different engine approach. The reviewer wonders what the emissions are and the lambda value and profile, such as H_2, CO, and HC.

The reviewer continues that the lower values of NH_3 during HECC should be directly related to the engine-out NOx, especially during the DeNOx event.

A reviewer comments on emissions, durability, and cost being listed as barriers, and suggests that the details for understanding and overcoming the latter two were implied via efficiency as measured by total fuel usage which included LNT. The reviewer continues that well-planned approach coupling LNT with HECC; and good connection to other related initiatives ('bubble slide').

Another reviewer comments that there was excellent bridging of fundamental/basic research all the way to real-life applications.

A reviewer suggests that there seem to be so many possible avenues that the objectives and goals are not clear. The reviewer continues that many good things can be done, and cites a need to focus on what the funding can cover. The reviewer ends that desulfation and durability were not mentioned very much.

A reviewer says that introduction of Ce-based LNT is a useful addition to the scope of the project. Another reviewer mentions a good effort in trying to understand a complex system and different options and the implications that result in areas like coking from EGR. Another reviewer mentions that lots of detail on how to implement is useful.

Another reviewer suggests linkage of LNT performance to a diesel engine operation under multimode is highly desirable. A catalyst system can handle both NOx and high HC and CO under engine operation conditions. One reviewer states that this program is building on several key strengths of FEERC, including extensive experience with laboratory testing of NOx adsorber materials, engine combustion expertise and advanced gas analytics.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer states it seems that a lot of activity is on hardware/EGR tuning/development/deposits. The reviewer sees a reliance on obsolete hardware as a problem, and states the move to the GM engine is good. One reviewer says that there has been good progress on LNT/HECC optimization for efficiency while meeting emissions. The reviewer was still not clear on costs (initial & O/O) and durability effects; e.g., total fuel usage and additional EGR deposits.

One reviewer mentions that technology deployment aspects are in focus as the research work covers fundamental characterization to engine testing with HECC. The reviewer adds that the project addresses multiple emissions reduction barriers in a systematic fashion, and that realistic engine operation, albeit with an "older" Mercedes engine. The reviewer notes the carcass is Mercedes Benz but the NTRC researchers made state-of-the-art hardware out of it. The reviewer also says that the project addressed realistic multi modes. The reviewer ends by saying that the questions of last year's reviewers were thoroughly addressed.

One reviewer felt that it was good work, but wondered whether OEMs have similar data internally. The reviewer still felt that the public and published data is very valuable.

Another reviewer felt that it was hard to access project 9248 since it was presented together with project 12249. The reviewer added that their perception was the LNT work was repeating a lot of previously conducted work, and that the project overlaps with other current LNT related projects.

A reviewer comments that this is basic engine development, and that the results can be used in a sort-of benchmark mode to check engine development. The reviewer adds that HC SCR would be very useful and that the nanotubes idea is great and has a lot of potential. The reviewer believed that noise was an oversight.

A reviewer states that the project explored HECC and LNT synergy and found an optimal operation condition. The reviewer adds that, under heavy EGR, HC coking and deposition in EGR issue needs to be addressed.

Another reviewer adds that an outstanding volume/quality of complementary experimental data related to the impact of various combustion modes/strategies on the operation of a NOx adsorber catalyst. The reviewer continues that the project includes a healthy mix of applied research (on-engine evaluation supported by the advanced gas analytics), in-depth lab research (bench-scale tests) and even some exploratory work (testing of some advanced concept catalysts from U. Kentucky).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that development is probably behind the OEMs, so either the project must accelerate the activity and use more sophisticated methods or alter the focus to specialize on a more specific aspect of controls integration, or LNT/HECC optimization.. The reviewer adds that the scope of activities may be too broad.

Another reviewer commented on the project being well connected with the stake holders and doing relevant work. One reviewer said that there was useful data for OEMs, suppliers and university research, A reviewer mentioned that considering near-term plans in the industry for LNT commercialization, it is likely that whatever improvements can be derived, will be picked up by the industry.

One reviewer felt this was the type of information that advance calibrators use at an engine company. The reviewer adds that the findings about deposits should not be overlooked. Another reviewer states that there is a strong track record for publishing in the high impact/relevance meetings and journals (DEER, SAE, etc) and close ties to CLEERS community. One reviewer assumes the project will develop a stronger partnership with Engine OEM such as Mercedes Benz or GM.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

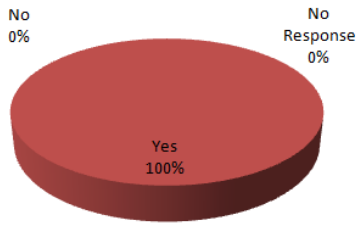
A reviewer suggests considering to do the urea-SCR work before the HC-SCR concept. The urea-SCR concept is more likely to deliver more interest and potential for transfer to industry. Another reviewer suggests that more is better for a wholesome and integrated plan such as this. The reviewer continues that the team core competency is high and should be leveraged with more support. One reviewer states that a faster pace of results would reduce the risk that it only duplicates what industry is doing internally. The reviewer continues that more value would be delivered with a faster effort. The reviewer suggests focus on most important goals so real progress can be made; avoid trying to work on everything all at once. A reviewer mentions that the funding seems excessive, especially considering the large number of LNT projects.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

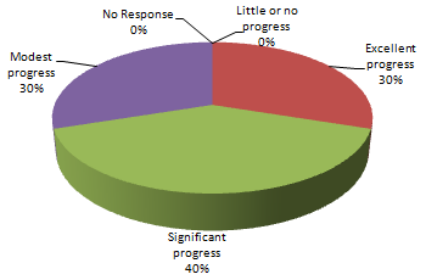
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation

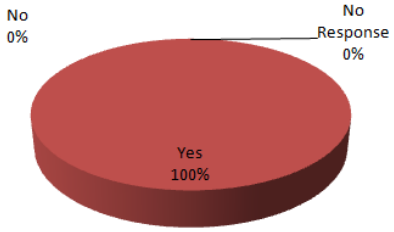
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



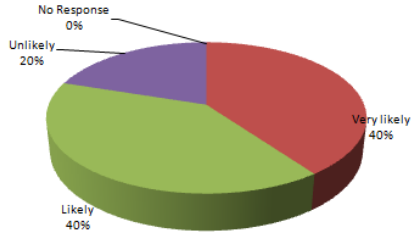
Question 3: Characterize the technical accomplishments and progress toward goals.



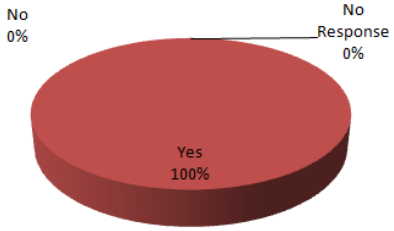
Question 2a: Are the goals of the project technically achievable?



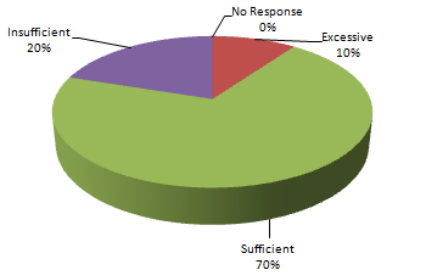
Question 4: How likely is the project team to move technologies into the marketplace?



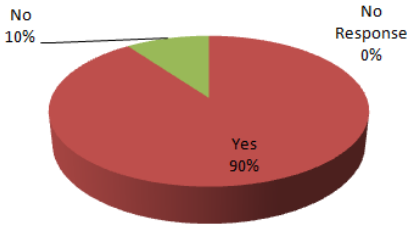
Question 2b: Have the technical barriers been identified and addressed?



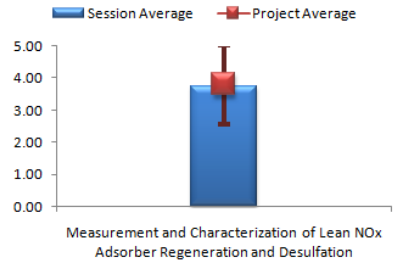
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) (Charles Peden, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that effective LNT technology enables LDT diesel implementation. Another reviewer said that CRADA with Cummins and Johnson-Matthey as a collaborator assumes commercialization of LNT is successful (Dodge Ram) long term to afford lower BSFC. Another reviewer commented on the excellent collaboration with Cummins and Johnson-Matthey via a CRADA.

It was stated, by a reviewer, that NOx catalysts are required for diesel engines. Another reviewer felt that improved understanding of sulfur poisoning of NOx adsorbers is likely to lead to improved aftertreatment devices and their integration, thereby reducing diesel fuel use. One reviewer commented that sulfur poisoning is the key hurdle for LNT catalyst application. The reviewer continued that fundamental understanding is critical for better design catalyst. A reviewer felt that the project was in line with DOE's vision.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that base LNT technology is already deployed, tweaking this via this technology has much potential for this limited application, but more importantly to develop the methodology for designing catalyst systems from scratch. The reviewer believes this would have a huge deployment payoff. A reviewer commented on the great partnering with key CRADA stake holders. The reviewer added that PNNL has the correct high tech analytical facilities to study the degradation mechanism.

One reviewer commented that working directly with a catalyst supplier and OEM seems to be a very effective method to quickly enhance catalyst development. Another reviewer spoke of the forging ahead with the release of the 2007 Dodge Ram truck.

A reviewer saw signs of excellent collaboration bringing first-rate lab capabilities together with industrial partners actively developing consumer products. Another reviewer felt with the application of the state-of-the-art characterization tools it is very likely that the sulfur poisoning mechanism will be better understood through this project. A reviewer stated that there was a fundamental understanding of sulfur degradation: optimum removal strategy before regeneration without significant fuel economy penalty.

A reviewer was unsure if a commercially viable way of easy sulfur removal will be developed in this effort.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that five years to look at sulfur deactivation is too long to impact the initial application, since the LNT technology is already deployed. The reviewer found the water impact interesting, but was unsure how to avoid water in any internal combustion engine.

One reviewer commented that giving data and input to Johnson-Matthey has proven to speed up catalyst development. The reviewer added that more CRADA programs should be done this way.

A reviewer stated that optimum processes for removing sulfur through fundamental understanding of reaction mechanisms were developed. The reviewer added the there had been an impressive use of the NSLS facility to identify sulfur species and formation sites, as well as to identify positive and negative effects of water. The reviewer wondered what the recommended resolution is, since water is always present in exhaust.

A reviewer noted that the value is reflected by the apparent interest from the industry partners to extend the project. Another reviewer commented that several important findings have been reported, including effect of water, influence of ceria-supported catalyst, etc.

A reviewer said that sulfur pick-up and removal under various conditions showed a whole cycle of sulfur on the catalyst. The reviewer added that the optimal condition for removing sulfur with spectroscopy data helped optimize the catalyst operation condition.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer was not clear on what the technical deliverables are, but added that if there are technical results that can be applied, there is a clear path to apply to the Dodge Ram. The reviewer continued that the overall technical approach of designing active catalysts from scratch is a noble and high payoff objective, so good results will find their way to the market.

A reviewer stated that the technology was already transferred, but the durability of the LNT at end-of-life is to be determined. Another reviewer felt that it had sort of done already. Several reviewers felt that the CRADA partners would use the technology directly. One reviewer added that this was a very good relationship, a fact which had been mentioned to him by members of both organizations.

One reviewer felt that regular technical reviews help to keep progress on track. The reviewer added that understanding of degradation must be accompanied by cost-effective methods to prevent.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

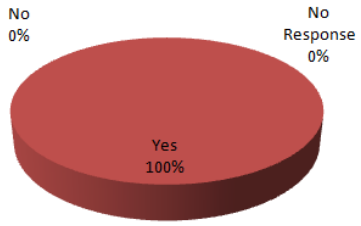
One reviewer said that it seems like a lot of work for $150,000. Another found the resources reasonable, considering the CRADA partner matching. One reviewer commented that the project comes to a close in 2008. Another reviewer wondered how much of the DOE funding goes for travel, publications and the like.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

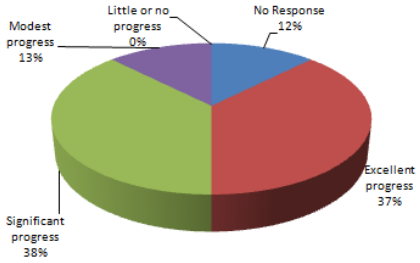
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins)

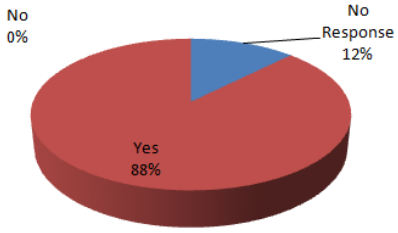
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



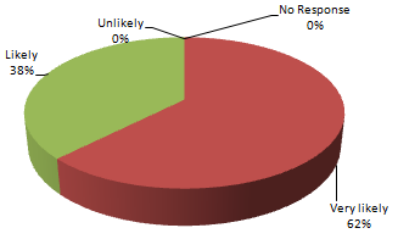
Question 3: Characterize the technical accomplishments and progress toward goals.



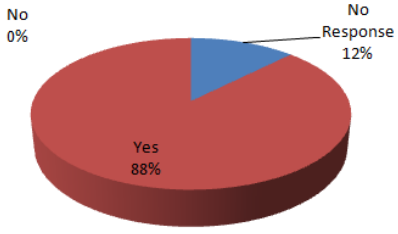
Question 2a: Are the goals of the project technically achievable?



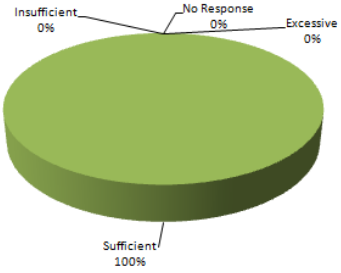
Question 4: How likely is the project team to move technologies into the marketplace?



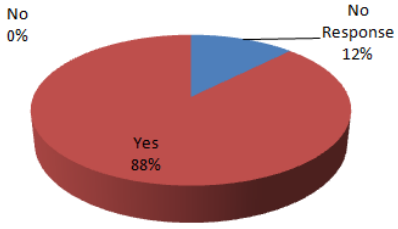
Question 2b: Have the technical barriers been identified and addressed?



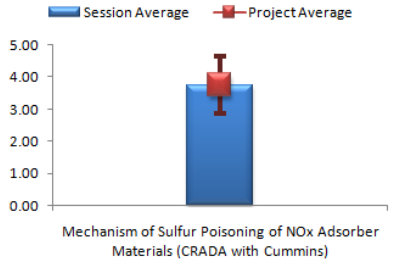
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NOx Adsorber Fundamentals (Charles Peden, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that any reduction in NOx emissions via active aftertreatment provides potential to break the traditional BSFC - NOx tradeoff. The reviewer adds the consortia based, non-competitive based approach moves the industry/academia forward in a collaborative way - the end result is better thermal efficiency.

Another reviewer states that the early NOx adsorber systems on the market are quite non-optimal and better understanding of this technology should lead to their improved fuel efficiency. One respondent believes that improving NOx storage capacity at high temperature greatly enhances GDI potential benefits to improve fuel economy. A reviewer states that diesels need NOx catalysts, and LNTs need significant improvement in cost and robustness. Another reviewer comments that LNT is one of the key technologies for Lean deNOx, which boosts fuel efficiency under lean burn condition for engines, while meeting gaseous emission standards.

A reviewer believed that higher efficiency and broader temperature range will increase the probability of petroleum use reduction when using NOx adsorbers. Another stated that this supports the introduction of the lighter diesel engines for transportation application.

One reviewer said that the project implemented high temperature studies based on the CLEERS survey, and assumes that improved BSFC is adequate to counter fuel usage penalty. Another reviewer says that like other CLEERS projects, this is a basic research program dealing with substrates and catalyst chemistry, and that like other CLEERS projects; it may be applicable to both diesel and direct-injection gasoline.

One reviewer found good connection between mechanism and model building.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer believes that with this being a consortium-based program, deployment is essentially automatic. The reviewer adds that the steering committee has a heavy industry focus including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer continues that DOE may want to consider having a similar consortia operating for other research and development programs to enable or accelerate deployment.

A reviewer states that this project plays a distinct role in the overall portfolio of NOx adsorber-related programs by providing insights into their underlying chemical mechanisms and surface science. Another reviewer comments that the project ties to CLEERS modeling studies; effects of CO_2 and water effects on NOx adsorption and storage, and the importance of chemical composition and phase where NOx adsorbs.

A reviewer comments that there should be work on improving precious metal utilization is critical for implementation of cost effective NOx aftertreatment system for large displacement engines as well as more work needed on aged catalysts. The adsorber adds that all LNTs look good green but the reviewer want to know how it works after an appropriate aging.

A reviewer comments that unknown areas of NOx adsorber performance have been identified and the technical approach is adequate for closing gaps. Another reviewer states that the research activity has contributed to Cummins' heavy duty truck application.

One reviewer states that PNNL has used some analyses to find useful insights with tools no one else has (i.e., high resolution NMR). Another reviewer comments that the program is using the appropriate techniques to get to their answer. One reviewer felt the work was not directly applicable but should be directionally OK.

A reviewer stated that this is a results project and does not carry the delivery risk. The reviewer stated that effective use the washcoat and precious metals is also of prime importance for cost. The reviewer went on to say that the learning will be useful in constructing real systems, and added that the layering of NOx storage was fascinating.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer states that CO_2 and H_2O impacts are quantified but was not sure how important the result is. The reviewer continues that the impact of the substrate, the impact to the overall kinetics is valuable and shows that the screening method should be applied more widely to screen substrate materials. The reviewer expressed concern that results are limited to degreened catalysts, when they really want to know the full thermal aged impact.

Another reviewer comments that the work identified phases of sulfur adsorbed on Alumina as "monolayer" and "bulk" phases which gave different performance characteristics for NOx adsorption. CO_2 affects bulk nitrate decomposition, mostly delay NO_2 release and reduce NO deabsorption.

One reviewer states that the insights on barium sites are very exciting, and depend on unique capabilities at PNNL. Work on PGM dispersion will be very important. Another reviewer states that the reported results elucidated several significant aspects of the NOx adsorber chemistry, for example offered possible explanation for the existing literature controversy regarding the impact of H_2O and CO_2 on catalyst performance due to different populations of Ba on the catalyst surface. The reviewer continues that the initial work on the high-T adsorber material also appears quite promising.

Another reviewer says that this was a good presentation of compositional changes and differences between bulk and monolayer sites - mechanism during regeneration, higher activity with magnesium aluminate vs. alumina as support for BaO and Pt allows better dispersion to avoid sintering of Pt.

A reviewer comments that $MgAl_2O_4$ support material and its dispersion characteristics are nice studies. The reviewer adds that the work identifies potential ways of having reduced precious metal loading, which can lead to broader use of NOx adsorbers. Another reviewer comments that the work is solid and it appears to be very original. This reviewer thinks the catalyst system designer can use this material.

One reviewer stated that hopefully a more rigorous treatment of the data will lead into more formal mechanistic modeling.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that the Cummins support is indicative of this tech transfer, the reviewer adds that nine technical publications over the last year are very impressive. Another reviewer comments that

the CRADA with Cummins with good acknowledgement from John Wall (VP/CTO at Cummins), the reviewer adds that upcoming work addresses likely combinations with DPF downstream, and that transfer depends on market for LNT's in light duty diesel applications. Two other reviewers commented on the close cooperation with industry via CLEERS and several CRADAs.

A reviewer felt that the work encouraged catalyst suppliers to reformulate their LNT catalysts with the new spinel alumina. Another reviewer commented that systematic study on alkaline earth doped alumina and gamma-alumina is highly useful to stabilized adsorber and platinum catalysts are highly valuable.

Another reviewer stated their belief that incremental improvements of efficiency and thermal operating range are likely to be used in commercial devices. One reviewer said that Toyota had revealed a parallel path and will apply it. A reviewer believed that some of the findings are already being used in the market transformation

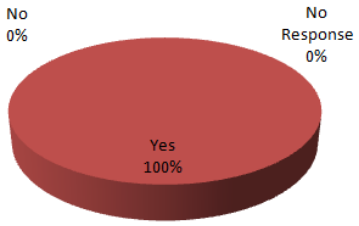
One reviewer stated that it would be very helpful to have all the CLEERS work highlight how all the labs work together. The reviewer believed it was not done well and was confusing. The reviewer believes it appears that there are competing groups and overlap of work, which is probably not the case. The reviewer mentions this here but it is a comment basically on all the CLEERS work. The reviewer believes this could be corrected with a summary slide and how all these are organized within this program and not repeat similar sounding programs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer questioned why this project received $400,000 compared to less funding for other projects. The reviewer wondered how much effort is expended on publications, presentations and travel. “Same comment applies for other projects throughout!” this reviewer commented. Another reviewer commented that while the project by itself is adequately funded, there are overlaps of technical activities at other NOx adsorber projects at other National Labs. One reviewer stated that as the program has continued for a few years, the program is approaching its close in next year.

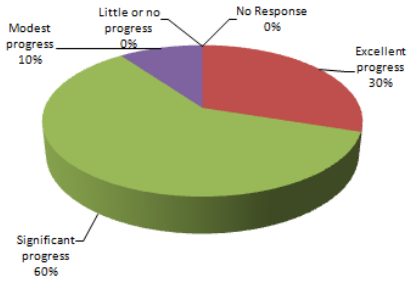
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project’s summary score.

Project: NOx Adsorber Fundamentals

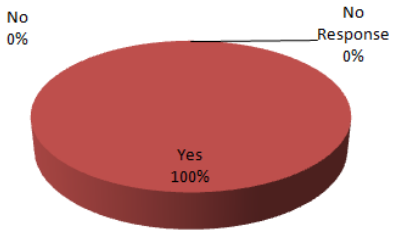
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



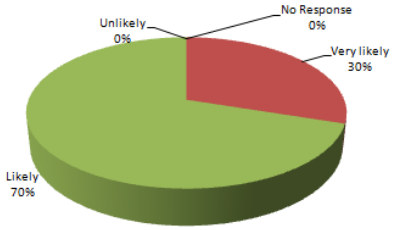
Question 3: Characterize the technical accomplishments and progress toward goals.



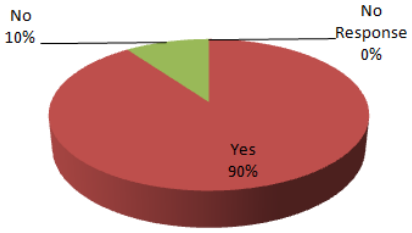
Question 2a: Are the goals of the project technically achievable?



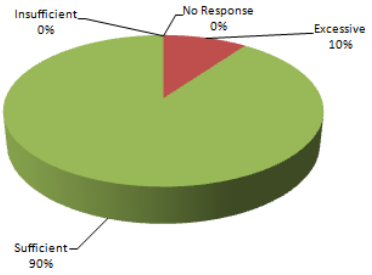
Question 4: How likely is the project team to move technologies into the marketplace?



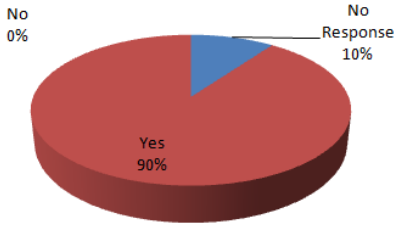
Question 2b: Have the technical barriers been identified and addressed?



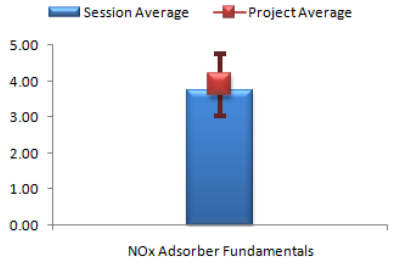
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NOx Adsorber R&D (CRADA between ORNL and International Truck and Engine Company) (Todd Toops, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 10 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer felt that LNT development and understanding was okay, but that this is not a new topic. The reviewer felt that very general objectives were presented and that it was not a new topic. The reviewer was unsure why this CRADA was important or unique. The reviewer was also puzzled that no data was present, and felt that as a result no value was being communicated.

A reviewer stated that durability of LNT was a major issue to enable dieselization. The reviewer felt the goals were limited, but that this was in keeping with the project's low funding. The reviewer thought the project seemed to be just testing used catalysts on a bench reactor. The reviewer did not believe that this requires National Lab capabilities, and that vendors such as SWRI can do this kind of testing, and all catalyst suppliers have the capability. The reviewer wondered what is ORNL adding.

A reviewer commented that while there was are no clear novel results that can come out of LNT portion of the research, the planned refocusing on SCR will provide opportunity for higher efficiency of future diesel engines, thereby reducing fuel use.

A reviewer said that at low temperature, CO and hydrocarbons tend to limit the NOx conversion due to competitive adsorption, and that the project addresses the fundamental of reaction kinetics and optimize vehicle operation conditions to optimize system efficiency.

Another reviewer stated that the VT mission can't be dealt with without addressing emissions control. The reviewer added that emissions have an associated energy penalty. The reviewer felt that technology deployment aspects are in focus as the CRADA participant is close to the front line.

A reviewer felt that work on field aged catalysts is important. Another reviewer saw good collaboration with International Truck with goals to increase NOx conversion during low temperature operations. A reviewer stated the project was in line with the DOE mission.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt the project had vague goals and needed to be more specific. The reviewer strongly suggests that DOE adopts quantitative goals, and also for intermediate goals. The reviewer felt that no specific barriers had been clarified and that no data was provided. Another reviewer felt that this was mostly measurement-based results.

A reviewer commented that there was good catalyst diagnostics work, but perhaps this was not the best use of the National Lab capabilities and expertise. One reviewer said that this is a small project, so the objectives need to be fairly modest. The reviewer continued that the generic results (relative low temperature activity of CO vs. C_3H_6) are already well known; new information is presumably the results for specific, aged catalysts.

Another reviewer was glad that the project was looking at some real industry barriers, aging and the subsequent low temperature LNT operation. One reviewer felt the project addressed higher NOx

conversion and/or fuel economy; and developed a deep/fundamental understanding of emission control chemicals over a wide range of conditions; cost effective solutions sought. The reviewer added that aging protocols jointly developed to represent engine conditions.

One reviewer felt that data generated in this CRADA with International should be helpful. It appears to fall in line with expected performance.

One reviewer felt the project addressed real-life issues and a project development hurdle. The reviewer added that the program capitalizes on NTRC core competency to help an industrial partner. The reviewer also felt that the program capitalizes on an excellent bridging of fundamental/basic research to real-life applications.

A reviewer wondered why the project would refocus on SCR, suggesting instead the project press on to ITEC to consider a 4-way catalyst approach. Another reviewer felt the planned refocusing on SCR should enable overcoming the barriers associated with LNT.

A reviewer stated that the project has systematically studied space velocity and temperature impact on NOx conversion with two reductants (i.e., CO and C_3H_6) on two different catalysts. It was observed that CO is a much more effective reductant than C_3H_6. NH_3 and N_2O were observed as reaction intermediates released to exhaust gas stream during the regeneration. However, the project needs to address the reaction mechanism when the data becomes available, coupled with surface spectroscopy to identify the regeneration pathways. It is also highly desirable to study the catalyst regeneration in the presence of sulfur. Hopefully the next program will address these issues.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer stated that there was no data provided, and that trends are not valuable. The reviewer added that without data it was hard to see any technical results or accomplishments. The reviewer saw no confidential concerns, and wondered why data were not shown. Another reviewer wondered why ITEC didn't have a supplier do the work, and stated a belief that this type of work was happening at Oak Ridge about four years ago. One reviewer felt the results so far of the LNT work are not new. The reviewer continued that some results may be useful to the CRADA industrial partner (ITEC) due to the evaluation of ITEC specific devices and data points, but would be more appropriate for the User Agreement (Work for Others) as opposed to CRADA. A reviewer found the work relevant, and the project connected with the stake holders. Another reviewer felt the results are compatible with the funding. Another reviewer said that the project evaluated two engine-aged catalysts, identified chemical processes limiting LNT performance, identified by-product variants vs. temperature; quantified reductant effect. One reviewer stated that CO and C_3H_6 are important model reductant in exhaust for learn catalyst performance. The details of reaction pathway with these two different reductants will be highly desirable for better understanding and design new catalysts.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer asked "What technology?" The reviewer continued to state that LNT is a commercial technology today in the USA, and wondered what was shown in the presentation that could not be demonstrated with a commercially-available Dodge Ram system. A number of reviewers cited direct involvement of ITEC, along with ITEC's technical direction should ensure transfer of useful results to the marketplace. One reviewer expressed concern about the switch to SCR. Another thought this move was a good idea.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

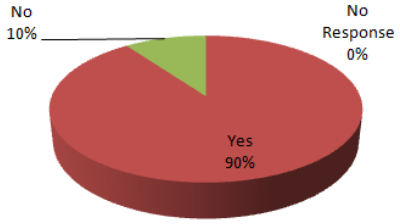
One reviewer felt there had been low return on investment because no value had been shown by the work. Another felt that it was meager funding to make a difference. Another reviewer felt the project would be more appropriately funded by an industrial partner. One reviewer saw the resources as limited due to a lack of a non-disclosure agreement with a catalyst supplier in order to understand molecular implications. Another reviewer listed work on fundamental understanding the regeneration process with various reductants and co-existence of the reductants will need additional resources on surface species and reaction mechanisms.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

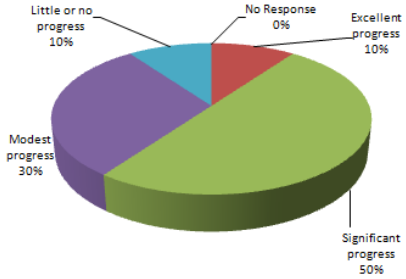
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NOx Adsorber R&D (CRADA between ORNL and International Truck and Engine Company)

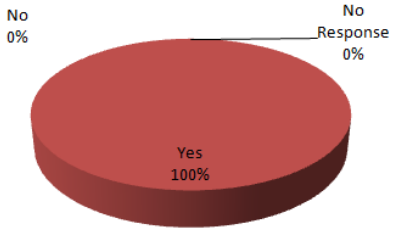
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



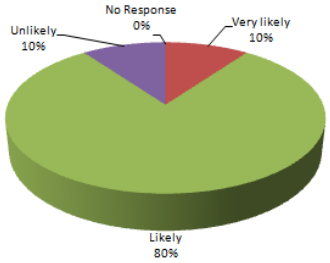
Question 3: Characterize the technical accomplishments and progress toward goals.



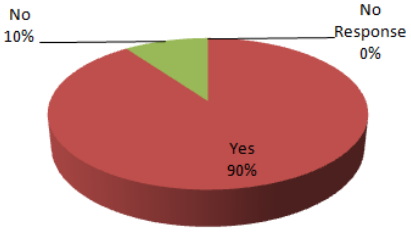
Question 2a: Are the goals of the project technically achievable?



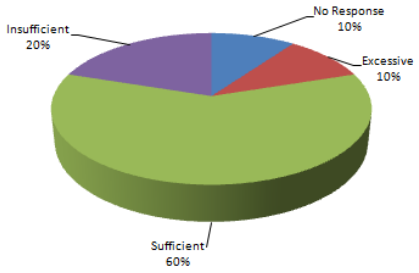
Question 4: How likely is the project team to move technologies into the marketplace?



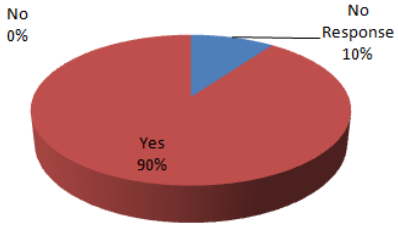
Question 2b: Have the technical barriers been identified and addressed?



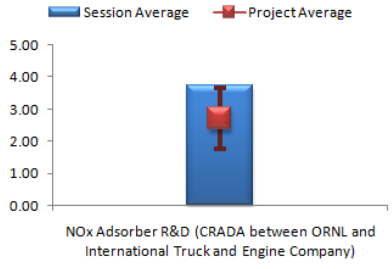
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NOx Aftertreatment CRADA with Cummins (Bill Partridge, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer says that supporting the adoption of diesel for the LDT market seems very practical, yet the objectives fully utilize national labs skill sets. The reviewer continues that the online oil dilution method looks very good, and comments that there was nice tool development by Oak Ridge National Lab. The reviewer continues that SpaciMS is another good application of a national lab tool that is applied to real world issues that are difficult for OEMs to handle; the reviewer adds that NH_3 is tricky.

A reviewer suggests getting the real-time feedback on oil dilution to investigate engine operations and novel engine hardware solutions to avoid high oil dilution. A reviewer states that on-engine real time measurement systems can diagnose engine oil dilution issues on time; the reviewer adds that the system can impact fuel injection for LNT regeneration. One reviewer says that better understanding of diesel LNT has potential of reducing diesel fuel use.

Another reviewer comments that the project focused on fuel efficient diesel engines driven by Cummins market penetration drivers. The reviewer wondered what the actual improvements in BSFC were. Another reviewer says that diesel NOx control is needed. Oil dilution is a major limiter for several technologies. NH_3 generation and use is increasingly part of aftertreatment systems.

A reviewer saw evidence of a good connection with industry to understand key issues. Another reviewer stated that the VT mission can't be dealt with, without addressing emission control. The reviewer adds that emissions have an associated energy penalty and continues that technology connection with industry to understand key issues.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer comments that supporting adopting diesel for the LDT market seems very practical, yet the objectives fully utilize national lab skill sets. The reviewer continues that interaction with CLEERS is a good plus - increases collaboration. Another reviewer states the project addresses a real-life issue and a product development hurdle, the reviewer continues that the project capitalizes on an NTRC core competency to help a major industrial partner.

It is stated by a reviewer that the project be combined with a commercially available oil condition monitor, and develop an on-board fuel dilution sensor and also to study the phenomena and trend of fuel depletion from the crankcase oil under realistic operation conditions. This can be a nucleus for a future project.

A reviewer said that an oil dilution measurement system has been successfully developed. Another reviewer suggested that previously developed MS sampling will add to the understanding of ammonia generation and control.

A reviewer suggests that the project should use the SpaciMS much more to determine the chemistry along the core length for different types of LNT formulations and after aging these formulations. The reviewer continues that some of these activities are in the projects future plan, but encourages aggressively pursuing this plan and including the LNT/SCR system and the NH_3-SCR only concept.

Another reviewer focuses on a real-time on-engine diagnostic oil dilution to streamline development process; very sophisticated tool to provide accurate and timely feedback to the engine test engineers. The reviewer continues ASTM GC correlation to LIF. Technical targets established for oil dilution rate. The reviewer adds that this was a well-structured approach.

One reviewer states that the future plans seem to involve an expansion of objectives (cyclic dispersion). The reviewer warns against "mission creep" so objectives don't move beyond funding.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer comments that they have developed a robust tool for real-time oil dilution rate. The reviewer adds that understanding of LNT ammonia chemistry for managing slip and system design provides valuable input to models. Another reviewer comments on a new approach to identify real time fuel dilution. The reviewer calls this clever, and suggests patenting it and pursuing further refinements. The reviewer wonders how the project capitalizes on NH_3 generation, but does not address NH_3 slip. The reviewer also says to be aware of the cross talk and interference of other species when measuring NH_3, that is, know/ensure what you're measuring. The reviewer wished to know is the statistically significant, or is it once (a few) through measurement?

A reviewer believes that a useful oil dilution measurement technique was developed, and that the continued LNT study was also learning new things. Another reviewer added that SpaciMS was developed. Another reviewer focused on how the measurement system probes the catalyst chemistry to elucidate reaction mechanism, adding that the information helps design catalyst and engine operations.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer commented that there were good objectives for a national lab, with good results and efforts. The reviewer also felt that this was the appropriate partner to put the results into the market. Numerous other reviewers comment that the methodology developed here was already being used by the CRADA partner. One reviewer wondered if the oil dilution instrumentation could be commercialized. Others saw a strong partnership with Cummins leading to continued success of reaching goals. One reviewer believed that Cummins will be able to use this real time diagnostic to better control fuel dilution of lube oil.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

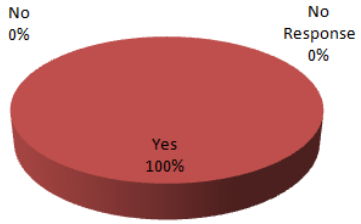
A reviewer stated that the next steps look good, especially the oil dilution diagnostic as applied to cylinder and cyclic dispersion. Another reviewer said that SpaciMS is great and wondered if there was a SpaciFTIR. The reviewer felt that would be great to study NH_3 SCR catalysts. A reviewer wondered if the development of an on-board oil dilution sensor makes sense. Another reviewer warned against growing the team/facilities too fast. One reviewer felt there had been a very efficient use of resources. A reviewer felt that the funding was excessive.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

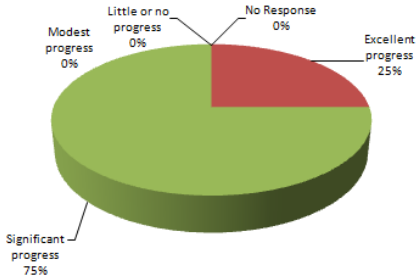
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NOx Aftertreatment CRADA with Cummins

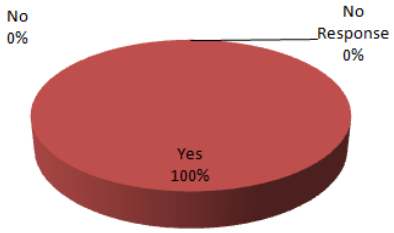
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



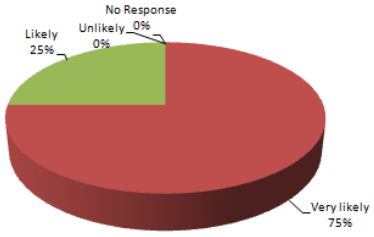
Question 3: Characterize the technical accomplishments and progress toward goals.



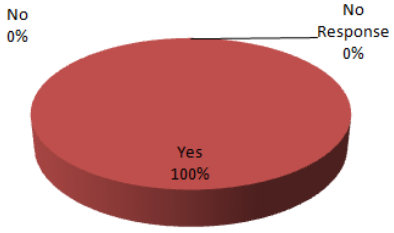
Question 2a: Are the goals of the project technically achievable?



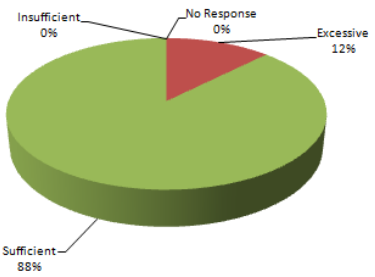
Question 4: How likely is the project team to move technologies into the marketplace?



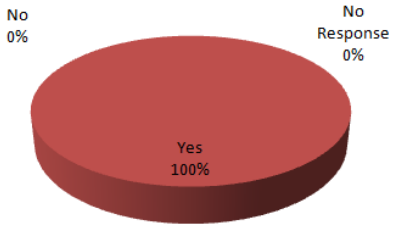
Question 2b: Have the technical barriers been identified and addressed?



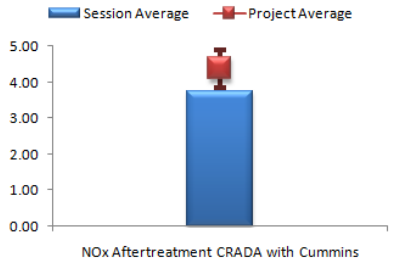
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



PNNL CLEERS Activities – Overview (Darrell Herling, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that any reduction in NOx emissions via active aftertreatment provides potential to break the traditional BSFC - NOx tradeoff. The reviewer adds the consortia based, non-competitive based approach moves the industry/academia forward in a collaborative way - the end result is better thermal efficiency. Another reviewer felt that the program was valuable for coordination, adding that various companies cannot communicate easily and that CLEERS creates a forum where communication can occur. A second reviewer also felt that it is important to keep interacting with all cross sections of the emission industry.

One reviewer saw clear ties to industrial needs in "Performance Measures" slides. Another commented on a good link of aftertreatment and the commercial feasibility of diesel engines in the future. Another reviewer commented that the systematic study of DPF, SCR and LNT systems will provide critical information for the industry to get fully understanding on various systems.

A reviewer said that more projects and activities need to be realigned to include more SCR research. Another viewer said that VT goals cannot be achieved without addressing emissions control. Emissions control has an associated energy penalty.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer believes that this being a consortium based program, deployment is essentially automatic. The reviewer adds that the steering committee has a heavy industry focus including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer continues that DOE may want to consider having a similar consortia operating for other research and development programs to enable or accelerate deployment. A reviewer commented that this was a report-out of results. Another reviewer stated that this is a continuous crosscut activity, and that some of the question elements are not applicable to the project. One reviewer did not see why the results were anything but straightforward. One reviewer commented on the good recognition of ties between basic fundamentals and industrial systems; micro modeling tools that are user-friendly (GUI).

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that in general the CLEERS activities do not have quantitative targets - so the targets are achievable since the strategy tends to be general/directional and not quantitative. The reviewer went on to say that CLEERS is more focused on methodologies and deployment or these, rather than on specifically overcoming the identified technical barriers. The reviewer adds deployment aspects of coordinating National Lab and academia towards industry needs will continue to pay increasingly significant dividends over time (in my opinion). The reviewer thinks this approach deserves a spot in the DOE strategy.

Another reviewer commented that simulation is an extremely robust and useful tool when used properly. One reviewer commented that they had seen similar data from suppliers that were a few years old.

Another reviewer mentioned coordination of unified programs including DPF, SCR and LNT and future 4-way system.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that this being a consortium based program, deployment is essentially automatic on all levels (from what we learn of the hardware, to the diagnostic methods, to the cross-fertilization of the different technical discussions, to other insights into the underlying physics). The reviewer adds that the steering committee has a heavy industry focus - including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer suggests that DOE may want to consider having a similar consortia operating for other RD programs to enable or accelerate deployment. The reviewer felt that CLEERS is not really developing specific aftertreatment technologies that would apply to an engine, rather it is using standard commercially available catalysts to develop better understanding and methodologies, in DOE's diverse portfolio, and that this is an excellent program. The reviewer suggests that more opportunities for this approach should be applied to other programs if possible to further enhance deployment.

A reviewer mentions that deployment aspects are in focus as CLEERS participants are close to the front line in their respective industries.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

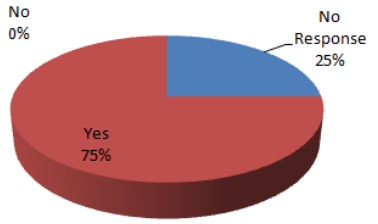
A reviewer believes the CLEERS return on investment is very good due to the collaborative approach and the focus on methodologies and base understanding over developing new hardware. Another reviewer makes a general comment that applies to the funding and projects carried out by the National Laboratories. There seems to be a tendency to duplicate facilities at more than one site. For example, a review of the last several years (10 years?) investments in engine and chassis dynamometer installations at various National Laboratories could be revealing. A general comment was also made that investing in technology and enhanced collaboration among the National Laboratories is a far better utilization of DOE funds than spending it on brick and mortar. Even if a national lab is using non-DOE funding for facility duplication, DOE should evaluate such as a poor investment. The reviewer goes on to ask if there is a rationale for review of the CLEERS charter since the focus now on more deployment rather than basic research.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

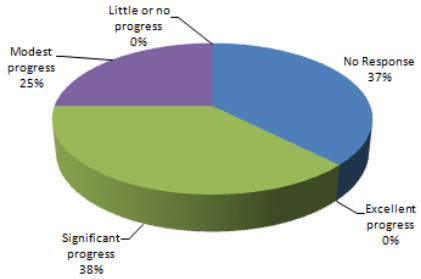
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: PNNL CLEERS Activities – Overview

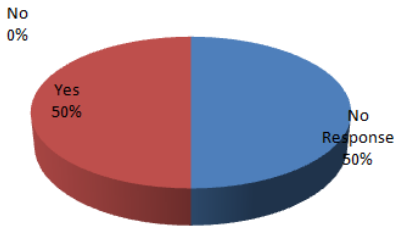
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



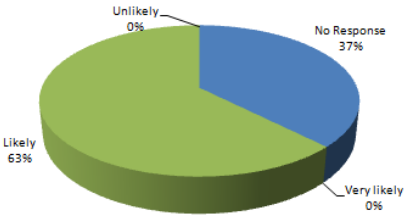
Question 3: Characterize the technical accomplishments and progress toward goals.



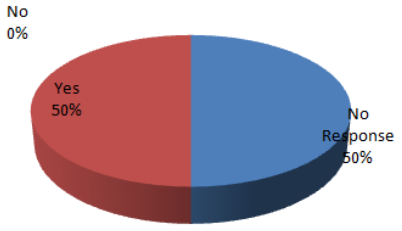
Question 2a: Are the goals of the project technically achievable?



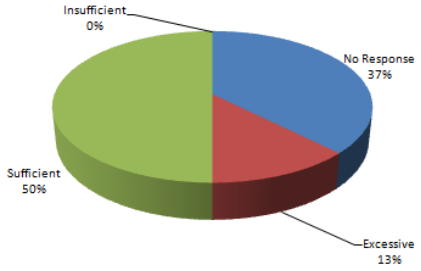
Question 4: How likely is the project team to move technologies into the marketplace?



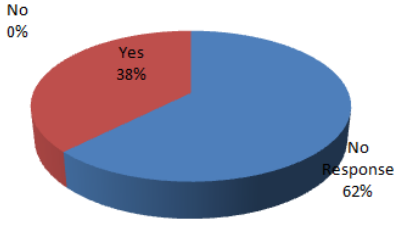
Question 2b: Have the technical barriers been identified and addressed?



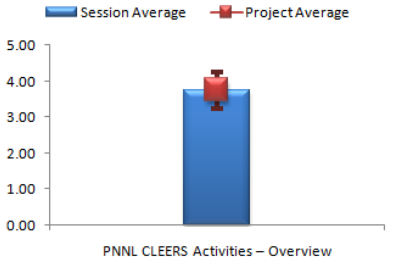
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Pre-Competitive R&D on NOx Adsorber Mechanisms (Jae-Soon Choi, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that any reduction in NOx emissions via active aftertreatment provides potential to break the traditional BSFC - NOx tradeoff. The reviewer adds the consortia based, non-competitive based approach moves the industry/academia forward in a collaborative way - the end result is better thermal efficiency. Another reviewer felt that the program was valuable for coordination, adding that various companies cannot communicate easily and that CLEERS creates a forum where communication can occur. A second reviewer also felt that it is important to keep interacting with all cross sections of the emission industry.

Another reviewer commented that deeper understanding of NOx adsorber mechanisms and resolving sulfation issue could enable lean-burn gasoline engines, which will reduce petroleum use in transportation. A reviewer commented that NSR catalysts are a vital part of diesel operation. The reviewer hoped this could be transferred. A reviewer also said that the fundamental understanding of sulfaltion and desulfation are critical for commercial success of LNT, as well as further improvements on catalyst and substrate.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that with the state-of-the art tools and approaches used by ORNL, it is likely to expect that the chemistry and physics of NOx adsorbers will be fully understood through this research. Another reviewer suggested that the program be bridged to some possible application concepts at NTRC-ORNL. One reviewer said that while confidentiality is always a barrier, CLEERS has done a good job balancing this.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that CLEERS is more focused on methodologies and deployment or these, rather than on specifically overcoming the identified technical barriers. The reviewer adds deployment aspects of coordinating National Lab and academia towards industry needs will continue to pay increasingly significant dividends over time. The reviewer thinks this approach deserves a spot in DOE strategy.

A reviewer commented that they were always interested in real world fouling factors, like soot, ash etc., and dosing formulation and distribution issues. Another reviewer stated that conceptual LNT model already created. There are all reasons to believe that with the current level of effort and leveraging National Labs' capabilities, deeper understanding of NOx adsorber mechanisms should be achievable.

One reviewer suggested that it was much easier to make devices work in the powder lab than in an exhaust pipe.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that with this being a consortium-based program, deployment is essentially automatic on all levels (from what we learn of the hardware, to the diagnostic methods, to the cross-fertilization of the different technical discussions, to other insights into the underlying physics). The reviewer adds that the steering committee has a heavy industry focus - including both light-duty and heavy-duty and that this is a good model for deployment. The reviewer suggests that DOE may want to consider having a similar consortia operating for other R&D programs to enable or accelerate deployment. The reviewer felt that CLEERS is not really developing specific aftertreatment technologies that would apply to an engine, rather it is using standard commercially available catalysts to develop better understanding and methodologies, in DOE's diverse portfolio, and that this is an excellent program. The reviewer suggests that more opportunities for this approach should be applied to other programs if possible to further enhance deployment.

Another reviewer stated that working on commercial catalysts made the understanding more close to the real world application as well as providing opportunity to improve catalyst formulations.

A reviewer felt there could be enhancement if a specific industrial entity "owned" the project rather than the pool involved in CLEERS. The reviewer added that since it is precompetitive, there is a likelihood of a follow-up program to apply and transfer the technology.

Another reviewer felt that while deeper understanding of the NOx adsorber mechanisms is achievable, resolving sulfation issues is less likely, making their broad introduction to the marketplace questionable. One reviewer wondered what the robustness issues were.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer wondered why DOE is sponsoring this project at ORNL, competitively awarded. The reviewer also wondered if there was a rationale for review of the CLEERS charter and funding level since the focus now is on more deployment rather than basic research.

A reviewer stated that funding of $100,000 seems sufficient for this research, commensurate with the low likelihood of the broad deployment of this technology. Another reviewer stated that this is the most difficult area in new diesels, and we are only putting one FTE on the project.

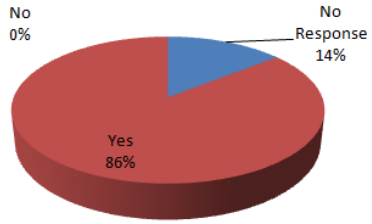
A reviewer believes the CLEERS ROI is very good due to the collaborative approach and the focus on methodologies and base understanding over developing new hardware.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

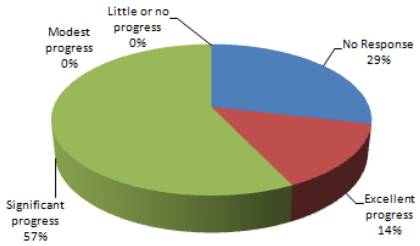
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Pre-Competitive R&D on NOx Adsorber Mechanisms

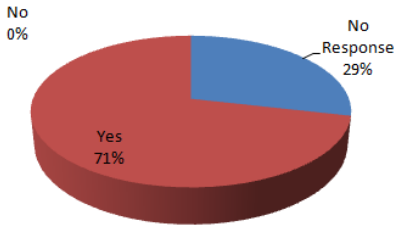
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



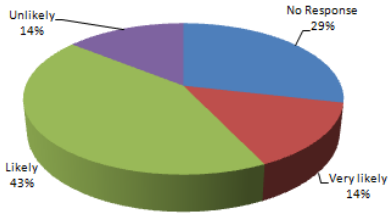
Question 3: Characterize the technical accomplishments and progress toward goals.



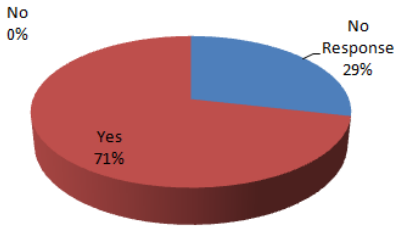
Question 2a: Are the goals of the project technically achievable?



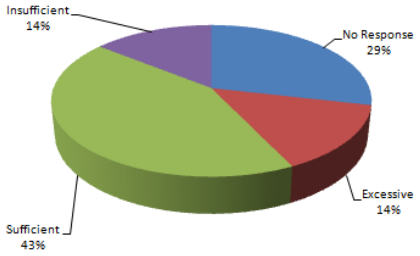
Question 4: How likely is the project team to move technologies into the marketplace?



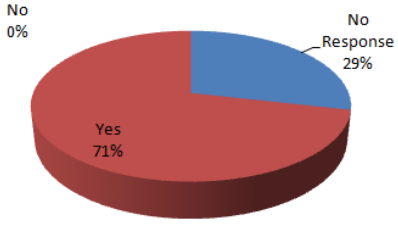
Question 2b: Have the technical barriers been identified and addressed?



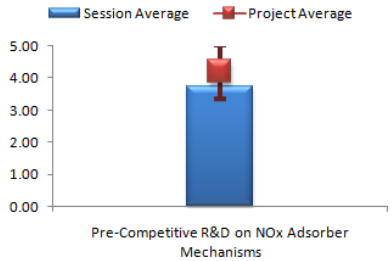
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Urea SCR Fundamentals (Jonathan Male, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that it addresses optimized urea usage and fuel economy; integration of emissions control systems. Another reviewer believes that the implementation of the SCR aftertreatment system is expected to lead to improved fuel efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer cites the developing understanding of competing reactions; the study of thermal transients for optimized conversion efficiencies and component integration; and the examination of alternative reductants to ammonia. Another reviewer mentioned the focus on the transient SCR behavior is well aligned with one of the key challenges of the SCR technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer describes the demonstration as having a good understanding of the reactant interactions for efficient urea usage, as well as transient effects. The reviewer adds the method developed for testing small powder samples ensures faster turnaround of results - need to continue verifying with monolith samples. Another reviewer states that the initial experimental work is interesting, but so far appears mostly phenomenological (which is understandable at this early stage of the SCR project). The reviewer says that going forward it would be more appropriate for the National Lab to focus on understanding the underlying chemical and reaction engineering processes rather than detailed replication of the FTP or any other transient cycles.

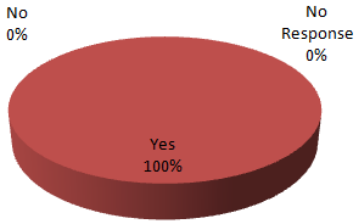
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer describes the project as a very well-aligned fundamental study with the overcoming of real-world barriers. Another reviewer states that close ties to industry are ensured by CLEERS format.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Both reviewers were unsure.

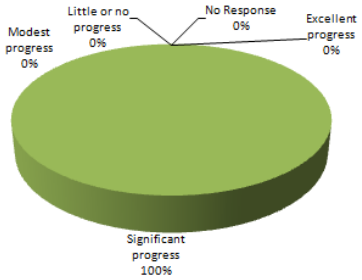
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Urea SCR Fundamentals

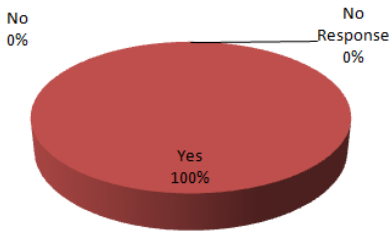
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



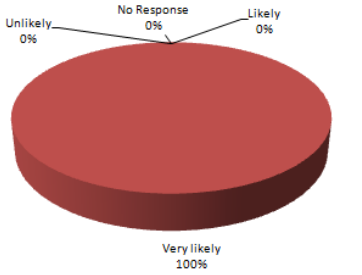
Question 3: Characterize the technical accomplishments and progress toward goals.



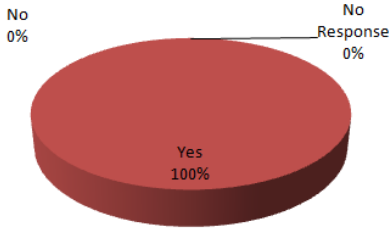
Question 2a: Are the goals of the project technically achievable?



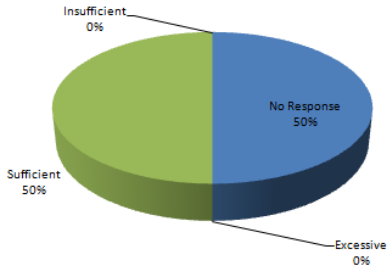
Question 4: How likely is the project team to move technologies into the marketplace?



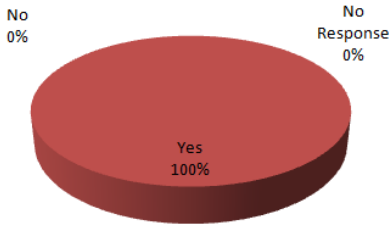
Question 2b: Have the technical barriers been identified and addressed?



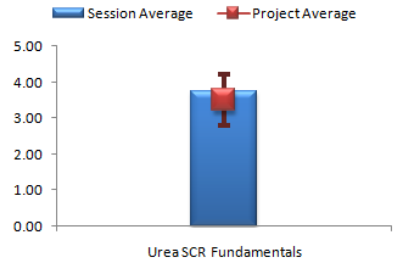
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



10. Fuels Technologies

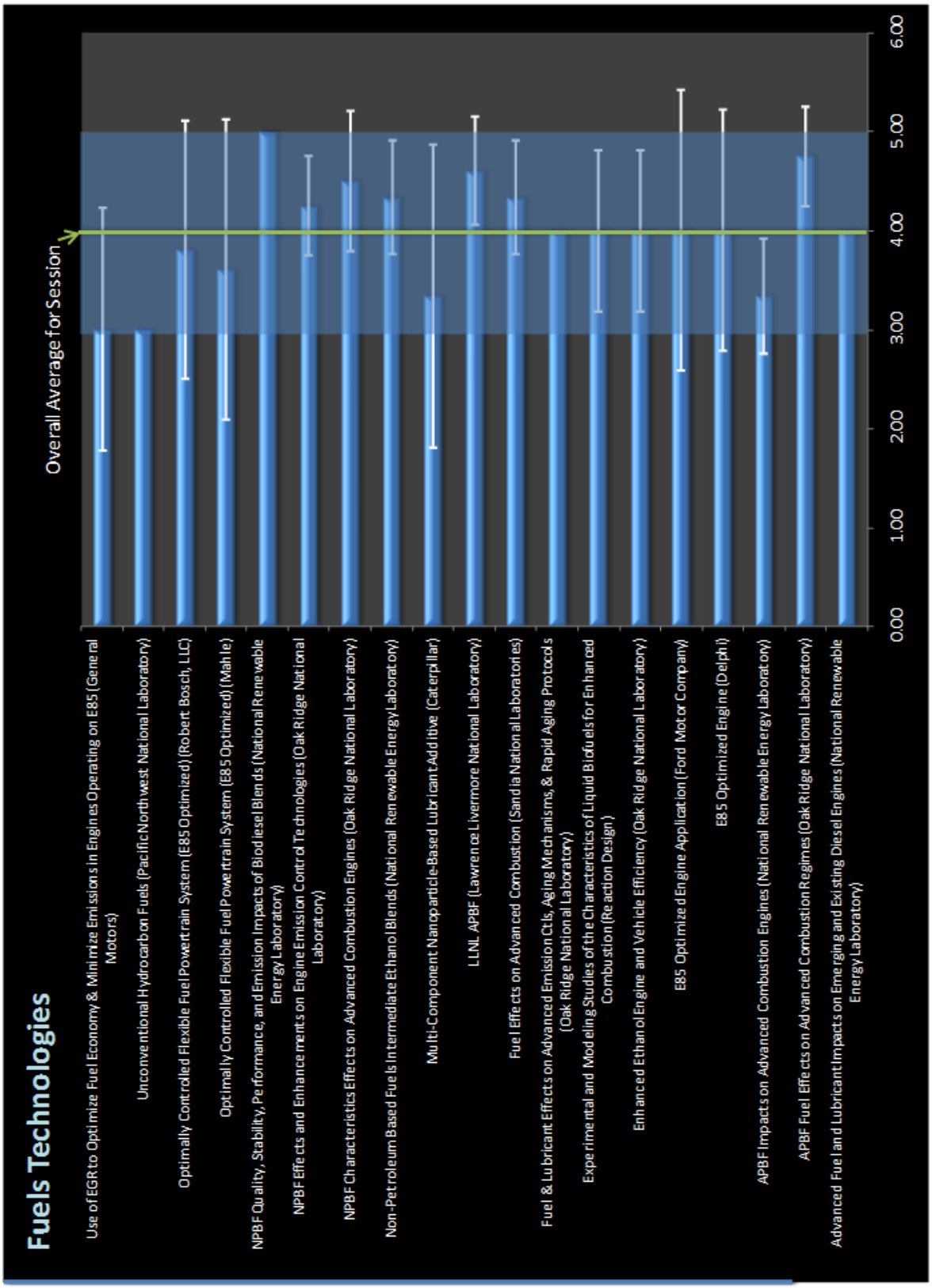
Introduction

The fuels and lubricants effort supports research and development to provide vehicle users with fuel options that are cost-competitive, enable high fuel economy, deliver lower emissions, and contribute to petroleum displacement. Activities aim to identify advanced petroleum- and non-petroleum-based fuels and lubricants for more energy-efficient and environmentally friendly highway transportation vehicles. A major focus of the Advanced Petroleum-Based Fuels and Non-Petroleum-Based Fuels activities is determining the impacts of fuel and lubricant properties on the efficiency, performance, and emissions of advanced internal combustion engines. This new breed of engines uses advanced combustion regimes that are expected to become more prevalent in the marketplace because of their high efficiency and continually improving emissions performance. Researchers are also studying the impacts of new fuels on the environment as part of the New Fuels Technology Impacts activity.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
10-4	Advanced Fuel and Lubricant Impacts on Emerging and Existing Diesel Engines (Matt Ratcliff, National Renewable Energy Laboratory)	4.00	
10-6	APBF Fuel Effects on Advanced Combustion Regimes (Bruce Bunting, Oak Ridge National Laboratory)	4.75	0.50
10-9	APBF Impacts on Advanced Combustion Engines (Matt Ratcliff, National Renewable Energy Laboratory)	3.33	0.58
10-11	E85 Optimized Engine (Keith Confer, Delphi)	4.00	1.22
10-14	E85 Optimized Engine Application (Apoory Agarwal, Ford Motor Company)	4.00	1.41
10-17	Enhanced Ethanol Engine and Vehicle Efficiency (Brian West, Oak Ridge National Laboratory)	4.00	0.82
10-20	Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion (Ellen Meeks, Reaction Design)	4.00	0.82
10-23	Fuel & Lubricant Effects on Advanced Emission Controls, Aging Mechanisms, & Rapid Aging Protocols (Bruce Bunting, Oak Ridge National Laboratory)	4.00	0.00
10-25	Fuel Effects on Advanced Combustion (Chuck Mueller, Sandia National Laboratories)	4.33	0.58
10-28	LLNL APBF (Salvador Aceves, Lawrence Livermore National Laboratory)	4.60	0.55

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
10-31	Multi-Component Nanoparticle-Based Lubricant Additive (Atanu Adhvaryu Caterpillar)	3.33	1.53
10-34	Non-Petroleum Based Fuels Intermediate Ethanol Blends (Wendy Clark, National Renewable Energy Laboratory)	4.33	0.58
10-37	NPBF Characteristics Effects on Advanced Combustion Engines (Jim Szybist, Oak Ridge National Laboratory)	4.50	0.71
10-39	NPBF Effects and Enhancements on Engine Emission Control Technologies (Scott Sluder, Oak Ridge National Laboratory)	4.25	0.50
10-42	NPBF Quality, Stability, Performance, and Emission Impacts of Biodiesel Blends (Robert McCormick, National Renewable Energy Laboratory)	5.00	0.00
10-45	Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) (Hakan Yilmaz, Robert Bosch, LLC)	3.80	1.30
10-48	Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) (Bruce Woodrow, Mahle)	3.60	1.52
10-51	Unconventional Hydrocarbon Fuels (Tom Gallant, Pacific Northwest National Laboratory)	3.00	0.00
10-53	Use of EGR to Optimize Fuel Economy & Minimize Emissions in Engines Operating on E85 (Ko-Jen Wu, General Motors)	3.00	1.22
	Overall Session Average and Standard Deviation	**3.97**	**1.01**


Fuels Technologies
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Use of EGR to Optimize Fuel Economy & Minimize Emissions in Engines Operating on E85 (General Motors)
Unconventional Hydrocarbon Fuels (Pacific Northwest National Laboratory)
Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) (Robert Bosch, LLC)
Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) (Mahle)
NPBF Quality, Stability, Performance, and Emission Impacts of Biodiesel Blends (National Renewable Energy Laboratory)
NPBF Effects and Enhancements on Engine Emission Control Technologies (Oak Ridge National Laboratory)
NPBF Characteristics Effects on Advanced Combustion Engines (Oak Ridge National Laboratory)
Non-Petroleum Based Fuels Intermediate Ethanol Blends (National Renewable Energy Laboratory)
Multi-Component Nanoparticle-Based Lubricant Additive (Caterpillar)
LLNL APBF (Lawrence Livermore National Laboratory)
Fuel Effects on Advanced Combustion (Sandia National Laboratories)
Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols (Oak Ridge National Laboratory)
Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion (Reaction Design)
Enhanced Ethanol Engine and Vehicle Efficiency (Oak Ridge National Laboratory)
E85 Optimized Engine Application (Ford Motor Company)
E85 Optimized Engine (Delphi)
APBF Impacts on Advanced Combustion Engines (National Renewable Energy Laboratory)
APBF Fuel Effects on Advanced Combustion Regimes (Oak Ridge National Laboratory)
Advanced Fuel and Lubricant Impacts on Emerging and Existing Diesel Engines (National Renewable Energy Laboratory)

Advanced Fuel and Lubricant Impacts on Emerging and Existing Diesel Engines (Matt Ratcliff, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent stated that the work promotes advanced combustion through the support of the FACE program, and thereby promotes efficiency improvements and a reduction in petroleum use. The researchers are also considering GTL fuels, which are non-petroleum and can displace petroleum.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent commented that close collaborations through MOUs, CRADAs, and partnerships enable the transfer and deployment of the results. The project is developing essential knowledge on fuel chemistry, and thereby will contribute to overcoming fuel composition challenges to advanced combustion. In the ethanol vehicle studies, the detection and understanding of ethylnitrite can remove what may be a serious downside of alcohol-fueled vehicles on air quality.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent stated that work through FACE in the IQT is providing important insights into the elementary ignition process of APBF and NPBF. This understanding is essential to gaining control over advanced combustion through the application of fuel chemistry understanding. The reviewer adds that very good fuel chemistry insights are being generated, and the examination of exhaust constituents (unregulated) helps to understand the overall reaction pathways for the fuels in the text matrix.

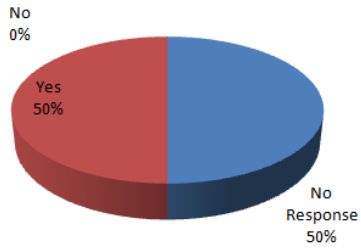
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent commented that the fundamental knowledge and linkage to industry and other labs through FACE provides the means to transfer and promote implementation of the fuel chemistry knowledge that is being generated. There are lots of collaborations in place and more are being added.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that, within the budget constraints, the budget appears to be reasonable and should be a worthwhile investment of program funds.

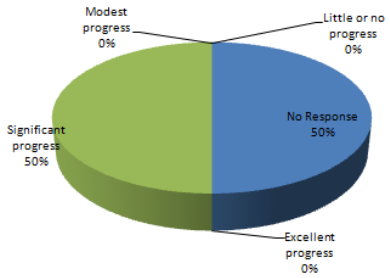
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Fuel and Lubricant Impacts on Emerging and Existing Diesel Engines

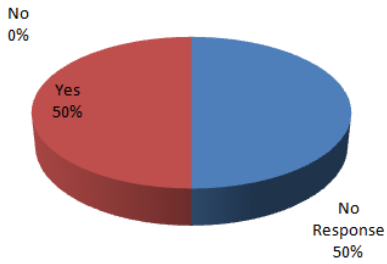
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



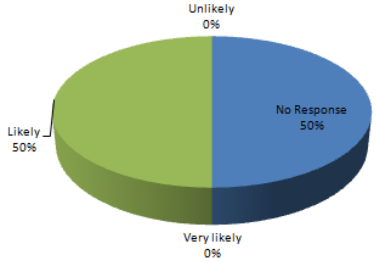
Question 3: Characterize the technical accomplishments and progress toward goals.



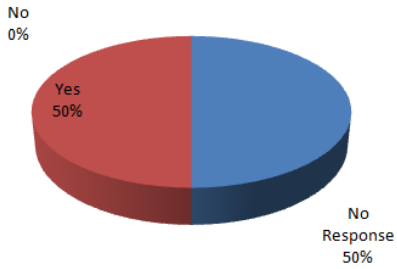
Question 2a: Are the goals of the project technically achievable?



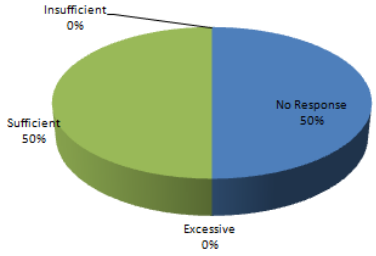
Question 4: How likely is the project team to move technologies into the marketplace?



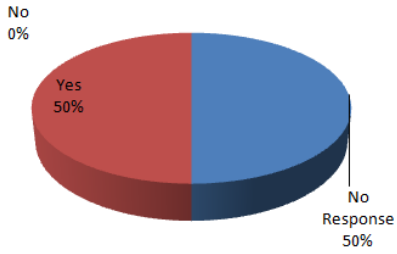
Question 2b: Have the technical barriers been identified and addressed?



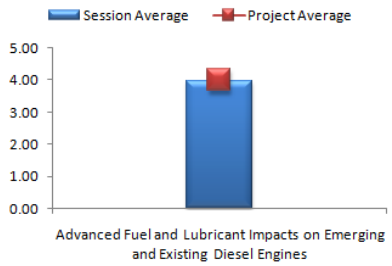
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



APBF Fuel Effects on Advanced Combustion Regimes (Bruce Bunting, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person indicated this program promotes the development and eventual deployment of advanced combustion engines, which will reduce petroleum consumption by promoting efficiency. This reviewer added that this is essential work to promote higher fuel economy and reduced emissions. One person commented that this program indeed focuses on identifying advanced petroleum-based fuel property requirements for advanced IC engines.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that this is very important work, lifting alternative fuels to the scientific level. Another stated that there is a good strategy of testing model and real petroleum and oil sands derived fuels in a single cylinder engine and in 2 production engines (GM and Mercedes). This includes looking at emerging engine control strategies such as variable compression ratio and the use of additives to try to expand the range of HCCI operation.

One final reviewer stated the program is considering various platforms (gasoline and diesel) and considers real world fuel effects, both of which contribute to flexibility and broad application potential for the results from the program. An essential element is the linkage of fuel chemistry and advanced combustion. By combining the fundamental and the practical, real progress can be made in promoting deployment of these technologies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated this project is taking a scientific approach to biofuels. This will make them a natural part in advanced engine development. Another person commented that the group has demonstrated an engine control strategy (variable compression ratio) that can potentially enable a wider range of HCCI operation. One other reviewer noted that they have demonstrated the potential for using variable valve timing in HCCI control with gasolines of different RON. They have demonstrated optimal performance in advanced combustion modes. By combining real and surrogate fuels, the group is showing the overlap and linkage between different fuel property variables and performance (ISFC, NOx etc). They have a CRADA in place with Reaction Engineering to gain access to fundamental modeling, and are showing the importance of fuel chemistry.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that, by the collaborations and frequent presentation of results from this program, the knowledge gained can be and is being effectively disseminated. For example, the involvement with the FACE program provides broad linkage to the fuels and engines/vehicles industry. Additionally, this reviewer comments, CRADA and MOU involvement provides for a rapid sharing of results.

One other person commented that at this point it isn't clear whether full-time HCCI using "realistic" fuels will be technically feasible or not. This work helps to understand and advance the technology towards that goal.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

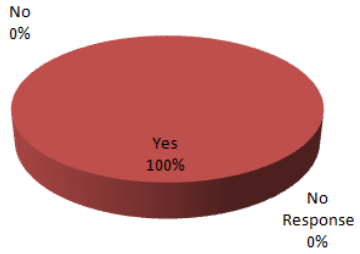
One reviewer stated that the project seems to be making good progress using a variety of engines, so it seems that resources are reasonable. The other respondent commented that certainly more funding would always help, but given the constraints of the overall budget, this project seems to have an appropriate level of funding. This reviewer added that this project looks like it can provide real benefits to industry in the near term, and therefore should provide a good return on investment.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

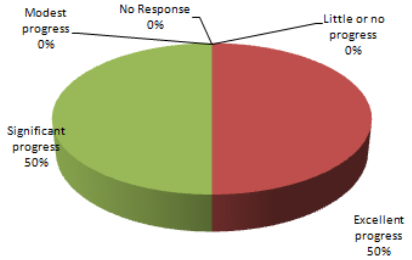
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: APBF Fuel Effects on Advanced Combustion Regimes

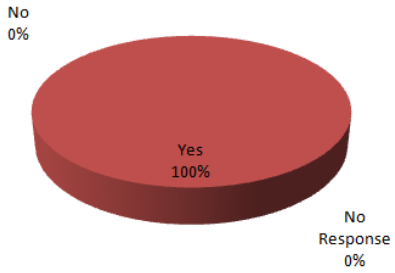
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



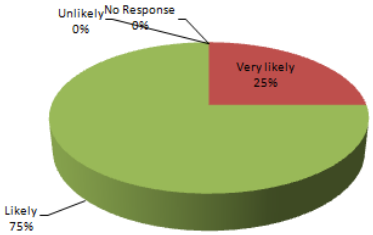
Question 3: Characterize the technical accomplishments and progress toward goals.



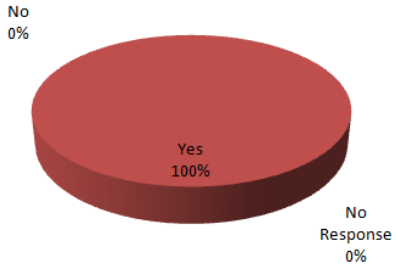
Question 2a: Are the goals of the project technically achievable?



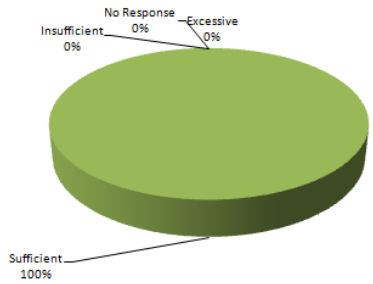
Question 4: How likely is the project team to move technologies into the marketplace?



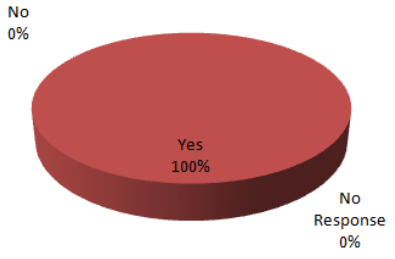
Question 2b: Have the technical barriers been identified and addressed?



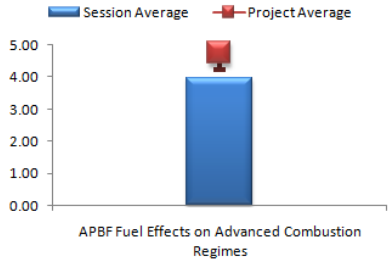
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



APBF Impacts on Advanced Combustion Engines (Matt Ratcliff, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent stated that trying to determine what fuels/properties (including biodiesel) will work in advanced combustion engines which have improved fuel efficiency fits with DOE goals.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the strategy of using tools such as IQT to try to determine the suitability of fuels for advanced combustion is good. The other respondent commented that they support the use of IQT but would like to see IQT results correlated to engine performance. This reviewer is somewhat worried about IQT NOx work because mixing in IQT is not complete, so he or she would expect a correlation between NOx and ignition delay that would not mimic engine impacts.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
There were no responses to this prompt.

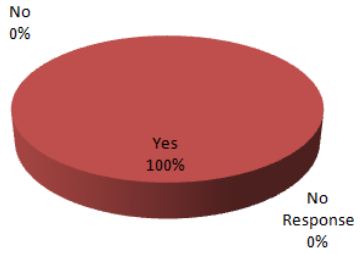
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent stated that, between the various projects, it is likely that the work will help move one or more of these technologies into the marketplace.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent indicated that they had a separate comment regarding ethanol work. Understanding ethanol emission impacts is important, but it is not clear how to evaluate ethyl nitrate results. They need to compare to detailed speciation from gasoline vehicles, they need data from more than one vehicle, and they need an air quality assessment to full understand the overall impact here.

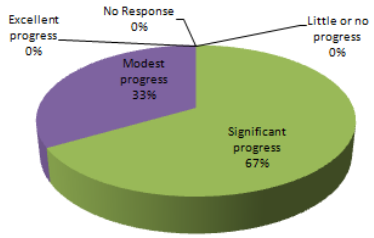
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: APBF Impacts on Advanced Combustion Engines

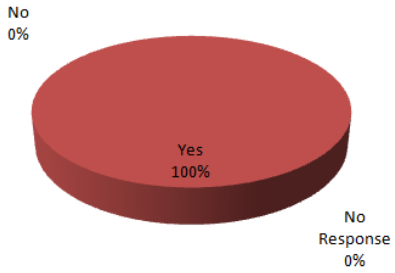
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



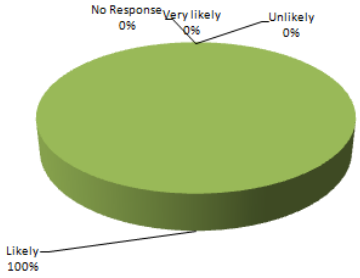
Question 3: Characterize the technical accomplishments and progress toward goals.



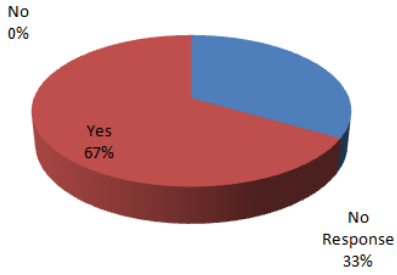
Question 2a: Are the goals of the project technically achievable?



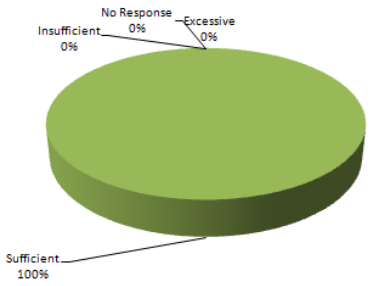
Question 4: How likely is the project team to move technologies into the marketplace?



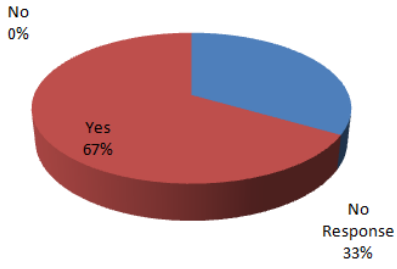
Question 2b: Have the technical barriers been identified and addressed?



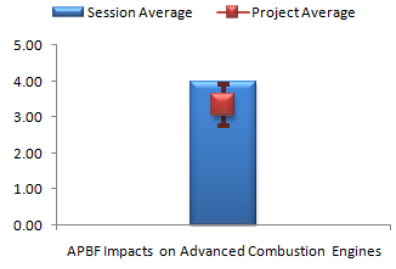
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



E85 Optimized Engine (Keith Confer, of Delphi)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that finding ways to improve fuel economy of E85 vehicles would increase their market appeal/acceptability to the public and thus reduce the amount of petroleum used. Another remarked that ethanol has unique properties that could improve efficiency. Improving efficiency of gasoline/ethanol blends can provide significant benefits. One other response stated that, by focusing on improving the performance of an E85 vehicle, this project addresses petroleum displacement in two ways: displacing petroleum directly with ethanol use and improving efficiency so less fuel (ethanol and gasoline) is needed. This project is exceptionally well suited to meeting DOE goals because it can remove the real and significant barriers to petroleum displacement represented by shortcomings in E85 production vehicles.

One reviewer commented that optimizing an engine for E85 operation assumes minimal operation at E0 or E10. This reviewer noted that it would be interesting to see what the degradation on performance, fuel economy, and emissions will be when an optimized engine is operated on conventional gasoline.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the use of a production-viable engine is commendable. Another person remarked that the strategy of focusing on approaches that are cost-effective, production viable, take advantage of ethanol's favorable properties, and are capable of running on any ethanol/gasoline blend is very good. One reviewer noted that, by addressing durability when using high levels of ethanol and minimizing the economy penalty of using E85, this project removes barriers to customer acceptance of E85. This will enhance the potential for the deployment of E85 vehicles and enable the planned petroleum displacement through increased ethanol usage. The reviewer likes the approach of using practically realizable compression ratio variation (varying lift duration and phasing) to allow optimization for E85 and prevention of knock when operating on gasoline.

One reviewer commented that deployment is fast paced. This reviewer asked if confirmation of the ethanol sensor accuracy is a critical path. What will the project do if the ethanol sensor is more lab quality instead of commercial quality?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer commented that the project is new so progress is expected to be modest, but nonetheless the means of optimizing E85 performance while maintaining knock resistance on gasoline via valve lift changes shows great promise to meet a major objective. So, the progress looks very promising for such a new project.

Another individual commented that they did not rate this aspect since the project is very new and hasn't generated as many results to date as other, more established programs. However, the plans sound good. Another also commented that this is still early into the project but the basic approach appears very practical. One reviewer stated that this is a new project, so it is difficult to define progress at this point.

One reviewer stated that a 10% improvement is not sufficient.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer remarked that, if successful, the accomplishments should improve fuel efficiency, improve performance of ethanol-blended gasoline, and increase customer demand for the vehicles and fuel. The claims that the products could be brought to market as early as 2011 suggest a commitment to quickly move from R&D to commercialization. One person said, since the lead in this project is Delphi and involves engine optimization, the outcomes from the project will definitely find their way into the marketplace. And success in the project will help ensure successful deployment of E85 vehicles.

Another reviewer stated this is the obvious choice of technology. One other individual was not sure how this will impact OEM programs. Since the group is using a production-type system, this should be easily transferable to commercial systems.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

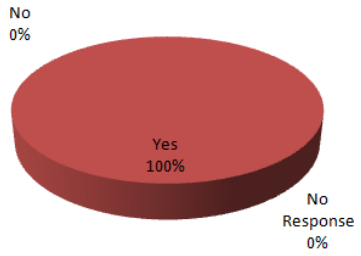
The first response stated that the use of an OEM supplier is a plus in developing a system that can be commercialized. Another remarked that the funding level is low, but since this is an industry-led project, cost sharing and leveraging of industrial resources are enabling the project. One person wrote there are no indications that the resources are insufficient or excessive.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

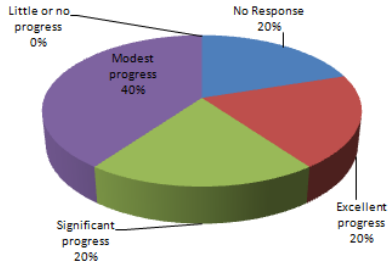
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: E85 Optimized Engine

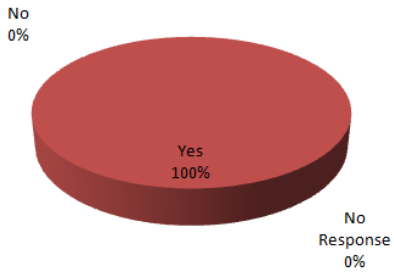
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



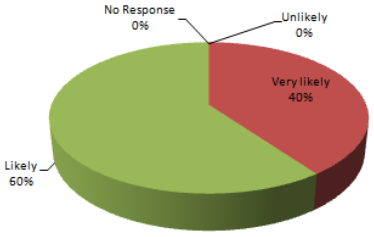
Question 3: Characterize the technical accomplishments and progress toward goals.



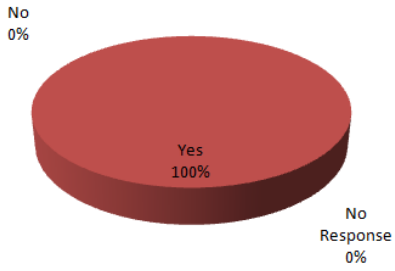
Question 2a: Are the goals of the project technically achievable?



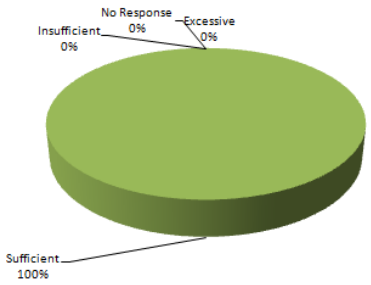
Question 4: How likely is the project team to move technologies into the marketplace?



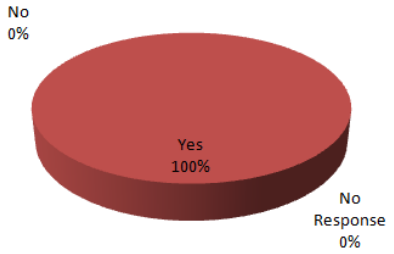
Question 2b: Have the technical barriers been identified and addressed?



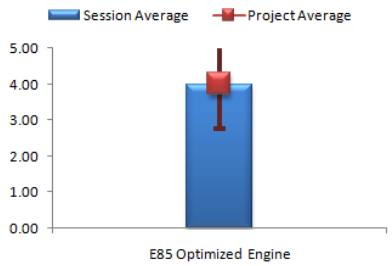
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



E85 Optimized Engine Application (Apoory Agarwal, of Ford Motor Company)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that improving fuel economy while meeting emission regulations for E85 fueled vehicles is consistent with DOE objectives. Another reviewer added that, by focusing on improving the performance of an E85 vehicle, this project addresses petroleum displacement in two ways: displacing petroleum directly with ethanol use and improving efficiency so that less fuel (ethanol and gasoline) is needed. This project is exceptionally well suited to meeting DOE goals because it can remove the real and significant barriers to petroleum displacement represented by shortcomings in E85 production vehicles. One person stated that this project was similar to other E-85 projects, but using EBS is a novel concept that could provide additional benefits.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer noted that this is a new technology with great potential. It overcomes the problem of too expensive ethanol. The 70% torque increase is a very good idea that will make the vehicle very attractive. It will give the vehicle a diesel-like character that will appeal to the typical light truck and SUV buyer. The reviewer added that two fuels are not a major problem since the vehicle needs very little ethanol and can run without ethanol.

Another reviewer commented that the researchers are targeting 15-20% energy efficiency improvement over current gasoline engines for a Ford F-150 truck. The intent is to utilize the unique characteristics of ethanol (knock resistance, etc.) in a downsized, boosted high compression ratio V8 engine. So, the project targets a key barrier (fuel economy) in the deployment of ethanol in a large sales volume vehicle. This is a highly innovative strategy for utilizing the benefits of E85. But, the "EBS" strategy requires filling two fuel tanks which may impair customer acceptance. One person added that this requirement of two fuels/fuel tanks for the Ethanol Boosting System may not be readily acceptable to the public.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that this overcomes the ethanol price issue, while another stated that it is an interesting conceptual design. The dual-fuel optimization may overcome some of the E85 performance issues. One person indicated that modest progress was made in the first quarter of FY08 on the project. The researchers defined engine configuration and completed 1-D modeling of the boosting system, project vehicle efficiency, and performance (diesel-like performance at full load). The performance projections are very impressive. While there is a potential show-stopping customer acceptance problem with the EBS strategy, the level of innovation in this project makes it stand out among the similar DOE supported projects. This is a great project and has great potential. This is also an excellent example of effective industry-government partnership, in that the DOE support is enabling some substantial "out of the box" R&D.

One other reviewer did not provide a rating since the project is relatively new, although it looks like there is good progress on modeling/design work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first response stated that this will give the vehicle a diesel-like character that will appeal to the typical light truck and SUV buyer. Two fuels is not a major problem since the vehicle needs very little ethanol and can also run without ethanol. Another person commented that the target is a high sales volume vehicle platform, which ensures that successful completion of the project objectives will see implementation in commercial vehicles. To contrast, one reviewer stated that, even if technically successful, nontechnical barriers of the requirement of two fuels/fuel tanks (gasoline & E85) and E85 availability may not be readily overcome.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

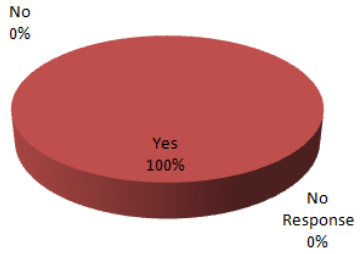
One reviewer stated that the project funding is modest, but there is clearly substantial leveraging of industry resources. Another person stated that there is no indication that resources are not appropriate or sufficient. One final respondent stated that it is still early in the program, making it difficult to assess progress.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

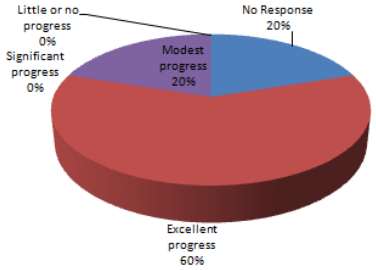
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: E85 Optimized Engine Application

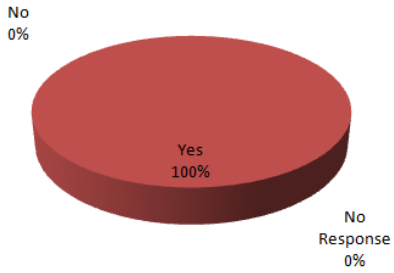
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



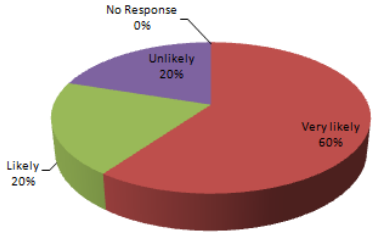
Question 3: Characterize the technical accomplishments and progress toward goals.



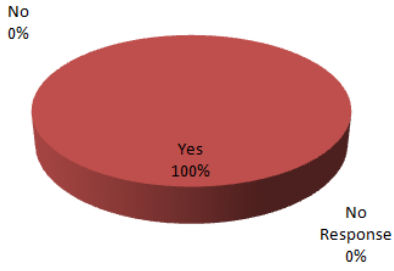
Question 2a: Are the goals of the project technically achievable?



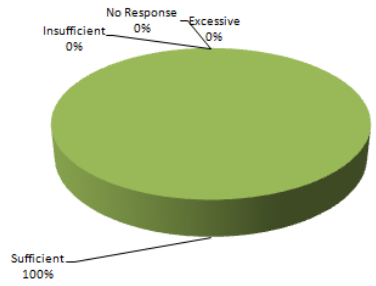
Question 4: How likely is the project team to move technologies into the marketplace?



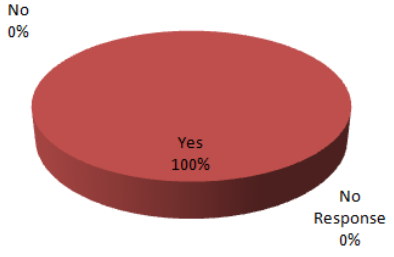
Question 2b: Have the technical barriers been identified and addressed?



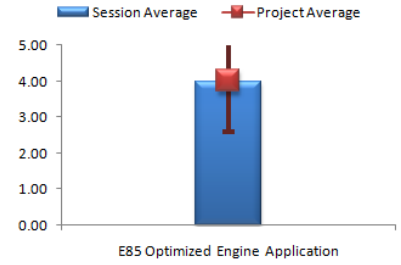
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Enhanced Ethanol Engine and Vehicle Efficiency (Brian West, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were positive overall. One reviewer stated that the research is finding ways to improve the fuel economy of E85-fueled vehicles, which is consistent with DOE objectives to displace petroleum-derived fuels. Another person commented that improving the fuel efficiency of gasoline/ethanol blends is important. Technologies that can be applied broadly in gasoline engine fleets would provide the biggest benefit. One final reviewer commented that, by focusing on improving the performance of ethanol engines, this project addresses petroleum displacement in two ways: displacing petroleum directly with ethanol use, and improving efficiency so less fuel (ethanol and gasoline) is needed. This project is exceptionally well suited to meeting DOE goals because it can remove the real and significant barriers to petroleum displacement represented by shortcomings in ethanol-fueled vehicles.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the project targets both laboratory engine studies and FFV studies to understand and overcome barriers to more efficient ethanol engines and vehicles. In particular, the thrust on lean-burn ethanol-optimized FFV systems shows great promise to make a readily deployed advanced ethanol vehicle. Another reviewer felt that the strategy of running in lean mode to improve efficiency coupled with a better NOx catalyst that uses ethanol as a reductant seems reasonable. This reviewer added that it is also good that "real" engines are being used.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted the progress made on engine, vehicle and after-treatment studies, adding that this work continues to show great promise. Another person stated that the researchers have demonstrated some modest improvements in fuel economy and have ideas (spark/combustion timing control) to improve it further. One final reviewer expressed some concerns about emissions control if ethanol is not available.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first respondent stated that there are good partnerships and connections to industry to deploy the knowledge. The other reviewer indicated that, if developments are technically successful and cost-effective, they will likely be commercialized, particularly if E85 becomes more widely available.

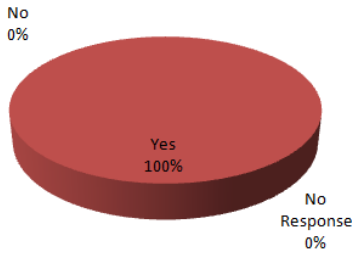
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the resources seem appropriate given funding constraints, while the other stated that the good progress of the group suggests that resources are sufficient.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

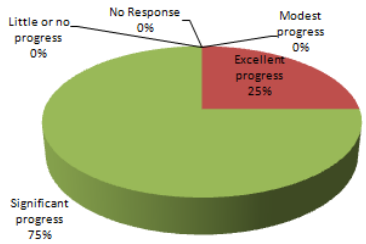
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Enhanced Ethanol Engine and Vehicle Efficiency

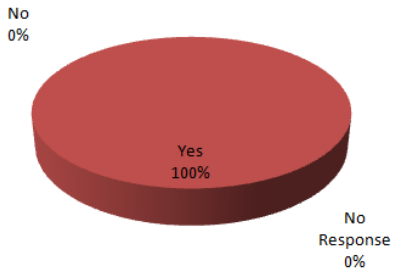
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



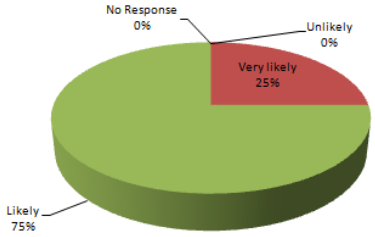
Question 3: Characterize the technical accomplishments and progress toward goals.



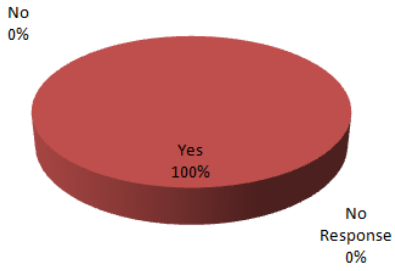
Question 2a: Are the goals of the project technically achievable?



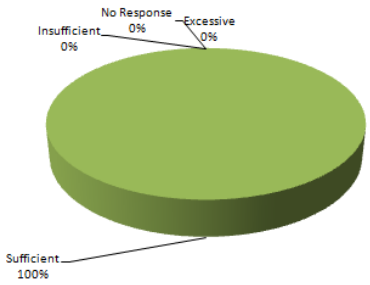
Question 4: How likely is the project team to move technologies into the marketplace?



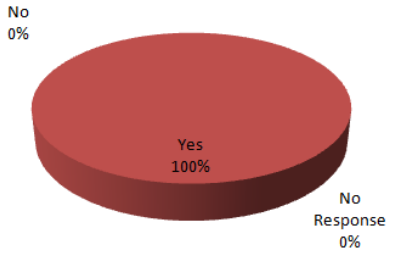
Question 2b: Have the technical barriers been identified and addressed?



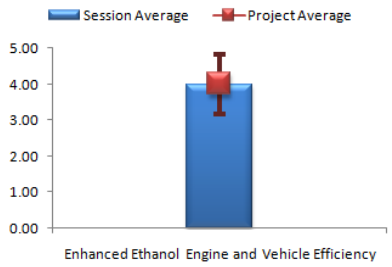
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion (Ellen Meeks, of Reaction Design)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the group is conducting basic research on biofuels to enhance understanding of how they behave in practical systems, and knowledge of how they burn at the kinetic level of description is needed to design both effective fuels and systems to use those fuels.

The other respondent stated that improved models are key to improving engine efficiency, but he or she expects overall benefits from this program to be small due to the limited supply of VO and the similar behavior of diesel and biodiesel in standard diesel engines.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that kinetic models for biofuels are a necessity. The other reviewer responding to this question stated that this project concerns developing a more complete fundamental understanding of the behavior of biofuels. The deployment impacts are that it enables industry, the national labs, and academia collaboration to develop advanced combustion engines and fuels for those engines. In short, this reviewer feels that this work is essential to promoting understanding and effective design.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that this was very nice work, while another stated that the work appears to be progressing at a good rate. Another person commented on the new models presented. One final respondent noted that the various efforts in model validation and kinetic model development are ongoing. The group has completed modeling of flame data from USC. The results look very promising in capturing laminar flame speed behavior.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer noted a close connection with OEM/energy mechanism users. The other person responding to this prompt commented that extension collaborations are in place with the national labs and academia and, through the various MOUs (model fuels consortium, etc.), industry. Given the need for the information generated by this project, the data will certainly be incorporated in engine technology development activities.

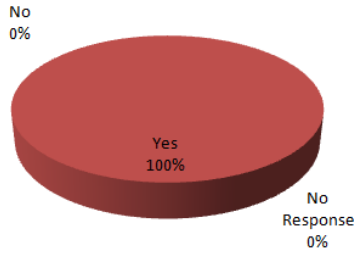
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented that no budget information was provided in the summary sheet. The other respondent asked whether DOE funding was applied to Phase 1 work.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

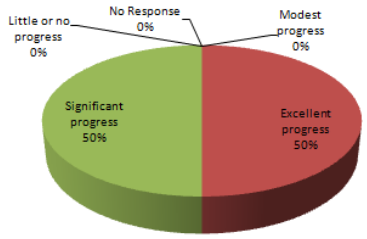
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion

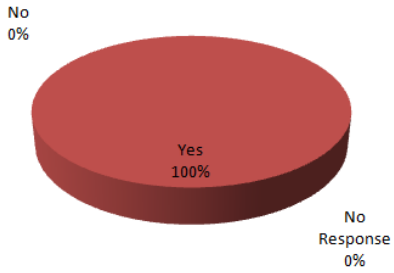
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



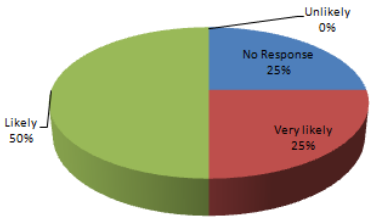
Question 3: Characterize the technical accomplishments and progress toward goals.



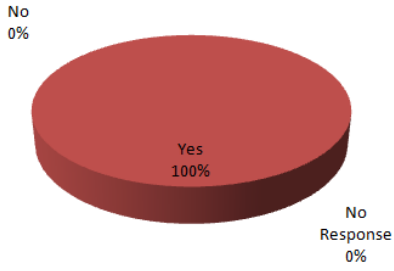
Question 2a: Are the goals of the project technically achievable?



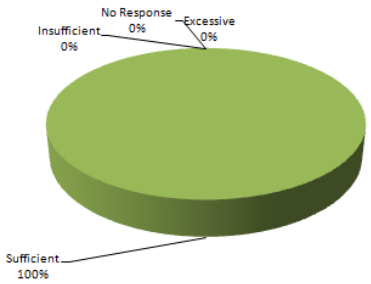
Question 4: How likely is the project team to move technologies into the marketplace?



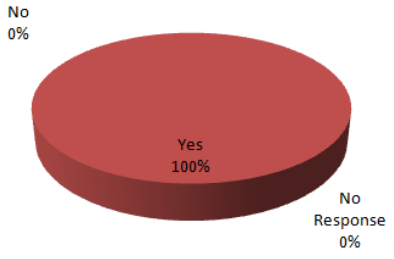
Question 2b: Have the technical barriers been identified and addressed?



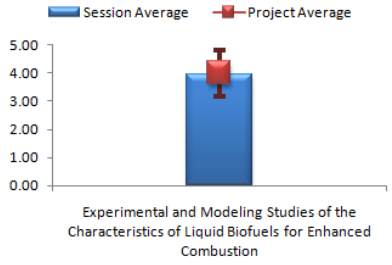
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Fuel & Lubricant Effects on Advanced Emission Controls, Aging Mechanisms, & Rapid Aging Protocols (Bruce Bunting, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent stated that the intent of this project is to improve aftertreatment systems and thereby reduce the fuel economy penalties. In so doing, the project allows clean diesel technology to be deployed, which will provide efficiency improvements, and the project specifically will maximize those efficiency gains and thereby maximize petroleum displacement from dieselization.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent stated that tighter emissions regulations and greater durability requirements combine to threaten vehicle efficiency. Overcoming these barriers to improved efficiency will recover efficiency.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent noted that the group has made progress on DOC, LNT, DPF and combined systems. Specifically, they found that soot masking of DOC is as significant as P poisoning and showed that LNT excursions above 850°C are particularly detrimental. They performed ash-loading studies in DPF and showed the differences in backpressure impacts for different DPF substrates and precious metal loadings. For LNTs, they have characterized degradation mechanisms (e.g., finding that sintering had little performance effect). For SCR combined systems, they examined thermal aging in the SCR caused by the high temperature regeneration of the DPF. The project has a great combination of the practical (hardware, operating conditions, poison exposures, etc.) and the fundamental (elementary characterization of materials, bench and practical scale specimens).

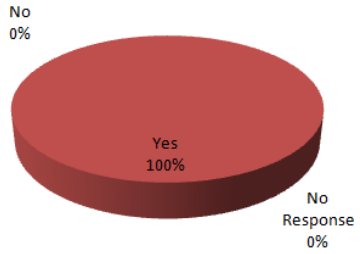
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent indicated that industry involvement is strong. He or she added that the new collaboration with MIT will generate more fundamental understanding of DOC behavior, and thereby may influence design. Mixing the practical and fundamental will generate useful knowledge and enable the industry to use this knowledge.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that funding appears to be appropriate given the constraints in program funds.

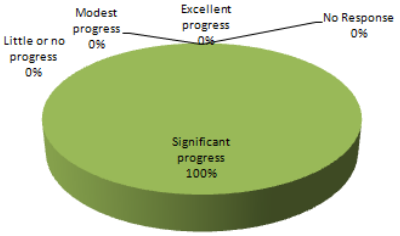
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols

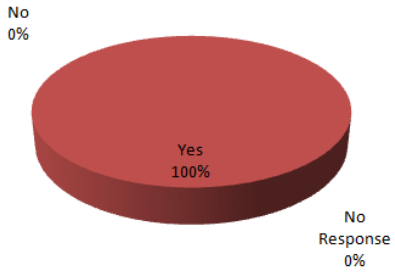
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



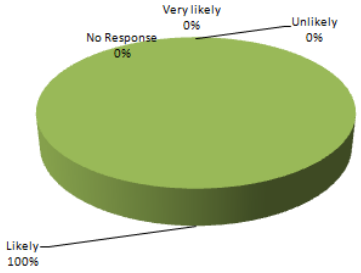
Question 3: Characterize the technical accomplishments and progress toward goals.



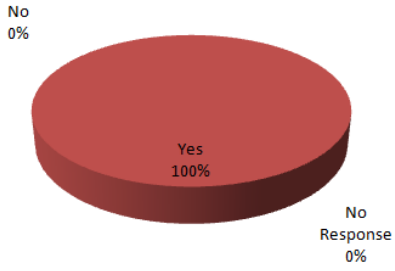
Question 2a: Are the goals of the project technically achievable?



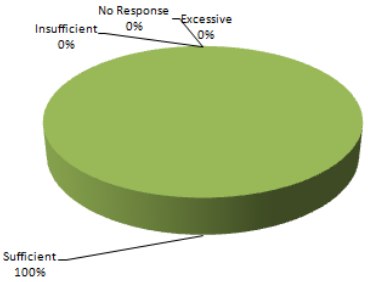
Question 4: How likely is the project team to move technologies into the marketplace?



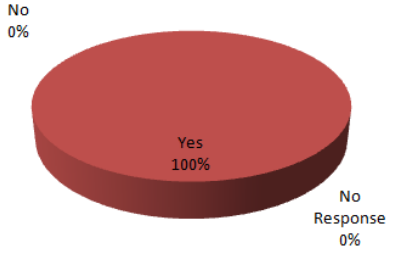
Question 2b: Have the technical barriers been identified and addressed?



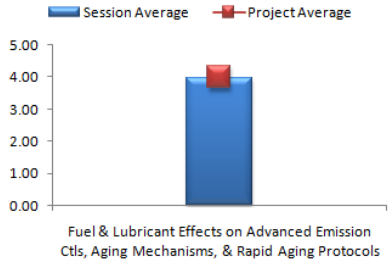
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Fuel Effects on Advanced Combustion (Chuck Mueller, of Sandia National Laboratories)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer commented that the goals of the program – facilitating the use of non-petroleum based diesel fuels (i.e biodiesel), developing strategies for more fuel-efficient HECC engines, and establishing fundamentals of fuel properties on combustion – all support DOE objectives.

One other person commented that the potential of 0.5 - 3 3 MMBPD reduction by overcoming barriers to implementing HECC, plus another potential 1 MMBPD potential through a better understanding of fundamentals of fuel effects (thus increasing efficiency and reducing aftertreatment fuel usage) sound reasonable and are significant targets that seem to be achievable. The reviewer adds it is good to see this stated as a stretch target in the presentation. The work on pool fire impact on soot and NOx formation is interesting.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent stated that these studies should provide good fundamental information to advance the technology in each of the work areas. The reviewer feels that the strategy of studying these phenomena in an optical engine to see what is happening in the combustion process is a good approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that there was very good progress in advancing the understanding of why NOx emissions are higher for biodiesel, why soot and NOx are higher for early injection DI HECC engines, and also for generating ideas on how to mitigate these. One other response indicated that identifying that the NOx increase is larger in HECC mode for biodiesel fuels is a significant accomplishment. This should be investigated more. Also, the information on pool fires impacting soot and NOx formation is interesting.

One final reviewer felt that an explanation for the increased NOx with RME was needed. The reviewer added that flame lift-off effects are very important for diffusion combustion and the key to high power density.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent said that these studies should provide good fundamental information to advance the technology toward commercialization in each of the work areas.

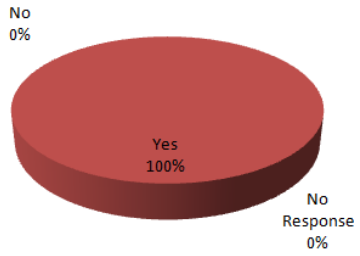
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the very good progress and accomplishments suggest that current resources are sufficient and being used effectively.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

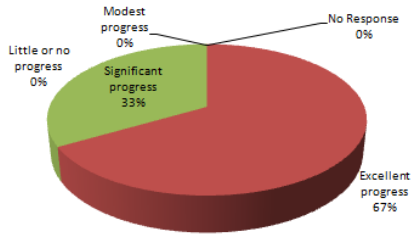
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Fuel Effects on Advanced Combustion

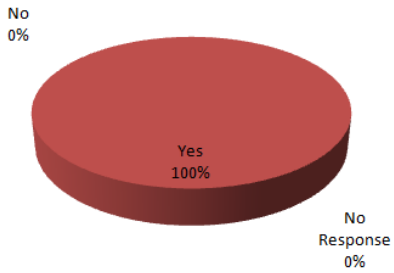
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



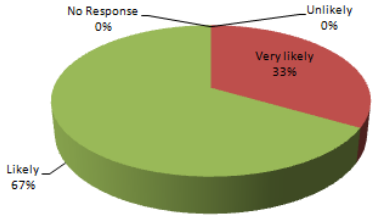
Question 3: Characterize the technical accomplishments and progress toward goals.



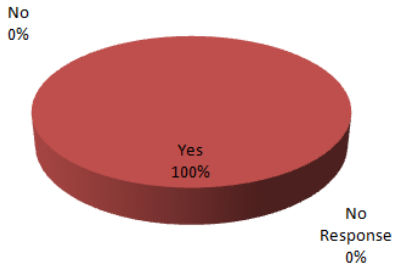
Question 2a: Are the goals of the project technically achievable?



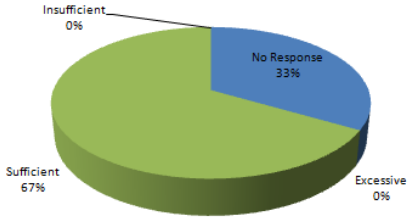
Question 4: How likely is the project team to move technologies into the marketplace?



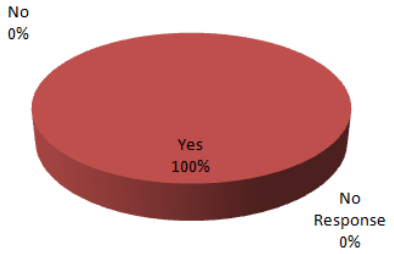
Question 2b: Have the technical barriers been identified and addressed?



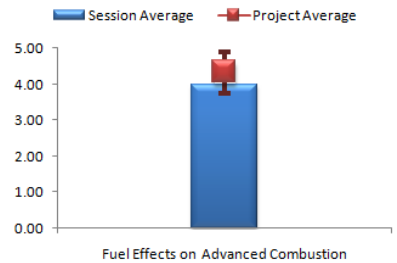
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LLNL APBF (Salvador Aceves, of Lawrence Livermore National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer simply stated that the improved models have value, while another expanded on this, stating that the development of kinetic models and high fidelity engine simulation tools are essential to the development of advanced combustion engines and thereby petroleum use reduction by improving efficiency. One other person stated that the goal of enabling efficient combustion of fuels through improved combustion and emissions modeling tools helps to improve fuel combustion efficiency and reduce the amount of petroleum used.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the group is doing important basic modeling work. Another person wrote that the improvement of tools for predicting the combustion of fuels and emissions is a good strategy. Also, comparing results of model predictions vs. engine results for a gasoline surrogate is a good approach. Another reviewer stated that the continuing development of kinetic models will help overcome the technical barriers to deploying advanced combustion engines, by furthering the ability to do numerically based design of combustion systems. It may also help overcome the shortcomings of some alternative fuels by providing a better understanding of their unique behavior.

One other individual stated that the deployment strategy is difficult to rate since progress in developing detailed chemical kinetic models is slow.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that this is important fundamental modeling work, while another added that validating model fidelity between numerical calculation and experimental work on surrogates is a significant accomplishment. Another reviewer stated that there is very good progress in advancing the modeling for both gasoline and biodiesel. Also, there are apparently very good interactions between LLNL and others such as Sandia to enable comparisons of modeling results with actual engine results. One other person commented on the fact that the group had published a methyl decanoate kinetic model with substantial validation, adding that that is one part of the continuing development and dissemination of kinetic models of surrogates to represent practical fuels. These kinetic models benefit the entire combustion community, academia, other national labs and industry.

One reviewer felt this was difficult to evaluate without timelines. He or she would like to see more a representative diesel surrogate that would include aromatics and naphthenes.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the development of the kinetic models and simulation tools will help support the development and deployment of advanced combustion engines. This work is an essential component of the overall drive to efficient and clean engines. The other reviewer responding to this prompt stated that this work is definitely advancing the fundamental understanding of fuels combustion, which should lead to fuel and engine improvements for advanced combustion.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

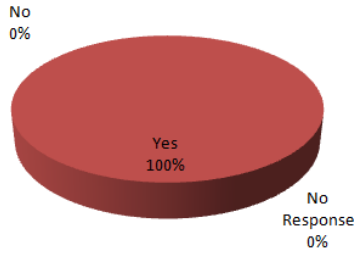
The first reviewer stated that there is very good progress, so resources seem sufficient. The other respondent commented that, within budget constraints, the budget for this program seems appropriate but perhaps is a bit lower (relatively) than the impact this program has. So, if more funds would become available, this would be the first program that this reviewer would provide with supplemental funds.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

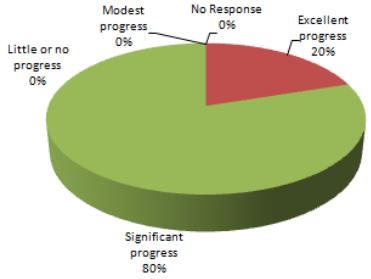
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LLNL APBF

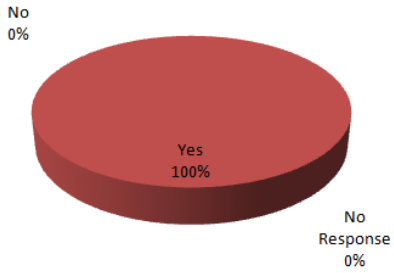
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



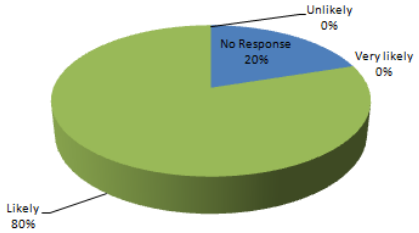
Question 3: Characterize the technical accomplishments and progress toward goals.



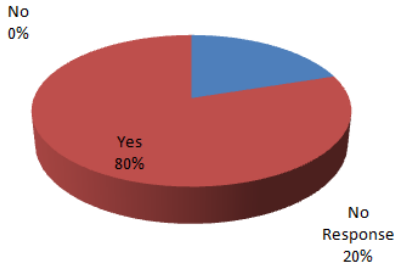
Question 2a: Are the goals of the project technically achievable?



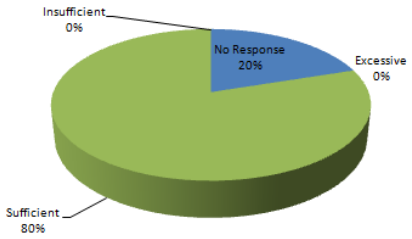
Question 4: How likely is the project team to move technologies into the marketplace?



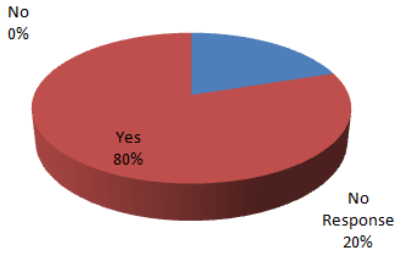
Question 2b: Have the technical barriers been identified and addressed?



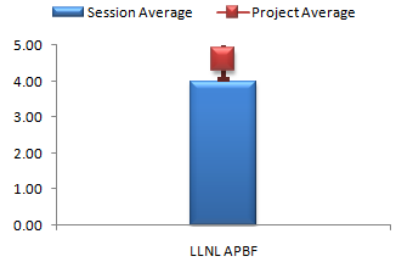
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Multi-Component Nanoparticle-Based Lubricant Additive (Atanu Adhvaryu, of Caterpillar)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One individual stated that, by promoting engine efficiency and durability, the project has the potential to reduce fuel consumption and thereby displace/prevent petroleum usage. The other respondent commented that this area is a nice compliment to other DOE fuel activities. This reviewer would like to see a quantification of potential benefits.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One individual stated that it was too early to evaluate thoroughly. The other reviewer began by commenting that, by providing nanoparticulate enhancers for lubricant performance, the effectiveness of boundary lubrication will be improved. There is ample information in the literature indicating that, with an appropriate nanoparticle design, the lubricant performance can be improved. An example is solid film lubricants (e.g., MoSx) which can be combined with conventional mineral oil and synthetic lubricants. So, this project targets an achievable goal and can be successful with appropriate nanomaterial development and matching with the lubricant formulation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that there was good progress in a limited period of time. Another person also indicated that the project just started, but added that analyses of the necessary processes for material production and material characteristics are underway. They have already demonstrated the need to "stabilize" nanoparticles to keep them dispersed in the lubricant, and have demonstrated reduced friction and wear with preliminary formulations.

One reviewer felt that it was difficult to assess technical accomplishments because of a lack of a lubricants expertise. Next year, it would be nice to get this presentation ahead of time to have a lube chemist or engineer from reviewer companies to review and comment on.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person suggested that, if the team is successful in achieving the project objectives, then it is very likely that the lead organization, Caterpillar, will put these materials into the marketplace, either directly or through partners. Another person commented that this research is longer-term in nature.

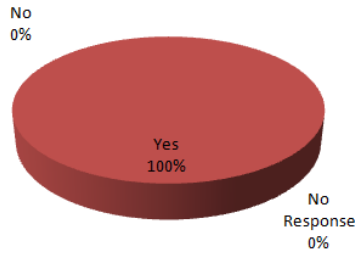
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the funding is modest but should be adequate to achieve the project objectives if the nanomaterial design and lubricant formulation are effective. However, this reviewer adds that commercialization will require substantial additional resources to put the candidate materials through the necessary test engine protocols to achieve certification. Another reviewer noted that this is a new project, making it difficult to assess progress.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

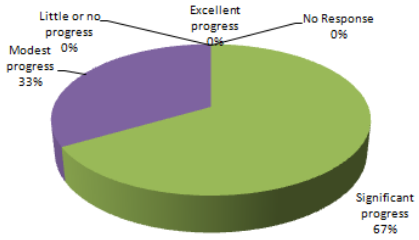
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Multi-Component Nanoparticle-Based Lubricant Additive

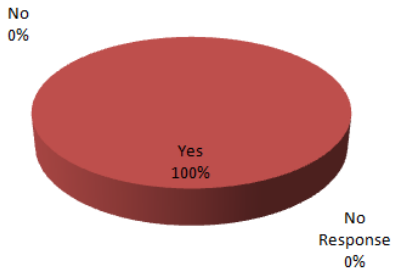
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



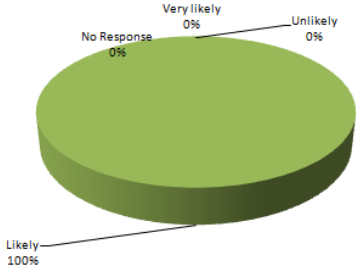
Question 3: Characterize the technical accomplishments and progress toward goals.



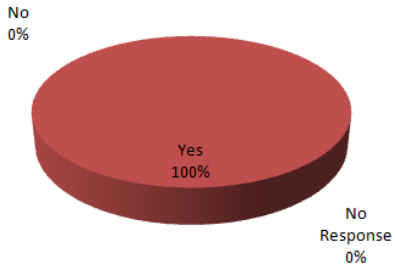
Question 2a: Are the goals of the project technically achievable?



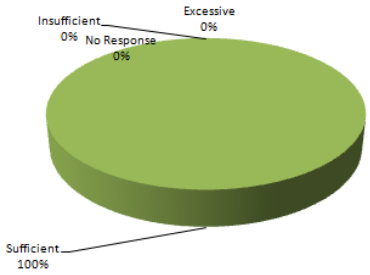
Question 4: How likely is the project team to move technologies into the marketplace?



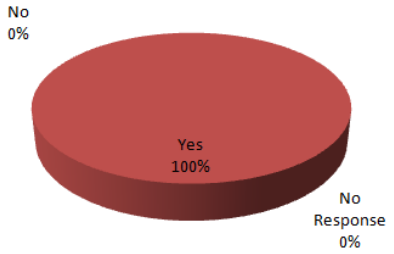
Question 2b: Have the technical barriers been identified and addressed?



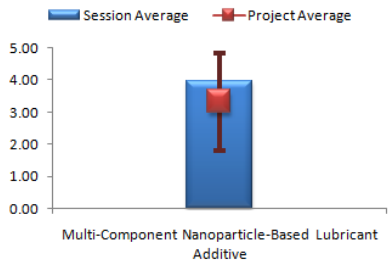
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Non-Petroleum Based Fuels Intermediate Ethanol Blends (Wendy Clark, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive to this prompt. One reviewer indicated that the use of ethanol directly displaces petroleum usage, albeit with many side effects and side concerns (efficiency, land usage, etc.). Also, consideration of intermediate level blends (e.g., E20) may provide a much more effective means of using ethanol than E85. Another person stated that the focus is on the use of intermediate amounts of ethanol in gasoline, which would increase the amount of ethanol used and displace petroleum-derived gasoline. One final reviewer commented that it is very important to determine the best near-term utilization of ethanol. To be most useful, there need to be technical results as soon as possible, since current legislation requires a rapid increase in ethanol production.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that they are deploying ethanol at intermediate levels (>E10), while the other respondent stated that there is a good strategy for investigating the impact of intermediate amounts of ethanol on existing "conventional" vehicles and small engines to determine whether this is feasible or catastrophic.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One response commented that this work appears to be relatively new and few results were presented, but a number of good studies have been initiated. Another reviewer added that the primary accomplishments were in planning, so substantial work was not completed but was put in motion. Considering vehicles, small engines and other equipment, the group is working with CRC and other entities to gain input and guidance. Much will be done by the end of CY 2008, since promising progress was made towards the organization of the project. This reviewer suggests that the program includes a pathway to a larger vehicle field study so that definitive recommendations on E20+ fuels can be produced.

One final reviewer stated that the progress in program design has been excellent as has been leveraged with other programs. This reviewer's only concern is whether the program is comprehensive enough.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the results will definitely help to influence decisions of whether intermediate levels of ethanol in gasoline can be used successfully/safely in conventional vehicles and small engines. Another person added that this work seems to be essential to circumvent the looming barrier for ethanol deployment at the levels requested by the Bush administration. This reviewer adds that looking at a broad range of equipment and vehicles is a good strategy and may pave the way for E20 and other intermediate blends. Another strongly endorsed close working relationships with CRC, EPA and other groups.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

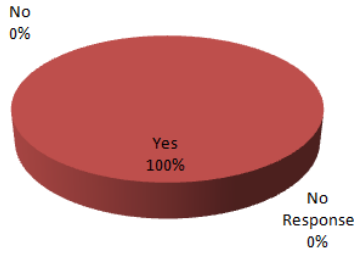
One reviewer commented that, given budget constraints, the funding for this program seems appropriate. But, if this program shows promise for the practical use of E20 (or other intermediate blends), then it may be necessary to expand this program substantially to validate on a much larger scale the use of E20. One other respondent added that the program may need more resources to fully resolve all of the issues across the range of engine/vehicles. One issue to consider is the impact on durability of evaporative control systems. This reviewer notes that CRC is considering work in this area.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

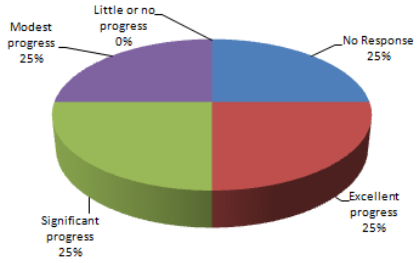
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Non-Petroleum Based Fuels Intermediate Ethanol Blends

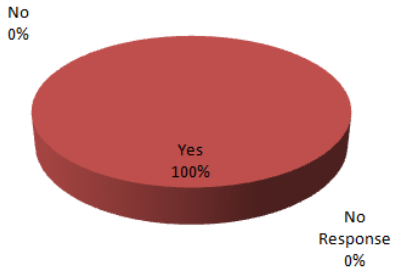
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



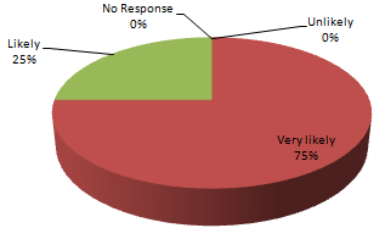
Question 3: Characterize the technical accomplishments and progress toward goals.



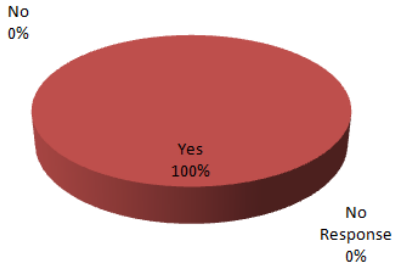
Question 2a: Are the goals of the project technically achievable?



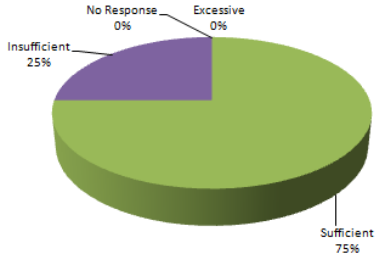
Question 4: How likely is the project team to move technologies into the marketplace?



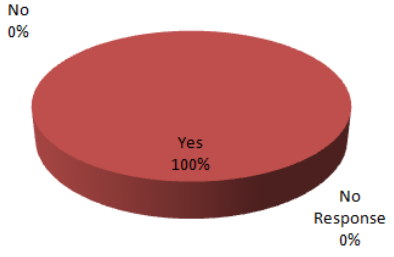
Question 2b: Have the technical barriers been identified and addressed?



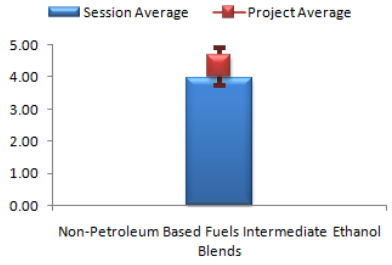
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NPBF Characteristics Effects on Advanced Combustion Engines (Jim Szybist, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent commented that improving efficiency in gasoline/ethanol blends can have the biggest impact on petroleum use. In the near term, there will be much more ethanol than biodiesel. Work on tar sands and diesel is also useful.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
There were no responses to this prompt.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the quality of work is very high. This reviewer is unsure of the commercial penetration of HCCI and some of the fuels studied. The other respondent said that information on fuel properties that can improve fuel efficiency/economy by delaying combustion phasing is important work, adding that the oil sands data sounds interesting.

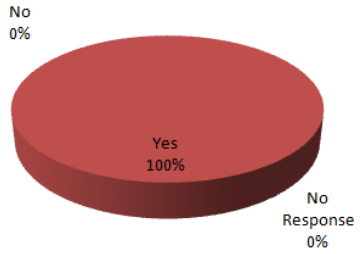
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
There were no responses to this prompt.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

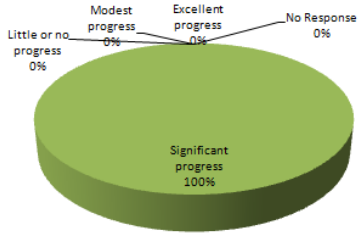
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NPBF Characteristics Effects on Advanced Combustion Engines

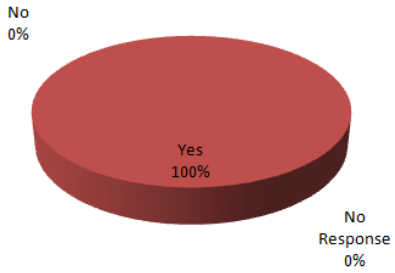
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



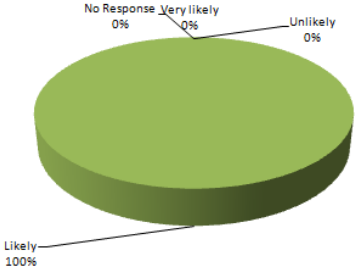
Question 3: Characterize the technical accomplishments and progress toward goals.



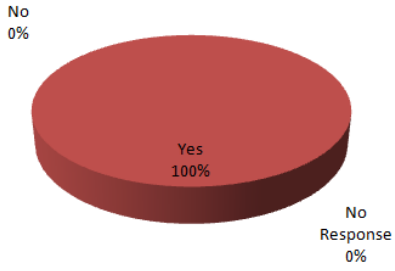
Question 2a: Are the goals of the project technically achievable?



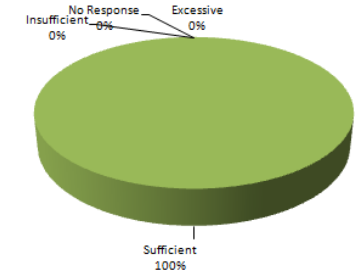
Question 4: How likely is the project team to move technologies into the marketplace?



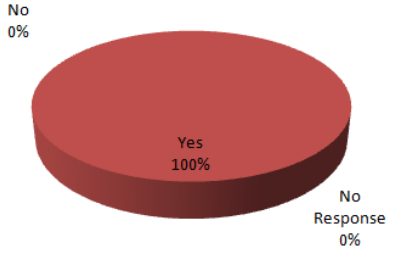
Question 2b: Have the technical barriers been identified and addressed?



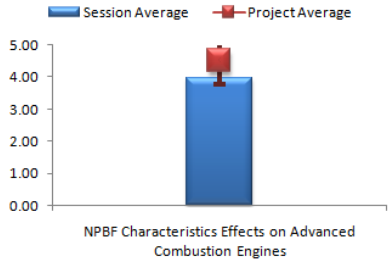
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NPBF Effects and Enhancements on Engine Emission Control Technologies (Scott Sluder, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer said that the NPBF programs can directly influence petroleum displacement and the DOE program since it considers emission controls and can enable clean diesel technology compatibility with NPBFs. Thus, this program is enabling the use of NBPFs. Another person commented that the focus on improving an understanding of the impact of NPBF's on emissions systems is important for enhancing the feasibility of their commercial use. One final reviewer stated that it is important to understand the potential biodiesel impacts on current and near-term vehicle technologies.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that this is a good approach in performing tests in real systems. The other respondent commented that this program addresses the lack of information and predictive tools regarding how NPBFs will influence emissions controls for clean diesel vehicles. This can help anticipate problems from a greater penetration of NPBFs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted the group demonstrated that PM reactivity is related to surface oxygen content (which seems, in turn, to be related to biodiesel level). They also demonstrated that EGR cooler fouling is not different for biodiesel blends vs. conventional diesel. One other person commented that the PM oxidation project showed the surface oxygen content effect on soot ignition temperature (although this has been demonstrated and explained by others already). This reviewer added that the EGR cooler fouling work is very important because it addresses a significant potential roadblock for clean diesel technology. Some of the soot/DPF analyses are repetitive of published work, and it was not clear in some cases where the uniqueness in the present work lies, although thorough characterization of PM from low blend levels (like B5) appears to be new. This reviewer felt that the impact of biodiesel on deposit formation in the cooler-related experiments and the characterization of the nature of the deposit layers are very valuable and interesting work.

One other person endorsed looking at higher HC conditions for EGR cooler impact. This reviewer asked whether the cold-start would be the worst case. One final reviewer stated that the coolant fouling data is interesting, adding that B5 anomalies in both PM oxidation and EGR fouling is intriguing.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One response stated that the results will provide direction regarding which issues need to be addressed for NPBF's and which do not. The other respondent commented that an emphasis on sophisticated analyses of emissions, materials, and combustion with practical engines and practical fuels is an excellent use of the national labs' unique skills to address practical near-term and long-term

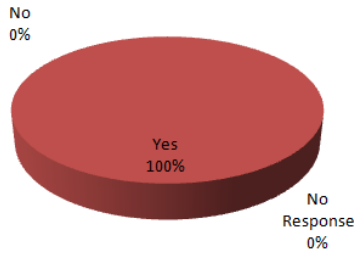
challenges. The strategy in this work and collaborations provide an excellent means for the knowledge gained to be deployed in the field.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the budget levels seem appropriate given the program's funding constraints, while another felt that the good progress suggests that resources are sufficient.

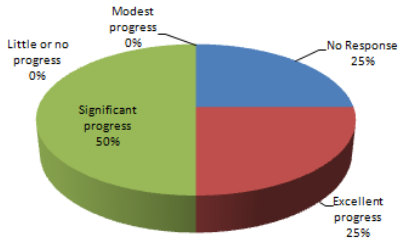
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NPBF Effects and Enhancements on Engine Emission Control Technologies

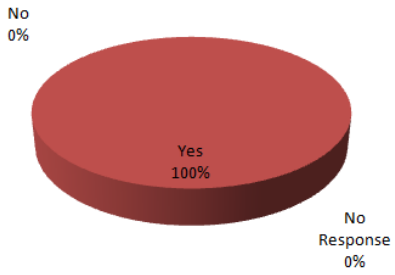
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



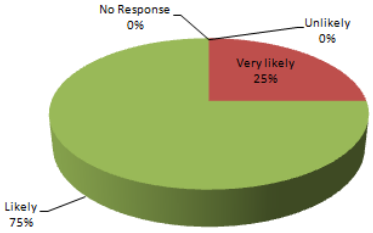
Question 3: Characterize the technical accomplishments and progress toward goals.



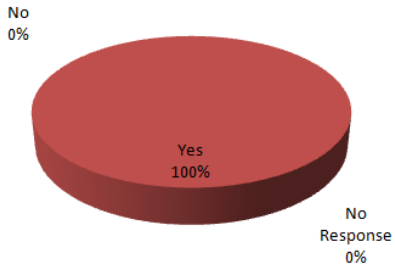
Question 2a: Are the goals of the project technically achievable?



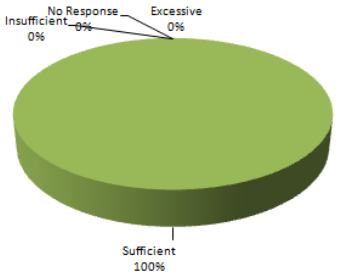
Question 4: How likely is the project team to move technologies into the marketplace?



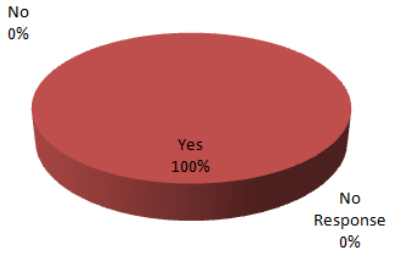
Question 2b: Have the technical barriers been identified and addressed?



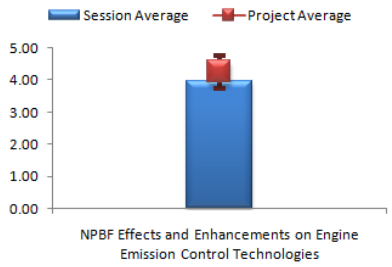
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NPBF Quality, Stability, Performance, and Emission Impacts of Biodiesel Blends (Robert McCormick, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer stated that this project is addressing technical issues related to biodiesel, while another added that this work has very high near-term commercial relevance due to the many technical issues resulting from increased biodiesel use. One other reviewer said that characterizing properties of alternative fuels in the market to identify areas of compliance/concern is critical for consumer acceptance as sales volumes ramp up.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the approaches of surveying the quality of the biodiesel marketplace, working with ASTM to develop appropriate biodiesel specifications and tests, and testing biodiesel blends' effects on aftertreatment systems are very important to ensure biodiesel being sold in the market is "fit for purpose" and doesn't damage the public perception of biodiesel. The other respondent commented on the PM regeneration rate data, which shows the PM from BD rate is faster than from ULSD. This is interesting, but how would this be implemented by an OEM to reduce fuel consumption on regeneration?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer identified good progress in identifying the number and types of biodiesel quality issues in the market, developing biodiesel tests and specifications, and testing the impact of biodiesel on emissions aftertreatment systems. Another person noted that proper ASTM standards are critical for commercial use, adding that the PM trap work is also critical. This reviewer recommends addressing the engine oil dilution issue in US vehicles, since this is a major issue in Europe.

One final reviewer stated that the survey of market-available alternative fuels is important. Reporting BD survey data by production volume was a good tool for getting a handle on where the quality issues are coming from. This reviewer asks whether this information is available in geographical format as well.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented that this work helps to identify issues with the use of biodiesel that need to be addressed for widespread use/acceptance of biodiesel. The other response stated that the data generated has been very important in ASTM and to the industry, and has facilitated the use of biodiesel. The main negative of the approach is the relatively limited VO feedstock supply.

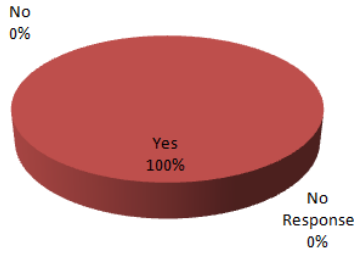
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the good progress suggests that the resources are sufficient.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

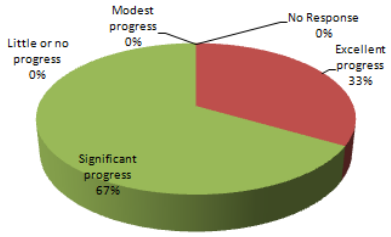
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NPBF Quality, Stability, Performance, and Emission Impacts of Biodiesel Blends

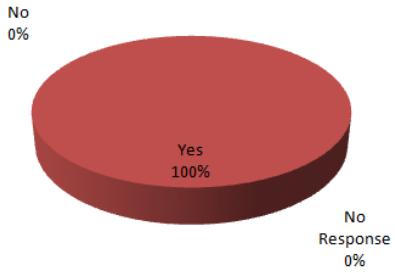
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



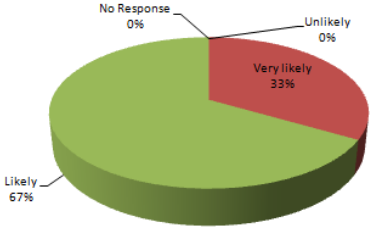
Question 3: Characterize the technical accomplishments and progress toward goals.



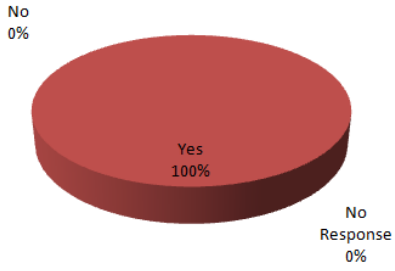
Question 2a: Are the goals of the project technically achievable?



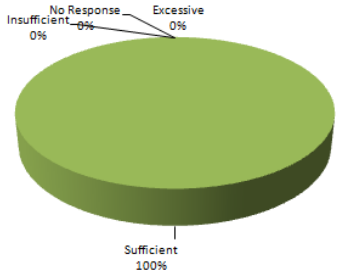
Question 4: How likely is the project team to move technologies into the marketplace?



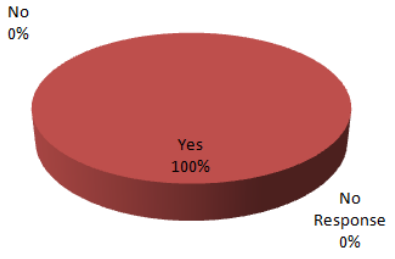
Question 2b: Have the technical barriers been identified and addressed?



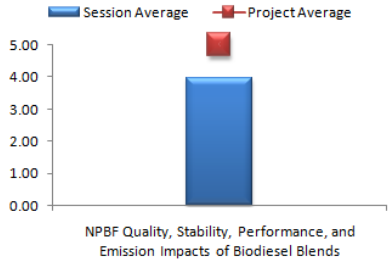
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) (Hakan Yilmaz, of Robert Bosch, LLC)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer indicated that improving fuel economy and emissions of E85 vehicles is consistent with DOE objectives, while another commented that improving gasoline/ethanol blend vehicle performance would provide significant benefits. One other person added that, by focusing on improving the performance of an E85 vehicle, this project addresses petroleum displacement in two ways: displacing petroleum directly with ethanol use and improving efficiency so that less fuel (ethanol and gasoline) is needed. This project is exceptionally well suited to meeting DOE goals because it can remove the real and significant barriers to petroleum displacement represented by shortcomings in E85 production vehicles.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response commented that the strategy of improving performance of E85 vehicles at minimal additional cost and hardware is a good strategy. One person noted that the project uses available technology. Another individual indicated that the investigators have identified performance and fuel economy as the key barriers to overcome. These are certainly major barriers to the success of E85 and the partnership in this project appears effective to overcome these barriers given their expertise in fuel system development and engine development. The lead for the project has already examined strategies to overcome cold start, injector flow restrictions, and other aspects of system design.

One person stated that there was not enough improvement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that it was still early, while another didn't rate this section since the presentation mainly talked about plans, and not many results, which suggested that this is a relatively new program. One reviewer stated that, with the extensive experience the team already has with ethanol fueling challenges and opportunities, the team has technologies available to it already to incorporate into their design and to find optimal combinations to exploit synergies. Much hardware and analysis progress has been made already despite this being a new project. The targets are aggressive and this is highly desirable. Ethanol brings many drawbacks from a life cycle perspective in efficiency and CO_2 emissions. Thus, aggressive efficiency targets are advisable.

As above, one person commented simply that there is not enough improvement.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that this is an obvious technology choice, while another person commented that, if successful, the probability is high that Bosch will commercialize the technology since they are a commercial producer of engine components. One person said, since the lead for the project is one of the major fuel system developers, the likelihood of deploying developed technologies is great. The

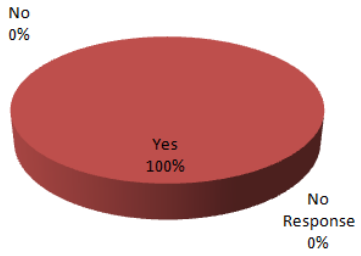
group can leverage past experience to find synergies between engine system technologies to achieve the project objectives.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented that the budget appears reasonable, provided that internal industry resources are being leveraged. Another stated that there was no evidence that the current resources are excessive or insufficient.

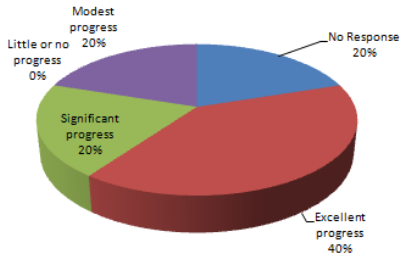
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized)

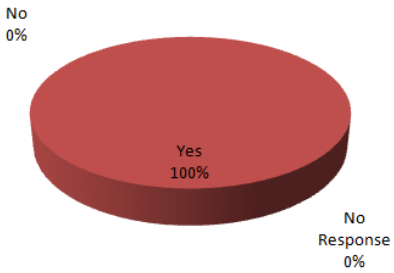
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



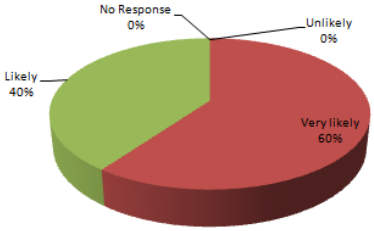
Question 3: Characterize the technical accomplishments and progress toward goals.



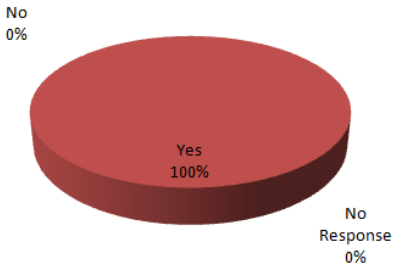
Question 2a: Are the goals of the project technically achievable?



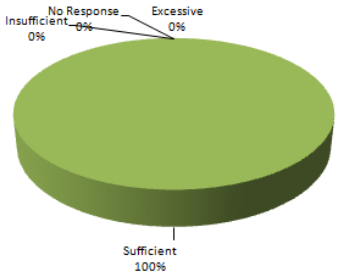
Question 4: How likely is the project team to move technologies into the marketplace?



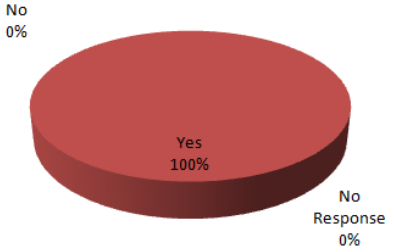
Question 2b: Have the technical barriers been identified and addressed?



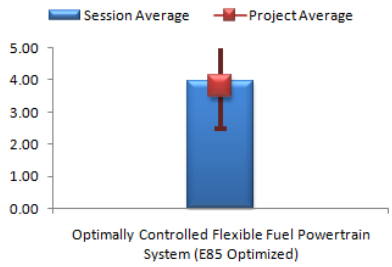
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) (Bruce Woodrow, of Mahle)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that improving fuel economy and minimizing the emissions of engines running on ethanol blends is consistent with DOE objectives. Another wrote that, by focusing on improving the performance of an E85 vehicle, this project addresses petroleum displacement in two ways: displacing petroleum directly with ethanol use and improving efficiency so less fuel (ethanol and gasoline) is needed. One other individual stated that this is similar to other E85 projects.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that there is good work, aggressive targets, and an aggressive choice of technology, while another person commented that the strategy of improving performance not only for E85 fueled vehicles, but also those fueled with lower ethanol content blends is good. One reviewer noted that they intend to develop a new engine that is fully optimized for E85, no emissions penalty and minimum fuel economy penalty. In addition, the researchers intend to demonstrate improved performance with E85 and higher fuel economy on E10 than on base gasoline. They are looking at a compromise between compression ratios and boost pressure, while keeping peak cylinder pressure within limits. They are also looking at how to achieve high cooled EGR rates. One other reviewer, as above, stated that this is similar to other E85 projects.

Another person commented that a social impact study, using GREET model, was mentioned. The reviewer asks, will this be a well-to-wheels analysis which includes the carbon footprint cost of the additional hardware to upgrade the FFV, or just a well-to-tank comparison of E85 with conventional gasoline? Will inputs for ethanol production include capital investments for infrastructure, fertilizer, irrigation and other production costs? What will the source of ethanol be (e.g. will E85 be produced by wet mill, dry mill, switch grass, or import of ethanol from a cheaper source)? Or will default GREET inputs be used whenever possible? The reviewer notes this can become a very complex analysis.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that there is good work, aggressive targets, and an aggressive choice of technology. Another stated that being able to run at any ethanol level is a good goal.

One person didn't rate, since the program is relatively new and few results were presented.

Another reviewer commented that it appears that very little progress has been made thus far, although the project is just getting started at this point. Another wrote, as above, that it is similar to other E-85 projects.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that, in order to sell ethanol engines, there need to be aggressive fuel consumption reductions. The fuel is too expensive for low-efficiency engines. The reviewer added that this engine is based on genuinely good engineering inspired by diesel engines. Another person wrote that, since Mahle is a commercial engine/component manufacturer, the probability is high that if the technology is successful and cost-effective, then Mahle will move to commercialize it.

One reviewer noted that the team includes a major component supplier, but added that it is unclear how the engine design and development process will lead to implementation of the engines in commercial vehicles. For instance, where is the market for this 1.2L, 3-cylinder engine in the US marketplace?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer suggested that there should be increased resources for this promising technology. Another reviewer noted that the project activities seem very broad given the modest resources provided for this project. This reviewer added that a source of co-funding from an energy company is currently being pursued.

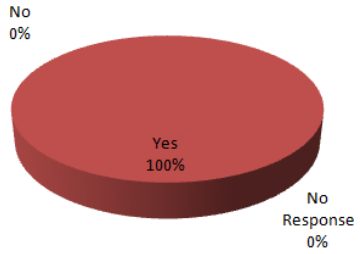
One person stated that there is no evidence that the current resources are insufficient or excessive. Another reviewer commented it is early in the program, such that it is difficult to assess progress.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

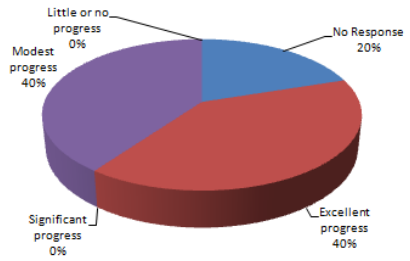
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized)

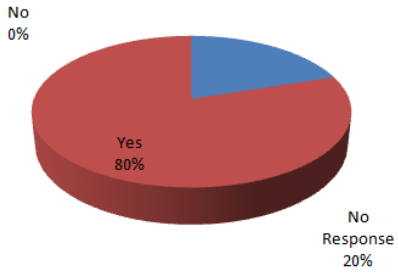
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



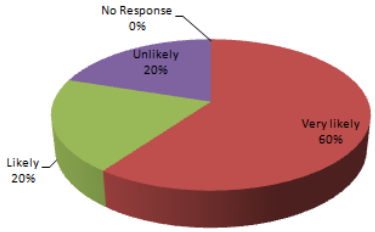
Question 3: Characterize the technical accomplishments and progress toward goals.



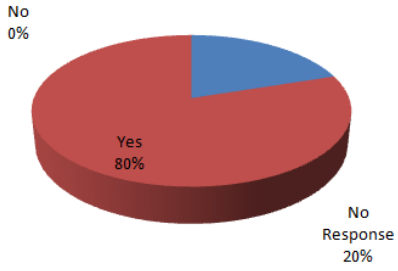
Question 2a: Are the goals of the project technically achievable?



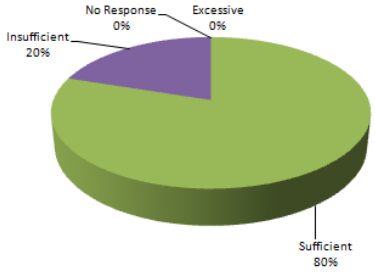
Question 4: How likely is the project team to move technologies into the marketplace?



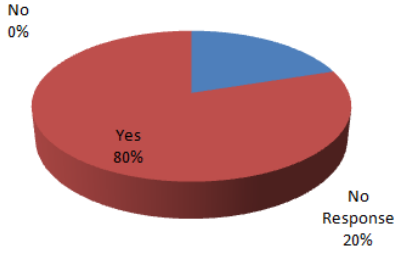
Question 2b: Have the technical barriers been identified and addressed?



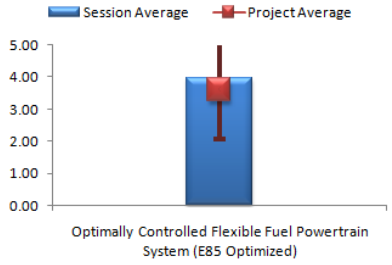
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Unconventional Hydrocarbon Fuels (Tom Gallant, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that unconventional fuels will directly displace petroleum. Another person commented that, as we replace more petroleum imports with unconventional hydrocarbons, analytical tools to collect physical property data of oil sands and other alternative blendstocks will become more and more critical.

One other respondent noted that heavy oils have been utilized commercially for 15+ years. This reviewer added that it is not clear what new information this project provides.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that oil sands derived fuels are a growing part of the fuel supply in the US and they are fundamentally different from conventional crude oils. So, a better understanding of the syncrude and its impacts on fuel processing and fuel properties will be needed to incorporate more oil sands fuels in the US system.

One other person said that it is not clear that there are any barriers to expanded use.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent commented that the investigators have completed chemical analyses of various unconventional hydrocarbon process streams and are coordinating and disseminating information and samples to linked projects on oil sands fuels. The challenges of analyzing the oil sands fuels seem to be significantly exaggerated. Many labs focused on fundamental fuel chemistry (e.g., organic geochemistry of coal and coal liquids) face far more significant analytical challenges than those found in analyzing oil sands fuels. This project does provide value in being a clearinghouse for information on the oil sands fuels, whether finished fuels or process streams.

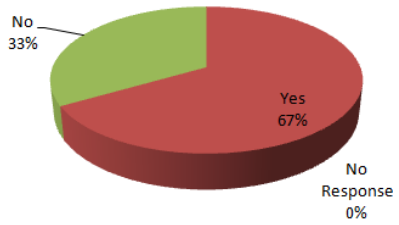
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the partnerships and collaborations in the project ensure that information is getting to users and refiners to account for oils sands impacts. Another person stated that analytical techniques and fuel streams are already available.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent indicated that funding is modest but seems appropriate for the level of effort, given program funding constraints.

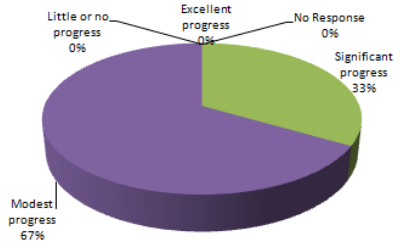
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Unconventional Hydrocarbon Fuels

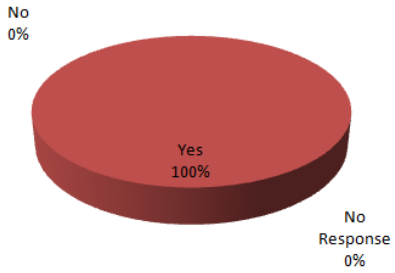
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



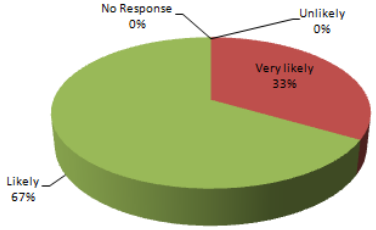
Question 3: Characterize the technical accomplishments and progress toward goals.



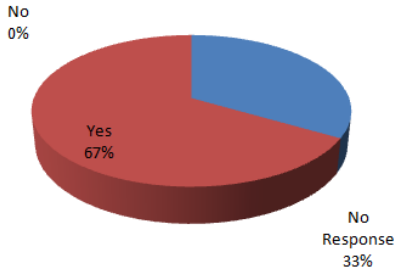
Question 2a: Are the goals of the project technically achievable?



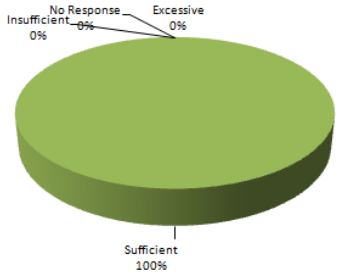
Question 4: How likely is the project team to move technologies into the marketplace?



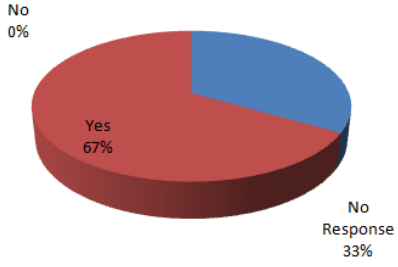
Question 2b: Have the technical barriers been identified and addressed?



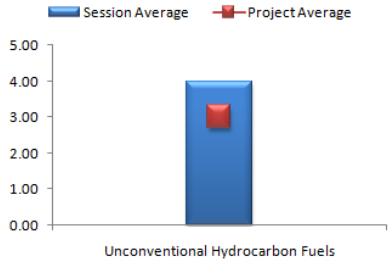
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Use of EGR to Optimize Fuel Economy & Minimize Emissions in Engines Operating on E85 (Ko-Jen Wu, of General Motors)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that improving fuel efficiency and reducing emissions of E85 fueled vehicles is consistent with DOE's objectives, while another agreed, stating that improving the fuel efficiency of gasoline ethanol blends can have large impact. The technology described can also reduce fuel consumption significantly in gasoline engines. One other person stated that, by focusing on improving the performance of an E85 vehicle, this project addresses petroleum displacement in two ways: displacing petroleum directly with ethanol use and improving efficiency so less fuel (ethanol and gasoline) is needed. By including the consideration of emissions, the project also can prevent adverse impacts from ethanol use and prevent a potential public concern about the use of ethanol. This last point is a real problem, given the growing public concern over CO_2 equivalent emissions and air quality problems that surround ethanol production. This project is exceptionally well suited to meeting DOE goals because it can remove the real and significant barriers to petroleum displacement represented by shortcomings in E85 production vehicles.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the strategy of focusing on turbocharging and EGR system and on transients seems good, while another noted that the use of an OEM improves the likelihood of commercial use. One respondent commented that the project seeks to improve E85 vehicle FTP fuel economy by 15% through the use of cooled EGR and air induction optimization. The participants have targeted an engine that is part of GM's future engine lines, so the outcomes from the project can be directly implemented in future vehicle products. Thus, if successful, the technologies developed can be readily implemented. The barriers of the project have been clearly identified. The project directly addresses these barriers: loss of economy and performance with E85, and the consequent adverse response from customers. But, the targeted fuel economy improvement seems modest. Will 15% better E85 performance remove the public concerns over reduced tank mileage with E85? Following this, one reviewer felt there was not enough improvement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer commented that, since this is a new project, there has not been much time for progress to be made. The project will combine engine dynamometer experiments and simulation that will be validated with data and used to project hardware configurations to meet the targets. The investigators have completed simulation configurations and are moving toward engine selection and configuration. Despite the brief time the project has been in place, good progress has already been made.

Another person noted that the project is relatively new, so there are not as many results to date as other programs, but this reviewer wouldn't characterize progress as slow. Another indicated that it is still early in the program. One individual stated that downsizing the engine by optimizing for E85 is an interesting concept. This person asks, how much of the 15% fuel economy would be achieved with the hardware changes on a conventional engine running on conventional fuel?

One reviewer, as above, felt there was not enough improvement.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer stated that this is an obvious technology choice, while another cited the OEM participation. One person commented that, since the lead is a manufacturer of flex fuel vehicles, successful completion of project objectives should provide a direct path to implementing the outcomes in the vehicle fleet. However, there is dependence on outside vendors to achieve a number of the project tasks, which may impede the rate of progress and potential commercialization. One final reviewer noted that, as a producer and marketer of vehicles, GM has a strong driver to commercialize developments. One question is whether developments will be restricted to use in GM vehicles only. Another is where will all the ethanol come from for widespread use of E85?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

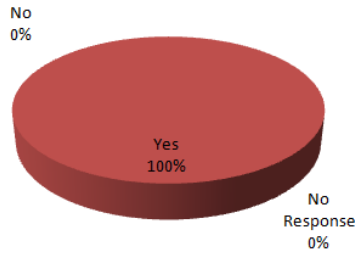
The first response stated that the budget seems reasonable for the project, especially since this is industry led and is directly relevant to existing commercial products. Another felt that there was no evidence that resources are excessive or insufficient. One final reviewer stated that progress appears to have been slow, and it is unclear what quantity/complexity of modeling work was done or needed to be done to develop this concept.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

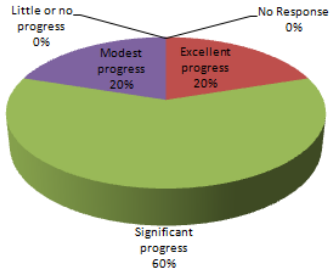
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Use of EGR to Optimize Fuel Economy & Minimize Emissions in Engines Operating on E85

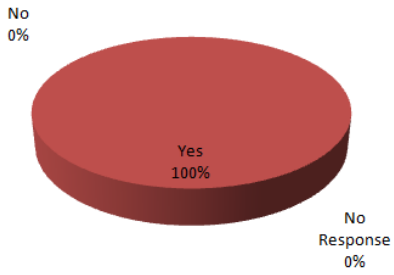
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



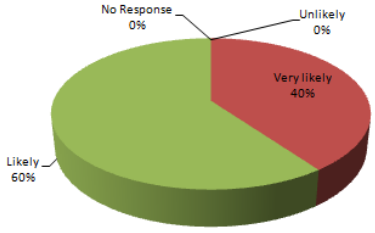
Question 3: Characterize the technical accomplishments and progress toward goals.



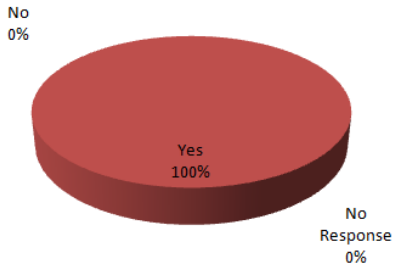
Question 2a: Are the goals of the project technically achievable?



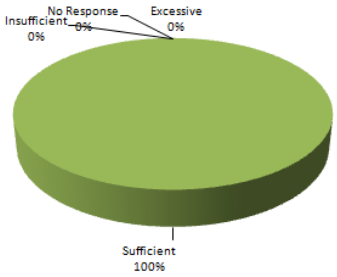
Question 4: How likely is the project team to move technologies into the marketplace?



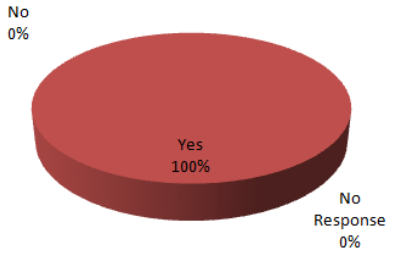
Question 2b: Have the technical barriers been identified and addressed?



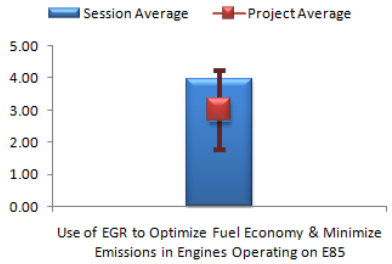
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



11. Lightweight Materials

Introduction

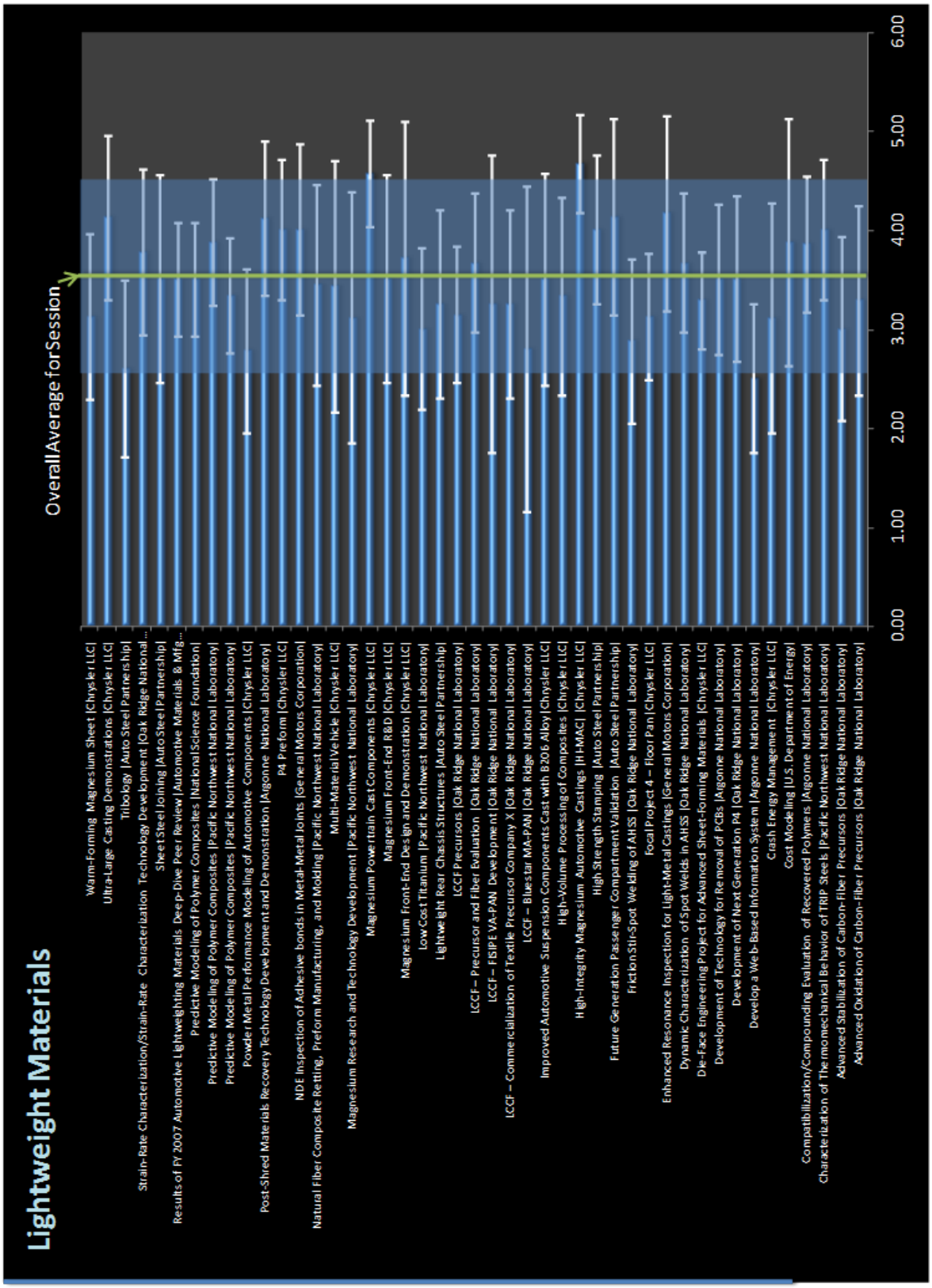
Automotive Lightweighting Materials (ALM) focuses on the development and validation of advanced materials and manufacturing technologies to significantly reduce automotive passenger-vehicle body and chassis weight without compromising other attributes such as safety, performance, recyclability, and cost. The specific goals of ALM are to develop material and manufacturing technologies by 2010 that, if implemented in high volume, could cost-effectively reduce the weight of passenger-vehicle body and chassis systems by 50% with safety, performance, and recyclability comparable to 2002 vehicles. ALM is pursuing five areas of research: cost reduction, manufacturability, design data and test methodologies, joining, and recycling and repair. Because the single greatest barrier to the use of lightweight materials is cost, priority is given to activities aimed at reducing costs through development of new materials, forming technologies, and manufacturing processes. Priority lightweighting materials include advanced high-strength steels (AHSSs), aluminum, magnesium, titanium, and composites including metal-matrix materials and glass- and carbon-fiber-reinforced thermosets and thermoplastics.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
11-5	Advanced Oxidation of Carbon-Fiber Precursors (David Warren, Oak Ridge National Laboratory)	3.29	0.95
11-8	Advanced Stabilization of Carbon-Fiber Precursors (David Warren, Oak Ridge National Laboratory)	3.00	0.93
11-11	Characterization of Thermomechanical Behavior of TRIP Steels (Mark Smith, Pacific Northwest National Laboratory)	4.00	0.71
11-14	Compatibilization/Compounding Evaluation of Recovered Polymers (Ed Daniels, Argonne National Laboratory)	3.86	0.69
11-18	Cost Modeling (Joe Carpenter, U.S. Department of Energy)	3.88	1.25
11-21	Crash Energy Management (Gerry Olszewski, Chrysler LLC)	3.11	1.17
11-24	Develop a Web-Based Information System (Ed Daniels, Argonne National Laboratory)	2.50	0.76
11-27	Development of Next Generation P4 (David Warren, Oak Ridge National Laboratory)	3.50	0.84
11-30	Development of Technology for Removal of PCBs (Ed Daniels, Argonne National Laboratory)	3.50	0.76
11-33	Die-Face Engineering Project for Advanced Sheet-Forming Materials (Eric McCarty, Chrysler LLC)	3.29	0.49

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
11-36	Dynamic Characterization of Spot Welds in AHSS (Phil Sklad, Oak Ridge National Laboratory)	3.67	0.71
11-39	Enhanced Resonance Inspection for Light-Metal Castings (Cam Dasch, General Motors Corporation)	4.17	0.98
11-43	Focal Project 4 – Floor Pan (Gerry Olszewski, Chrysler LLC)	3.13	0.64
11-46	Friction Stir-Spot Welding of AHSS (Phil Sklad, Oak Ridge National Laboratory)	2.88	0.83
11-49	Future Generation Passenger Compartment Validation (Roger Heimbuch, Auto Steel Partnership)	4.13	0.99
11-52	High Strength Stamping (Roger Heimbuch, Auto Steel Partnership)	4.00	0.76
11-55	High-Integrity Magnesium Automotive Castings (HI-MAC) (Eric McCarty, Chrysler LLC)	4.67	0.50
11-59	High-Volume Processing of Composites (Gerry Olszewski, Chrysler LLC)	3.33	1.00
11-62	Improved Automotive Suspension Components Cast with B206 Alloy (Eric McCarty, Chrysler LLC)	3.50	1.07
11-65	LCCF – Bluestar MA-PAN (David Warren, Oak Ridge National Laboratory)	2.80	1.64
11-68	LCCF – Commercialization of Textile Precursor Company X (David Warren, Oak Ridge National Laboratory)	3.25	0.96
11-71	LCCF – FISIPE VA-PAN Development (David Warren, Oak Ridge National Laboratory)	3.25	1.50
11-74	LCCF – Precursor and Fiber Evaluation (David Warren, Oak Ridge National Laboratory)	3.67	0.71
11-77	LCCF Precursors (David Warren, Oak Ridge National Laboratory)	3.14	0.69
11-81	Lightweight Rear Chassis Structures (Roger Heimbuch, Auto Steel Partnership)	3.25	0.96
11-83	Low Cost Titanium (Mark Smith, Pacific Northwest National Laboratory)	3.00	0.82
11-86	Magnesium Front-End Design and Demonstration (Eric McCarty, Chrysler LLC)	3.71	1.38
11-90	Magnesium Front-End R&D (Eric McCarty, Chrysler LLC)	3.50	1.05
11-94	Magnesium Powertrain Cast Components (Eric McCarty, Chrysler LLC)	4.57	0.53
11-97	Magnesium Research and Technology Development (Mark Smith, Pacific Northwest National Laboratory)	3.11	1.27
11-100	Multi-Material Vehicle (Eric McCarty, Chrysler LLC)	3.43	1.27
11-103	Natural Fiber Composite Retting, Preform Manufacturing, and Molding (Mark Smith, Pacific Northwest National Laboratory)	3.44	1.01
11-106	NDE Inspection of Adhesive bonds in Metal-Metal Joints (Cam Dasch, General Motors Corporation)	4.00	0.87
11-110	P4 Preform (Gerry Olszewski, Chrysler LLC)	4.00	0.71

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
11-113	Post-Shred Materials Recovery Technology Development and Demonstration (Ed Daniels, Argonne National Laboratory)	4.11	0.78
11-117	Powder Metal Performance Modeling of Automotive Components (Eric McCarty, Chrysler LLC)	2.78	0.83
11-120	Predictive Modeling of Polymer Composites (Mark Smith, Pacific Northwest National Laboratory)	3.88	0.64
11-123	Predictive Modeling of Polymer Composites (Mark Smith, Pacific Northwest National Laboratory)	3.33	0.58
11-126	Predictive Modeling of Polymer Composites (National Science Foundation)	3.50	0.58
11-129	Results of FY 2007 Automotive Lightweighting Materials Deep-Dive Peer Review (Subi Dinda, Automotive Materials & Mfg Tech)	3.50	0.58
11-131	Sheet Steel Joining (Roger Heimbuch, Auto Steel Partnership)	3.50	1.05
11-134	Strain-Rate Characterization/Strain-Rate Characterization Technology Development (Phil Sklad, Oak Ridge National Laboratory)	3.78	0.83
11-137	Tribology (Roger Heimbuch, Auto Steel Partnership)	2.60	0.89
11-140	Ultra-Large Casting Demonstrations (Eric McCarty, Chrysler LLC)	4.13	0.83
11-143	Warm-Forming Magnesium Sheet (Eric McCarty, Chrysler LLC)	3.13	0.83
	Overall Session Average and Standard Deviation	**3.53**	**0.98**


Lightweight Materials
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Warm-Forming Magnesium Sheet |Chrysler LLC|
Ultra-Large Casting Demonstrations |Chrysler LLC|
Tribology |Auto Steel Partnership|
Strain-Rate Characterization/Strain-Rate Characterization Technology Development |Oak Ridge National ...
Sheet Steel Joining |Auto Steel Partnership|
Results of FY 2007 Automotive Lightweighting Materials Deep-Dive Peer Review |Automotive Materials & Mfg...
Predictive Modeling of Polymer Composites |National Science Foundation|
Predictive Modeling of Polymer Composites |Pacific Northwest National Laboratory|
Predictive Modeling of Polymer Composites |Pacific Northwest National Laboratory|
Powder Metal Performance Modeling of Automotive Components |Chrysler LLC|
Post-Shred Materials Recovery Technology Development and Demonstration |Argonne National Laboratory|
P4 Preform |Chrysler LLC|
NDE Inspection of Adhesive bonds in Metal-Metal Joints |General Motors Corporation|
Natural Fiber Composite Retting, Preform Manufacturing, and Molding |Pacific Northwest National Laboratory|
Multi-Material Vehicle |Chrysler LLC|
Magnesium Research and Technology Development |Pacific Northwest National Laboratory|
Magnesium Powertrain Cast Components |Chrysler LLC|
Magnesium Front-End R&D |Chrysler LLC|
Magnesium Front-End Design and Demonstration |Chrysler LLC|
Low Cost Titanium |Pacific Northwest National Laboratory|
Lightweight Rear Chassis Structures |Auto Steel Partnership|
LCCF Precursors |Oak Ridge National Laboratory|
LCCF – Precursor and Fiber Evaluation |Oak Ridge National Laboratory|
LCCF – FISIPE VA-PAN Development |Oak Ridge National Laboratory|
LCCF – Commercialization of Textile Precursor Company X |Oak Ridge National Laboratory|
LCCF – Bluestar MA-PAN |Oak Ridge National Laboratory|
Improved Automotive Suspension Components Cast with B206 Alloy |Chrysler LLC|
High-Volume Processing of Composites |Chrysler LLC|
High-Integrity Magnesium Automotive Castings (HI-MAC) |Chrysler LLC|
High Strength Stamping |Auto Steel Partnership|
Future Generation Passenger Compartment Validation |Auto Steel Partnership|
Friction Stir-Spot Welding of AHSS |Oak Ridge National Laboratory|
Focal Project 4 – Floor Pan |Chrysler LLC|
Enhanced Resonance Inspection for Light-Metal Castings |General Motors Corporation|
Dynamic Characterization of Spot Welds in AHSS |Oak Ridge National Laboratory|
Die-Face Engineering Project for Advanced Sheet-Forming Materials |Chrysler LLC|
Development of Technology for Removal of PCBs |Argonne National Laboratory|
Development of Next Generation P4 |Oak Ridge National Laboratory|
Develop a Web-Based Information System |Argonne National Laboratory|
Crash Energy Management |Chrysler LLC|
Cost Modeling |U.S. Department of Energy|
Compatibilization/Compounding Evaluation of Recovered Polymers |Argonne National Laboratory|
Characterization of Thermomechanical Behavior of TRIP Steels |Pacific Northwest National Laboratory|
Advanced Stabilization of Carbon-Fiber Precursors |Oak Ridge National Laboratory|
Advanced Oxidation of Carbon-Fiber Precursors |Oak Ridge National Laboratory|

Advanced Oxidation of Carbon-Fiber Precursors (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A few reviewers felt that the development of low cost carbon fiber is essential to achieve 50 percent mass reduction to meet the FreedomCAR goal. One reviewer felt that there is a potential for lighter vehicle structures through the use of CF structures, but the cost, logistics of supply, production rate and producability must be addressed as well. A reviewer felt that the project addresses critical process steps and cost reduction in the production of carbon fiber. Another reviewer found the project very challenging and said it deserves to be pursued.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer states that all the technical barriers can be solved but the cost of the production of low cost carbon fiber falling within the range of $6-$8 per pound is still very questionable. Another reviewer was concerned about the ability of the technology to achieve sufficient scale of production for automobiles. Another reviewer felt that deployment will be done in conjunction with other projects in the low cost carbon fiber program. The reviewer adds that this project is base process research and there is no clear need for deployment of the results of this specific project. A reviewer noted that the project placed significant emphasis in the getting the right stabilization process prior to oxidation and carbonization. Another said the lab results look promising.

A reviewer notes that composites will be used for more applications in the future. Analytical models to predict and optimize manufacturing processes to produce targeted material properties will be highly useful.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer notes that considering the length of time this program is going, the progress for technical feasibility is very slow and the commercial viability is still in doubt. Another reviewer notes that the project is a part low cost carbon fiber program. The reviewer adds that there is good progress in speeding up the carbon fiber manufacturing process. Another reviewer notes that plasma oxidation feasibility was clearly proven and a patent was filed. Another reviewer noted that the lab results appear promising with scale-up barriers duly assessed.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer notes that multiple tow reactors were purchased but scale-up will be slow. Low temperature oxidation is a real plus. E-beam is too unstable and too costly for mass production although it presents good possibilities for the future if proven quality control can be demonstrated. Current U.S. manufacturers are not interested unless cost comes way down. The weakening dollar makes it even more attractive for foreign countries such as China. Migration of IP will follow migration of manufacturing proving the fallacy of a "service economy". Market transformation in the U.S. is unlikely without huge government subsidies.

Another reviewer says that due to the reluctance of the CF manufacturers to consider or even adopt LCCF technologies that are evolving from the overall LCCF project portfolio, the barrier appears too high here. It appears that only a manufacturer that is outside the industry or partially associated with CF manufacture might be a better bet, but this takes time and requires fighting the establishment.

A reviewer says that this work can be useful even if carbon fiber composites are not used in auto applications. The reviewer continues that this project will not enable the cost reduction of carbon fibers to levels compatible with high volume automotive applications.

One reviewer felt it a bit early to make a proper assessment in the acceptance of the proposed process. Another reviewer saw no identification of a clear path to get industry to adopt this technology.

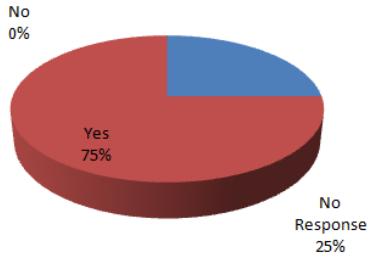
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A number of reviewers found that the resources were sufficient. One reviewer noted that the project appears to be richly funded compared to the others and yet the barriers appear to be extremely difficult to overcome with many highly specialized technologies needed to create a successful outcome.

One reviewer felt that further investigation was needed to prove mass production viability. One reviewer felt there should be a demand for progress toward implementation after funding for so many years, rather than simply continuing to fund for incremental improvements.

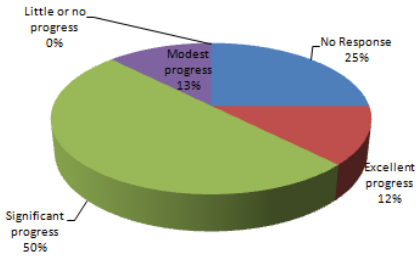
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Oxidation of Carbon-Fiber Precursors

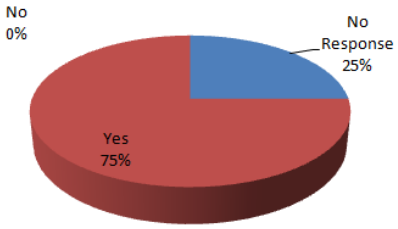
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



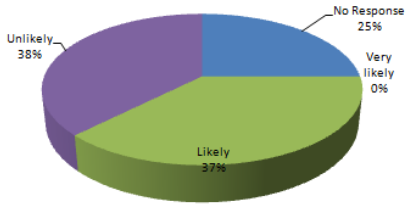
Question 3: Characterize the technical accomplishments and progress toward goals.



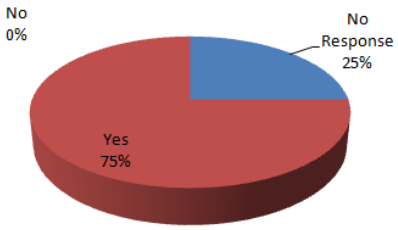
Question 2a: Are the goals of the project technically achievable?



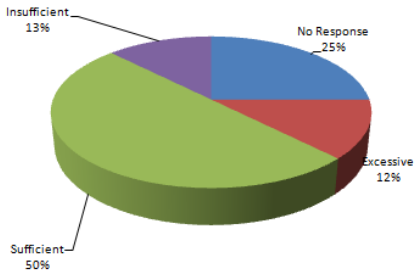
Question 4: How likely is the project team to move technologies into the marketplace?



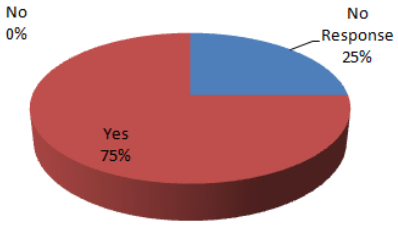
Question 2b: Have the technical barriers been identified and addressed?



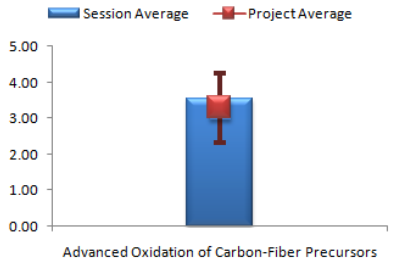
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Stabilization of Carbon-Fiber Precursors (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A few reviewers felt that the development of low cost carbon fiber is essential to achieve 50 percent mass reduction to meet the FreedomCAR goal. One reviewer felt that there is a potential for lighter vehicle structures through the use of CF structures, but the cost, logistics of supply, production rate and producability must be addressed as well. One reviewer felt the project makes low cost carbon fiber more cost effective.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer states that all the technical barriers can be solved, but the cost of the production of low cost carbon fiber falling within the range of $6-$8 per pound is still very questionable. Another reviewer was concerned about the ability of the technology to achieve sufficient scale of production for automobiles. Another reviewer felt that deployment will be done in conjunction with other projects in the low cost carbon fiber program. The reviewer adds that this project is base process research and there is no clear need for deployment of the results of this specific project. A reviewer felt that this was innovative technology and cost effective and advantages have been documented and promoted to industry. The reviewer adds that deployment will be done. One reviewer expressed reservations related to achieving goals at the target prices.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer notes that considering the length of time this program is going, the progress for technical feasibility is very slow and the commercial viability is still in doubt. Another reviewer notes that the project is a part low cost carbon fiber program. The reviewer adds that there is good progress in speeding up the carbon fiber manufacturing process.

A reviewer noted a significant reduction in stabilization time was achieved by smart chemistry, an enabling step in the LCCF cost reduction. One reviewer said that taking into account the resources, progress is clear.

Another reviewer felt that progress made on many options, but work doesn't seem focused to deliver results needed to commercialize the technology.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer notes that considering the length of time this program is going, the progress for technical feasibility is very slow and the commercial viability is still in doubt. Another reviewer notes that the project is a part low cost carbon fiber program. The reviewer adds that there is good progress in speeding up the carbon fiber manufacturing process.

One reviewer commented that if the cost of the carbon fiber can be produced within the target price ($6-$8 per pound) then it can be commercialized. Another reviewer felt that no path to commercialization had been identified. Another reviewer has doubts about achieving the target costs.

A reviewer stated that as a promising and new stabilization process for CF, the CF industry may be reluctant to change over to such a novel stabilization process due to embedded technology and changeover costs. The reviewer adds that until an economic incentive is offered the industry, only time will tell if the technology moves into the marketplace.

One reviewer states that improved processing methods for producing carbon fibers can be useful even if the fibers are not used in widespread automotive applications. The reviewer adds that this project will not enable the cost to be reduced to the levels required for most high volume automotive uses.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

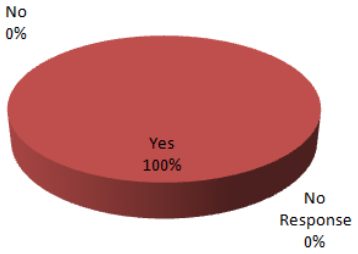
A number of reviewers found that the resources were sufficient. One reviewer noted that the project appears to be richly funded compared to the others and yet the barriers appear to be extremely difficult to overcome with many highly specialized technologies needed to create a successful outcome. Another reviewer felt that such a project needs much more funds in order to make a real difference. One reviewer says that the risk/reward scenario for LCCF relative to competitive lightweight materials appears right for this project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

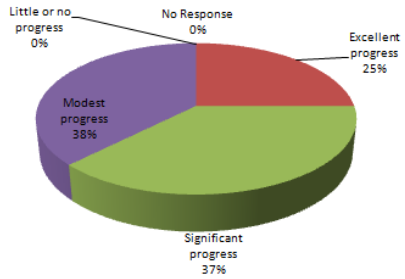
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Stabilization of Carbon-Fiber Precursors

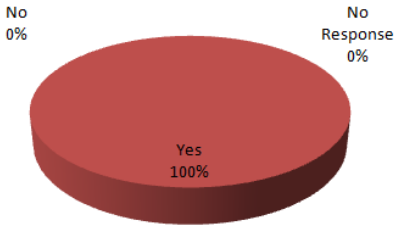
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



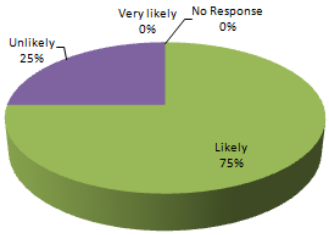
Question 3: Characterize the technical accomplishments and progress toward goals.



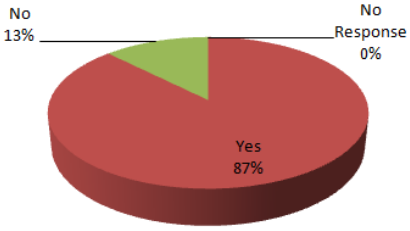
Question 2a: Are the goals of the project technically achievable?



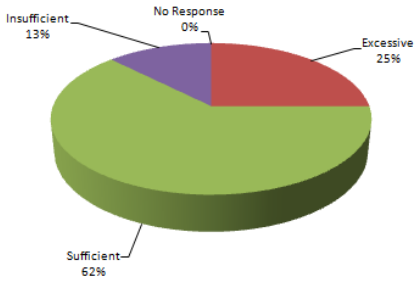
Question 4: How likely is the project team to move technologies into the marketplace?



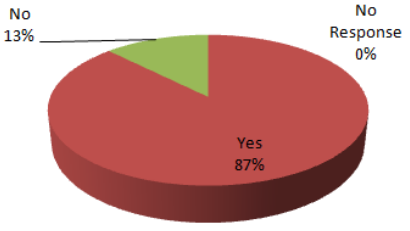
Question 2b: Have the technical barriers been identified and addressed?



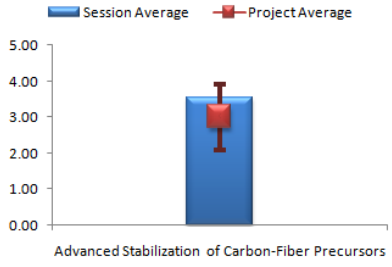
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Characterization of Thermomechanical Behavior of TRIP Steels (Mark Smith, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer felt that mild steels set the baseline for all body mass reduction efforts. Advanced lightweight high strength steel is an enabler for mass reduction. A number of reviewers stated that TRIP steels were critical to meeting the displacement objectives of FreedomCar. A reviewer added that steel is, and is likely to remain, the dominant material for vehicle structures so anything that can be done to advance steel technology is going to pay off in reduced fuel use. One reviewer felt that the project expedites implementation of TRIP steels by answering questions critical to OEMs, thereby lowering vehicle mass.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that steel has the strongest high volume manufacturing body of knowledge and innovations can be quickly implemented across a variety of technologies. The reviewer notes as models are developed, they can be readily made available to the CAE environment. Another reviewer stated that the deployment strategy for the project is well defined. The reviewer continued that deliverables and milestone were identified.

Another reviewer commented that this is clearly important work for the future auto industry. The reviewer continued that these issues around supply of alloying elements and thermomechanical processing, along with enhancing the forming and design analysis and coatings technologies will require additional work. A different reviewer said that excellent progress has been made to understand forming and joining characteristics of TRIP steels. One reviewer stressed the cooperation of steel industries with the National Laboratories.

A reviewer believed that since there is more and more AHSS use in the auto industry, the implementation will be occur, but introduction will be progressive. Another reviewer commented that within the project objectives and guidelines, yes, modeling approaches used on the project could be applied to AHSS other than TRIP.

One reviewer commented that characterization work isn't intended to address and overcome technical barriers, the project includes much more than the title implies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that measurement and modeling models and tools developed are readily transferable as analytical approaches to other metals analyses. Two reviewers felt that the timeline and technical goals had been met. Another reviewer spoke of the project as being sophisticated and well run.

Another reviewer stated that some of the technical barriers have been solved, but a lot of challenges still exist today. The reviewer said that solving those challenges are key to the success of this project. One reviewer said that the project has generated useful data, but there is less information about how the project has produced technical understanding and knowledge which will be used to improve the steels or manufacturing characteristics.

One reviewer said that it is difficult to assess accomplishments. The reviewer continued that the project is supportive to optimal introduce advanced high strength steel, and fatigue will become more an issue when introducing more high strength steel. The reviewer ends that it would be good to put more emphasis on this.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reviewers nearly all felt that the useful technologies are being actively disseminated amongst industry, and would continue to be so. One reviewer felt that there was good interaction with OEMs and steel suppliers. A reviewer felt that if the remaining technical barriers are solved, then it will be adapted by the industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Many reviewers felt the funding was sufficient. One reviewer felt the funding was okay so far, but that the project may need more resources if and when GEN III AHSS are introduced into the project.

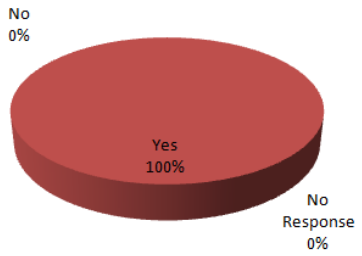
A reviewer stated that the presentation mentioned a funding level of $300K per lab per year for several years. This is a relatively huge investment for a material for which the number of applications may be limited. Moreover, characterization of most material properties should have been the responsibility of the suppliers of the material and there are questions about the supply base for these materials. It is not certain that the project, in fact, worked with materials which are representative of actual production materials.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

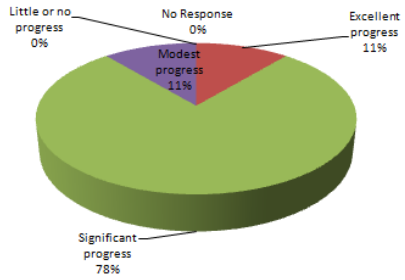
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Characterization of Thermomechanical Behavior of TRIP Steels

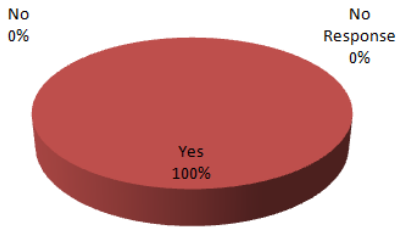
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



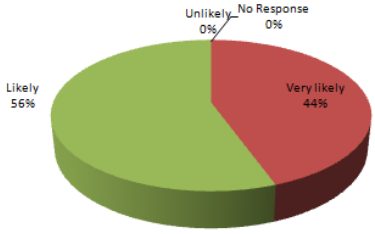
Question 3: Characterize the technical accomplishments and progress toward goals.



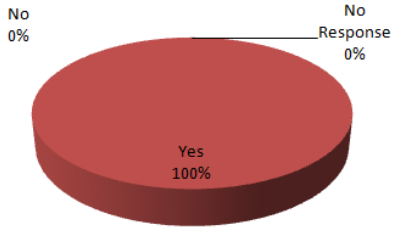
Question 2a: Are the goals of the project technically achievable?



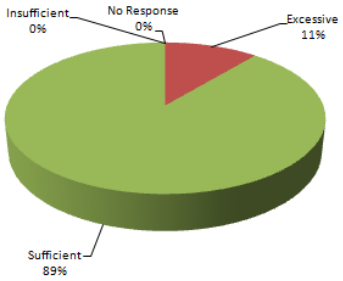
Question 4: How likely is the project team to move technologies into the marketplace?



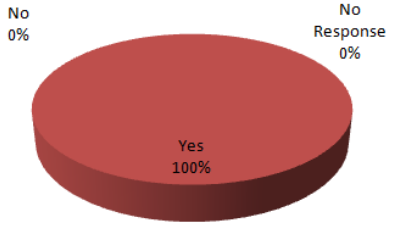
Question 2b: Have the technical barriers been identified and addressed?



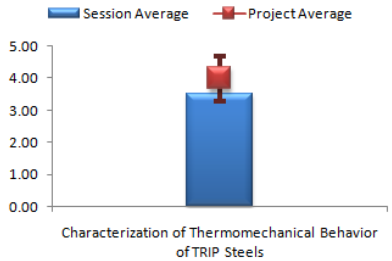
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Compatibilization/Compounding Evaluation of Recovered Polymers (Ed Daniels, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented that proven recyclability is very important, but doesn't displace any significant petroleum resources. The reviewer adds that 40,000 tons per year of shredder residue spread across plastics and residual metals results in about half the mass in sellable material. A reviewer stated that end customers are becoming increasingly sensitive to using vehicles that are made out of recycled materials or are recyclable. The reviewer continues that it is important to address the recyclability and repair aspect of new lightweight materials. One reviewer says that the recycling of polymeric materials is a key step in making them more viable automotive materials.

One reviewer believes that not only is the petroleum portion of plastics and composites recycled, but the project adds to the significant work being done on plastics recycling worldwide in relation to reduction in global warming potential. One reviewer comments on the need to establish usability of recovered polymers, which have the potential to replace virgin polymers, and many of which are made from petroleum feedstocks.

Another reviewer comments that recycling is a part of the FreedomCAR Program. The reviewer adds that in order to reduce waste and renew materials, this is a very important initiative. The reviewer continues that most of the plastic residue goes to landfills; this project demonstrated how the shredder residue can be recycled. This is an important project.

Another reviewer said this did not support DOE objectives in the first stage of the life of car material. A reviewer felt that this project does not contribute to petroleum displacement. The reviewer adds that one of the other goals mentioned was to achieve a 95% recyclabillity, and that this project contributes to this goal.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer called this a well structured program. A reviewer stated that mechanical separation and thermal-chemical conversion technologies have been addressed. The reviewer adds that polymeric fractions from shredder residue were confirmed. A reviewer felt that there was a need to address both technical as well as infrastructure issues. A reviewer focused on the identification of the plastic fraction, means of obtaining a concentrate, and further separating the concentrate makes sense and has proven to be successful on a pilot plant scale. One reviewer felt that the solutions to technical problems had been demonstrated and the process of transfer to industry had begun.

A reviewer said that it seems like a pretty solid plan - assuming the SOC issue can be worked out. Another reviewer states that this project is on basis of a CRADA. The reviewer adds that there is a good cooperation. Another reviewer says that the characterizing materials made from recovered polymers can be accomplished as can demonstrations of part making. The question is whether making such materials is an economically viable proposition.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer says that the project advanced the technology but can't hit regulatory targets for primary recycling. The reviewer felt that cost models still need to be developed. The reviewer continued that the business case for commercialization is still questionable. The reviewer observes that current cost model shows a trade off of $4,096,000 revenues with an investment cost of $4,050,000. One reviewer states that the results from the Argonne pilot plant and cost estimates for their 20 ton/h plant signify excellent progress toward DOE goals.

A reviewer states that this project has been completed in a timely fashion and overcame technical challenges. Another reviewer comments that there is a good demonstration of technical feasibility to make materials and parts. The reviewer continues that validation of functionality of the parts needs to be done, but most important challenge is to make the business case.

One reviewer comments that the SOC removal process must be developed and tested - otherwise this looks pretty good. A reviewer states that recycling investigation is needed to ensure that future options are sustainable.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that the probability of transferring technology developed under the CRADA to market place is usually high. The reviewer adds that as long there is an infrastructure and the technology is cost effective, it will be used.

A reviewer states that there are strong relationships with recyclers and post shredders. The reviewer adds that the business case for commercialization is still questionable in the absence of good cost models.

One reviewer comments that the technical achievements and promising cost analysis for the validation plant have sold the project to a commercial shredder. Another reviewer feels that this developed technology is already tried for commercial use by the recycling industry. A different reviewer found this to be a solid piece of work.

A reviewer states that it is important that the material properties in products made from shredder residues are measured. The reviewer believes that recyclability can then be better evaluated.

One reviewer comments that PRELIMINARY results indicate parts can be made but the team still needs to evaluate performance and durability. Another reviewer says that it depends upon the business case. A reviewer states that the cost model is too optimistic based on previous involvement with wTe.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

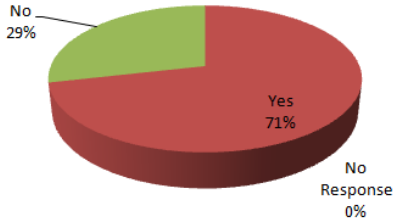
A reviewer states that the project has made excellent progress toward recycling most of the material. The reviewer says that a small amount of inorganics remain consisting primarily of PCBs. Two of the responding reviewers found the funding to be sufficient. One felt that it is insufficient due to the fact that the model is too optimistic in the prices of the recuperated materials.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

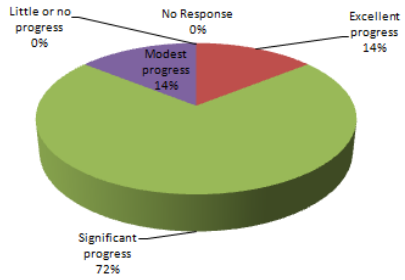
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Compatibilization/Compounding Evaluation of Recovered Polymers

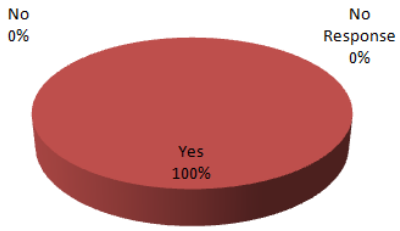
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



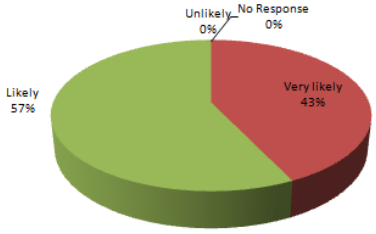
Question 3: Characterize the technical accomplishments and progress toward goals.



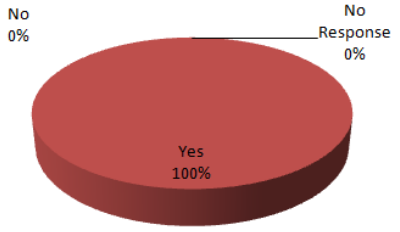
Question 2a: Are the goals of the project technically achievable?



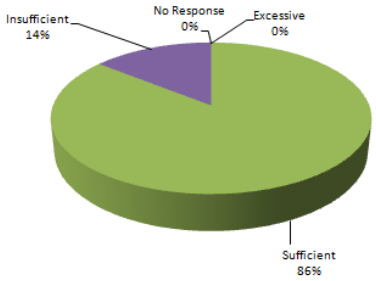
Question 4: How likely is the project team to move technologies into the marketplace?



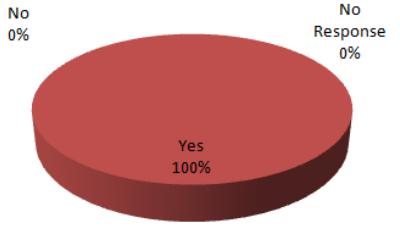
Question 2b: Have the technical barriers been identified and addressed?



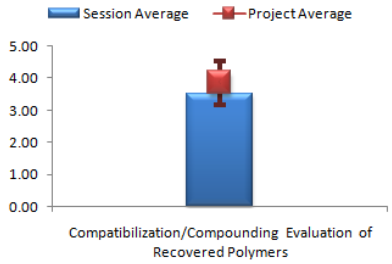
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Cost Modeling (Joe Carpenter, of U.S. Department of Energy)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer state that DOE objectives require mass reduction at cost parity. Another reviewer added that cost modeling determines the costs and other benefits of lightweighting by Mg in the front end from a life cycle standpoint -- Phase I -- and 66 projects of all the lightweighting materials in the ALM project portfolio. The reviewer continues that this is direct support.

A reviewer felt that this project is supportive for the whole light weight materials program. Another reviewer found the project to be very beneficial to the achievement of the FreedomCAR goal. The reviewer continues that cost modeling differentiates the importance of the project for different materials. The reviewer concludes that it is very important to determine what is important.

Another reviewer commented that the project identifies technology improvement needs and major cost drivers relative to materials with potential for decreasing vehicle mass. The reviewer concludes that the project helps focus on what is important rather than what is of interest. One reviewer stated that the cost modeling seems to dictate the orientation of the research that will be funded.

One reviewer felt that it is not clear how the work described in this project contributes to improved fuel economy or otherwise reduce petroleum use. Another reviewer commented that this is not really an applicable question for this talk.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that the project strategy and benefits were identified. A deployment process has been identified. The reviewer continues that near term and long term benefit have been identified. Another reviewer commented that the project was very well explained and made useful for political decisions. Another observed that the project evaluates the economic benefits of the program.

A reviewer stated that the three methods chosen to evaluate benefits vs. costs are reasonable, adding that if only one method was used, that would have been questionable. Another reviewer stated that the project was not intended to overcome any barriers, adding that it can achieve its intended results.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt that the cost modeling does a very good job of assessing the economic barriers. Another reviewer commented that significant progress has been excellent within the time frame. One reviewer felt that economical assessment is very important to address the usefulness of a government program. A different reviewer stated that a good cost modeling is essential for good selection.

A reviewer commented that the project doesn't overcome barriers; rather, it tries to quantify their influences over cost of materials. In a similar vein, a reviewer stated that a substantial amount of work was done, but was aimed at characterizing the lightweight materials program and performing other cost studies as opposed to overcoming technical barriers.

One reviewer comments that market gyrations of Mg and C-fiber make for difficult cost analysis. The reviewer continues that perhaps sensitivity analysis would help.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer comments that business decisions are based heavily on cost/benefits. Another reviewer states that the cost analyses within the industry/market varies so much that it would be difficult to compare marketplace results with those from this project team. The reviewer cites "the joke about economists: on the one hand..." The reviewer concludes that the results of this ALM project are useful internally to gauge progress and plan future work, but it will affect the marketplace indirectly. One reviewer answered yes, since research funds go directly to companies, national labs, and universities.

One reviewer felt that this cost modeling should be used for all projects to determine the benefit vs. risk management and also differentiate among projects. Another reviewer felt that it was not clear whether or how the results/output of this project will influence the implementation of any technologies. The reviewer continues that rather, it is aimed at evaluating the program by some selected "yardsticks". One reviewer felt the question does not apply.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

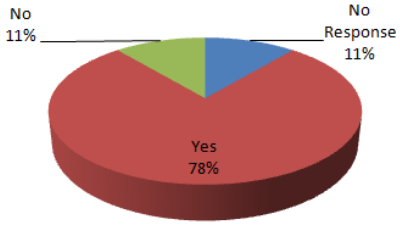
A majority of the reviewers that responded found the funding to be sufficient. One reviewer was unsure, but stating that the project was clearly a highly worthwhile activity as everything that happens in the auto industry is cost-driven and so all new technologies, materials and processes MUST be evaluated on the basis of realistic, well-informed and up-to-date cost models. Another reviewer felt that to make a significant impact on the nation's petroleum based fuel usage thru lighter weight vehicles, the vehicle weight in general must be reduced nearly 50%. Such a significant reduction can be achieved thru the use of carbon fiber composites or light weight advanced metallic materials. The reviewer continues that these materials can be used for mass production only when the basic production cost is reduced and reliable processing technology is further developed. Technical barriers are reasonably well known. The reviewer concludes that additional funding is needed to fully resolve these barriers.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

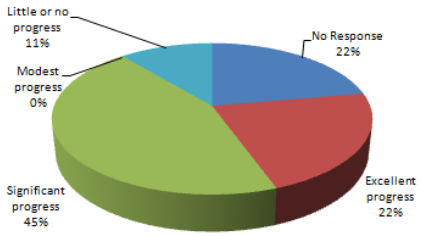
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Cost Modeling

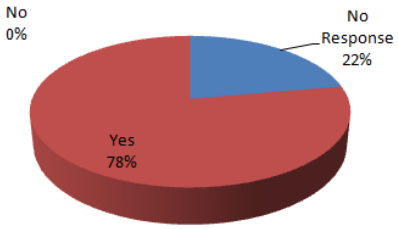
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



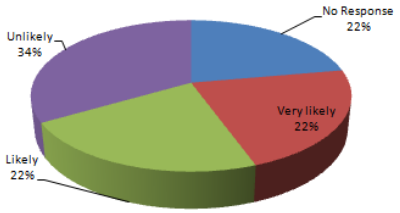
Question 3: Characterize the technical accomplishments and progress toward goals.



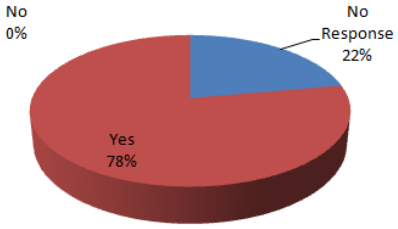
Question 2a: Are the goals of the project technically achievable?



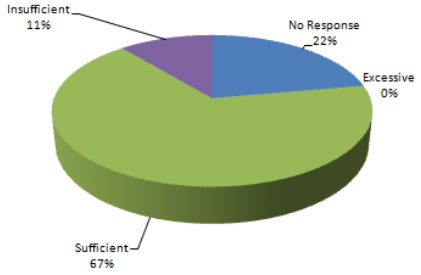
Question 4: How likely is the project team to move technologies into the marketplace?



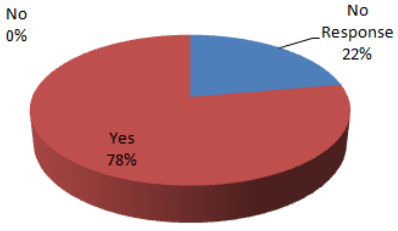
Question 2b: Have the technical barriers been identified and addressed?



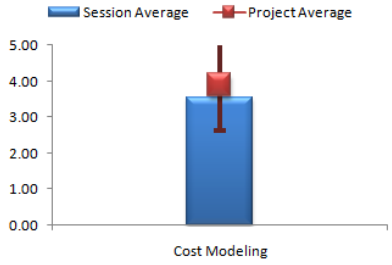
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Crash Energy Management (Gerry Olszewski, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers felt that the understanding of crash management of composite structures helps to utilize more composite components in structural applications; resulting in more weight savings and improve fuel economy. One reviewer added that there was a need to look at all combinations of materials.

One reviewer felt that while the ultimate goal of this is to enable composite body structures, it may be that this will not be the best choice and so the degree of effort involved in this project, which is very large, may not be justified.

One reviewer said that CF composites are prime materials for supporting petroleum displacement as they are the lightest weight structural material alternative in automotive. Another reviewer felt that DOT should be involved.

One reviewer commented that heavier vehicles are usually perceived as safer. The reviewer continues that crash energy management to demonstrate safety of lighter weight vehicles is necessary before lighter-weight advanced materials are accepted widely.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that converting Abacus software to the LS-Dyna algorithm is important for communication between university and industry on crash energy management of these composites. The reviewer continues that data collected are critical to data inputs into dynamic simulation models.

Another reviewer felt that since safety is concerned, reserve of opinion is of essence as long as experimental tests are not performed. The reviewer continued that the management part of the crash management was not addressed appropriately. One reviewer commented that some of the analysis tasks are very challenging - and it is not entirely clear how this will work out.

One reviewer said that predictive models should demonstrate technical feasibility. Another reviewer said that understanding of crash management of composite materials is essential for the use of these materials in structural applications; however, there are so many variations of manufacturing processes which affect the quality and performance of the components. The reviewer concludes that it is very difficult to control and project the final results. A different reviewer said that the project team is wide so the deployment of the technology is likely.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer noted that this project and others on the same subject which preceded it have been ongoing for many years and a very large amount of resources (probably more than $10 million) has been expended. The reviewer adds that it is reasonable to consider whether this has yielded or will yield adequate value for this expenditure. The reviewer wondered whether there are other approaches and strategies which might have better returns. A different reviewer commented that significant

resources have been spent, but the progress is very slow because of the complex nature of the problem. Another reviewer also commented on the slow development of information.

One reviewer expressed concerns about the lack of really reliable computational tools and the variability in the performance of fiber reinforced materials in impact situations in concerning. One reviewer felt the project was too new to show significant progress.

A reviewer commented that crash is one of the most weight determining loading conditions for cars. The reviewer adds that the weight saving potential is large. The reviewer concludes that the approach shown is straightforward. One reviewer commented on the excellent effort by the OEMs, National Labs, Universities, NSF and Suppliers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that CF composites are being used and will be used more and more in automotive applications and this project develops the enabling technologies to manage crash worthiness of CF composite parts. Another reviewer says that the car industry is probably very much interested in this. One reviewer felt that the use of common off-the-shelf software improves the likelihood of tech transfer. A different reviewer believed that since it is supported by all the OEMs this makes it likely that in case of success it will be introduced in the market. One reviewer felt that all key stakeholders were a part of the program.

One reviewer said that this development would not be sufficient to adopt by the industry because of the variability of the result. Another reviewer felt that it isn't clear how results will be integrated into LS Dyna (i.e., who will do it, when, etc.).

One reviewer commented that their response to the prompt was "unlikely" based upon the judgment that the project is aimed at enabling a composite body structure, which may not be the best long term choice and may never be implemented for high volume vehicles. The answer would be likely if the efforts were oriented to address the particular challenges for application in specific individual components.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer responded that their score was an assumption as resources were not addressed. Another reviewer listed a good team, good support, and no complaints from the team. One reviewer felt that the work should be linked directly with the PNNL predictive modeling work.

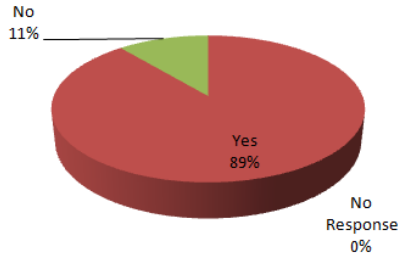
One reviewer stated that lots of tough challenges are here and they must ALL be solved before any applications can be considered. The reviewer thinks that it can be done but when and at what cost? Another reviewer says significant resources have been spent relative to the results obtained. A different reviewer felt that continued spending at the current rate is questionable, since this effort has been funded for many years at this or higher levels.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

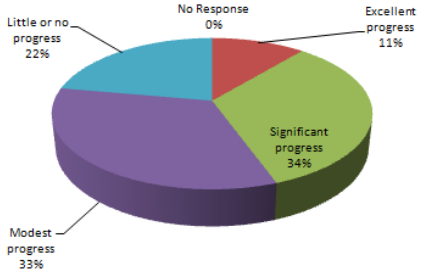
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Crash Energy Management

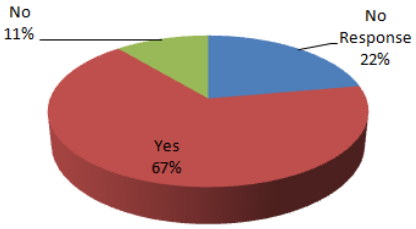
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



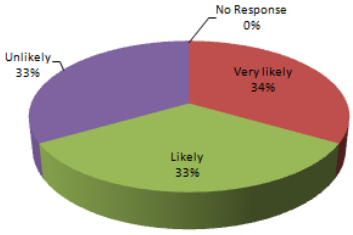
Question 3: Characterize the technical accomplishments and progress toward goals.



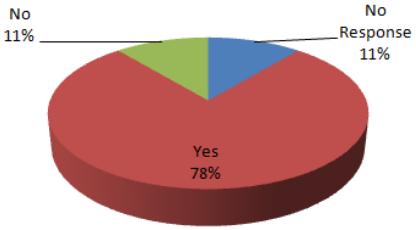
Question 2a: Are the goals of the project technically achievable?



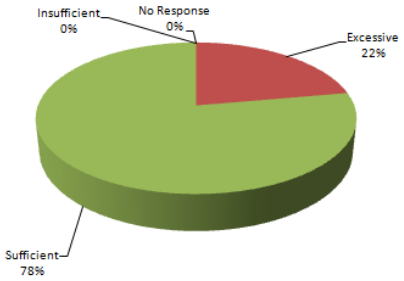
Question 4: How likely is the project team to move technologies into the marketplace?



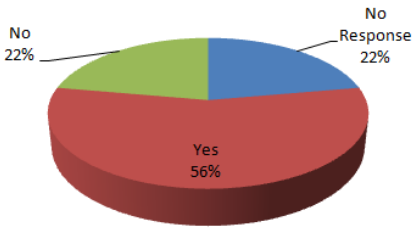
Question 2b: Have the technical barriers been identified and addressed?



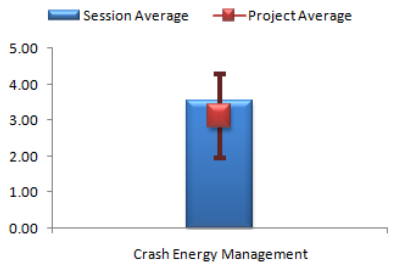
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Develop a Web-Based Information System (Ed Daniels, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that technology transfer and information exchange are key components of the DOE objectives with overall aim at petroleum displacement. Another reviewer added that sharing recycling is important. Another reviewer felt that the web based information system to share developments in the recycling technology will encourage the application of light weight plastics.

Some reviewers felt that this project was not a technology development, and did not see an ongoing technical value in developing new technology to meet DOE objectives. One reviewer said that this kind of material is detailed enough to justify a project on its own. It is what is necessary to start any significant project. Whether the information is to be kept within the organization or published on the web is irrelevant.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that ANL has done a great job in disseminating the results of their recycling work in professional meetings, public and private, publications, and web interaction. The reviewer continues that the web based information system that they are working on should be applicable to other projects in the DOE R&D portfolio. Another reviewer stated that this is a web base, and appears to be well thought of, and its development can be without end.

Some reviewers felt the deployment of information is not clearly defined. One of the reviewers added that a cost benefit analysis should have been done at the start of the program, and continued that no technical barrier had been defined.

One reviewer stated that generating unique information to be made available is where the barriers and challenges reside. The reviewer believes that these are being addressed by other projects.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that web based systems require continuous maintenance and data input, and this project has made significant progress to date. Another reviewer added that the project had done a good job of creating the web site. One reviewer felt that progress had been slow due to undefined variables. Another reviewer stated that copyright transfer agreements are resolvable and should be addressed. Another stated that the project can be useful, but did not see this effort within the scope of "light weight" materials.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer states that web based information systems are well established in the marketplace, as this one will be. The reviewer continues that there is no great barrier to market entry here. Another reviewer states that the site will be used. The reviewer continues that it is unclear how or whether it will help to move new recycling technologies into implementation. The reviewer suggests that a means of monitoring or assessing this should be created. One reviewer felt that people interested in recycling

may be likely to access this web site. Another reviewer commented on the information sharing with various organizations.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

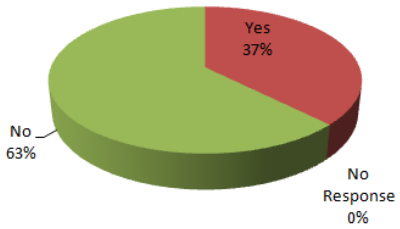
A number of reviewers felt that the funding should be limited for a specific time frame. One of these reviewers felt that if the funding amount was only required for one year, funding was sufficient but if was required for more than one year it was excessive. One reviewer chose sufficient because there are no major barriers to success here, and the path is straightforward on this project. Another reviewer found the purpose of the project unclear and yet another stated they would not fund the project at all.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

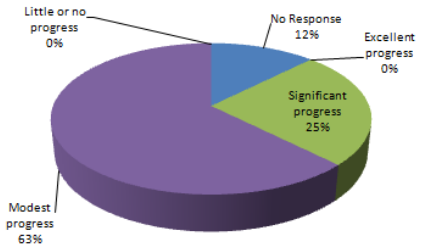
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Develop a Web-Based Information System

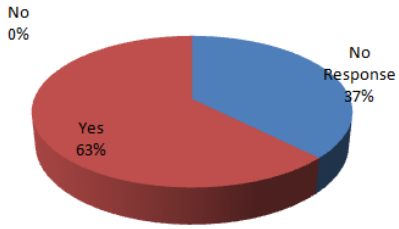
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



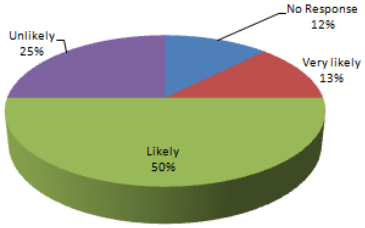
Question 3: Characterize the technical accomplishments and progress toward goals.



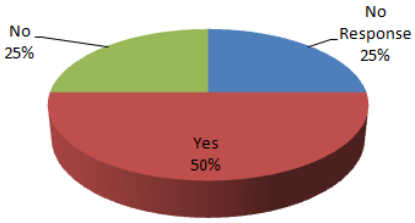
Question 2a: Are the goals of the project technically achievable?



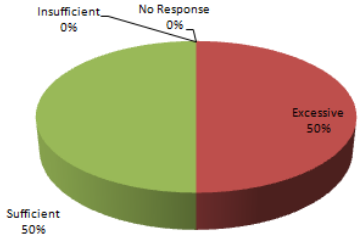
Question 4: How likely is the project team to move technologies into the marketplace?



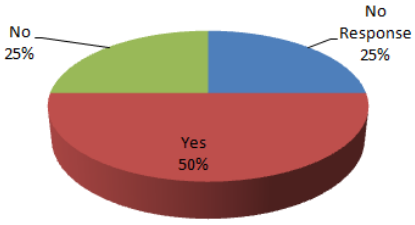
Question 2b: Have the technical barriers been identified and addressed?



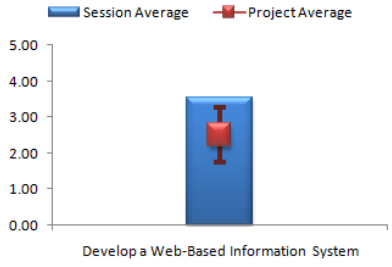
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Development of Next Generation P4 (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers noted weight reduction, which will lead to petroleum reduction. One reviewer commented that the development of manufacturing methods for fiber preforms is essential to moving the technology toward deployment. One reviewer commented that the project does seem directed toward increasing effectiveness of fiber used and therefore reducing mass, but the magnitude of weight saving potential was questionable.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer saw this as a very low risk project. A reviewer noted that all technical barriers have been identified and the deployment strategies were well defined. One reviewer commented that the project seems to have the right people and companies involved, so if the technical issues can be addressed then commercialization will follow promptly. Another reviewer felt the project partners would ensure deployment of the technology throughout the U.S. auto industry.

A reviewer felt this project built on the successes of current generation P4. One reviewer stated that work on adapting P4 for carbon fiber is worthwhile. The reviewer answered No to question 2c because the presentation did not provide any real guidance about whether it will be successful in terms of chopping carbon fibers at the required rate and with necessary tool durability.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that significant progress has been made with this program. The reviewer is confident that further technology barriers will be solved. The reviewer adds that the cost of the final composite components is still an impediment for large scale use in the automotive industry. One reviewer said that this was an excellent project in their view.

Another reviewer felt that there was relative low weight reduction potential for P4. The reviewer adds that on the combination with magnesium casting 50% weight saving is shown, reaching the DOE's objective.

One reviewer believes that automation and handling of P4 preforms is demonstrated and should improve further as project progresses. One reviewer believes the program still has many issues.

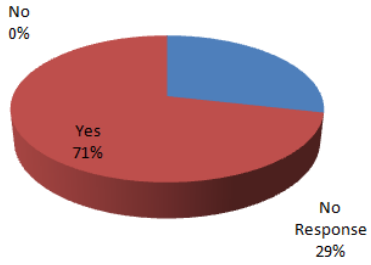
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer says that part of the project's development is already being used by the industry. One reviewer is confident that the project team will bring this process to the market place. Another reviewer states that optimized weight distribution of P4 preforms should be of interest to the marketplace for technical and cost reasons. A reviewer cites the project's close cooperation with automotive industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Most reviewers found the funding sufficient. One also said the work was productive. Another reviewer did not see that need for DOE involvement, even though they felt the work was important for practical reasons.

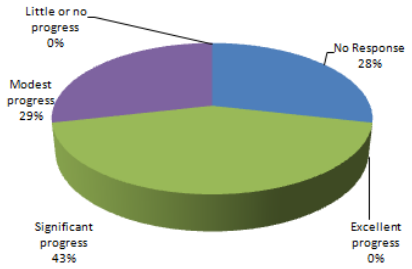
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development of Next Generation P4

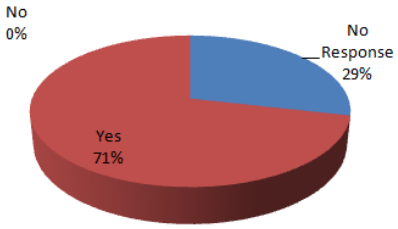
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



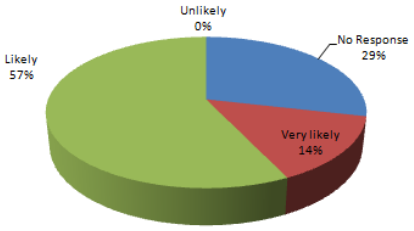
Question 3: Characterize the technical accomplishments and progress toward goals.



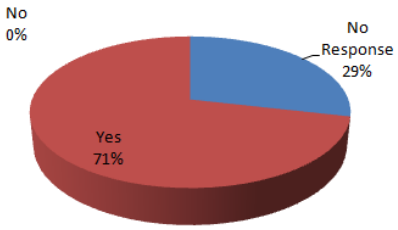
Question 2a: Are the goals of the project technically achievable?



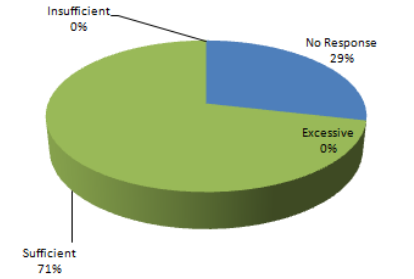
Question 4: How likely is the project team to move technologies into the marketplace?



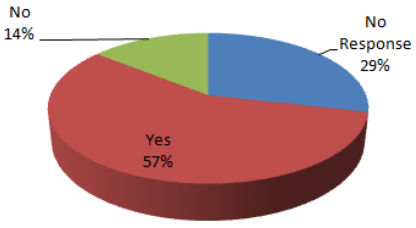
Question 2b: Have the technical barriers been identified and addressed?



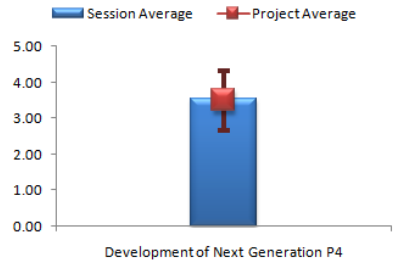
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Development of Technology for Removal of PCBs (Ed Daniels, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented that proven recyclability is very important, but doesn't displace any significant petroleum resources. The reviewer adds that 40,000 tons per year of shredder residue spread across plastics and residual metals results in about half the mass in sellable material.

A reviewer states that this is an enabling technology that solves an environmental/health/safety issue (meeting PCB EPA limits) related to the successful accomplishments of the post shredder material project. One reviewer feels that this work facilitates lighter structures. Another reviewer says that since recycling is a part of the FreedomCAR goals and PCB is a byproduct of the recycling of plastics, it is important to determine how PCB can be removed.

One reviewer feels that there is a need to address recycling issues before light weight materials, particularly polymers, can be used for reducing vehicle weight and improving fuel economy.

A reviewer says that it is necessary to reduce PCBs and other SOCs in order to be able to reuse recycled materials. One reviewer says that it is only indirectly related to "petroleum displacement" but this is a very important subject and it should be continued.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that mechanical separation and thermal-chemical conversion technologies have been addressed. The reviewer adds that polymeric fractions from shredder residue were confirmed. A reviewer believes that the multi-pronged technical approach for reducing PCBs in plastic recycled from the ANL process appears to cover all bases for achieving the 2 ppm target.

One reviewer says that the 2 stage removal process was developed to achieve the goal. The reviewer adds that all the technical barriers were identified. The reviewer continues that some demonstration has been made successfully in a lab scale. The reviewer suggests that more work is needed to complete the program for commercial viability.

A reviewer states that this project is on basis of a CRADA. The reviewer adds that there is a good cooperation. Another reviewer says the project is still in the developmental stage, but if successful a more detailed deployment strategy needs to be developed. The reviewer found the goals to be meaningful and technically feasible. A reviewer states that it is a well thought process led by a good PI.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer says that the project advanced the technology but can't hit regulatory targets for primary recycling. The reviewer felt that cost models still need to be developed. The reviewer continued that the business case for commercialization is still questionable. The reviewer states that current cost model shows a trade off of $4,096,000 revenues with an investment cost of $4,050,000. A reviewer

states that recycling investigation is needed to ensure that future options are sustainable. One reviewer felt there was good technical progress for the investment size.

One reviewer says that the technical accomplishments on a lab bench basis are on track, and future integration into scaleup is planned. Another reviewer says that this is a difficult project, but some progress has been made, and more work is needed.

One reviewer was unsure of the accomplishments. The reviewer felt that the project team seems to have identified the issues and is working on them - but the issues appear to be very challenging and so it is a little unclear how far along they are and how successful they will be.

A reviewer believes that the removal of PCBs below the threshold level was demonstrated, but the economics of the process is still to be determined. One reviewer saw the 2 ppm PCB metric as being very aggressive. The reviewer adds that this implies very high technical risk and, thus, this process may not yield the expected risks (that would be a good TIP project).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that there are strong relationships with recyclers and post shredders. The reviewer adds that the business case for commercialization is still questionable in the absence of good cost models.

Another reviewer felt that more field work on the scaleup is needed before a judgment can be made. A reviewer believes that if the cost of removal of PCB is justifiable, then it can be commercialized. A reviewer states that assuming they can get the PCB level down below acceptable levels this should be OK.

A reviewer says that all is dependent on the results of the cleaning process. The project is in its final stage: only a full scale test is left and this has to prove this. Another reviewer feels that it is likely to be used if the process is economic - and does not itself pose an environmental disposal issue.

One reviewer says that due to the technical risks, the chances of success are slim. The reviewer adds that if they succeed, there would be a very high payoff. The reviewer concludes that this project is quite enabling and could be applied elsewhere.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

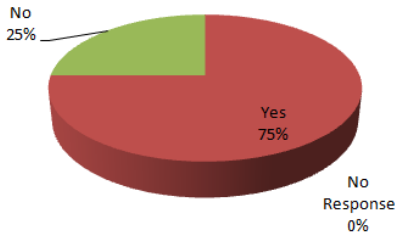
A reviewer states that the project has made excellent progress toward recycling most of the material. The reviewer says that a small amount of inorganics remain consisting primarily of PCBs. Another reviewer states that as most of the work has been and is bench scale, the resources are sufficient. The scaleup would probably come from another part of the post shredded scrap budget. Two other reviewers found the resources to be sufficient. One reviewer felt the technical risks had not been assessed properly.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

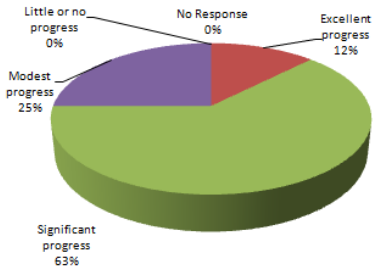
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development of Technology for Removal of PCBs

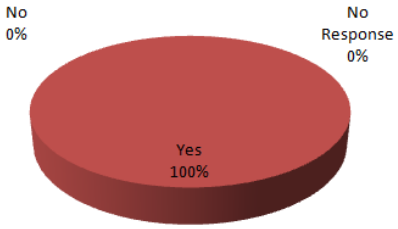
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



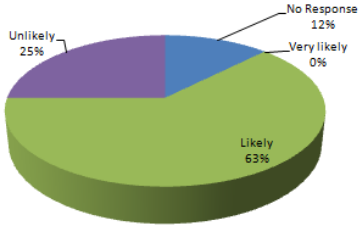
Question 3: Characterize the technical accomplishments and progress toward goals.



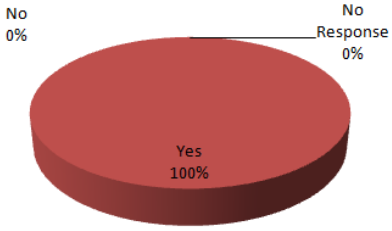
Question 2a: Are the goals of the project technically achievable?



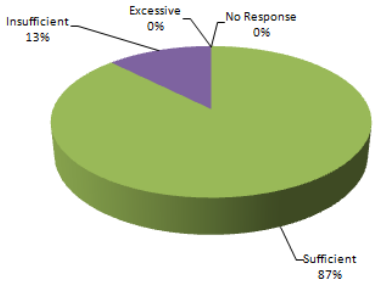
Question 4: How likely is the project team to move technologies into the marketplace?



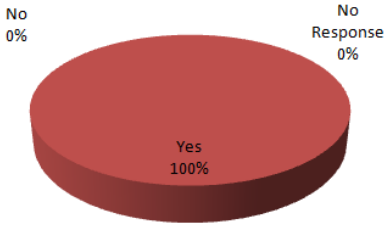
Question 2b: Have the technical barriers been identified and addressed?



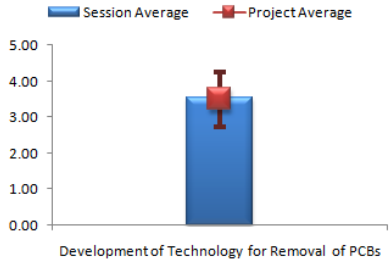
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Die-Face Engineering Project for Advanced Sheet-Forming Materials (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Some reviewers felt that the technology will be an enabler for increased use of aluminum and high strength steel stampings by reducing time and cost for die development. Aluminum and HSS will reduce vehicle weight and therefore improve fuel economy. One reviewer felt that the actual amount of gasoline saved by this work is hard to determine as the major benefits will be to improve the usage of AHSS, which can save some weight but has other important benefits in safety/crash energy management. One reviewer said yes, objectives are supported in the sense that it may diminish the aerodynamic resistance.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the project has identified technical barriers and "tried" to address them by conventional stamping die modification techniques, hoping that the models and software developed will cut down the time and effort in controlling springback on production dies. Another reviewer commented that there needs to be a new approach to solve the technical challenges identified, old methods will not work.

A reviewer felt that the goals and technical barriers were fully defined. The reviewer adds that overcoming technical barriers will continue to be a challenge. Another reviewer says that the ability to achieve a "perfect model" is a very (unrealistically) ambitious goal. The reviewer adds that it appears that significant improvements have been made. The reviewer continues that the people involved in the project are industry experts that are involved in implementing the results within the companies involved.

Some reviewers were unclear on whether the project goals could be achieved. One reviewer says that it seems as though the previous phase of the project has been completed in good order and the results will work their way into the die making industry to improve spring-back prediction.

A reviewer says that to their knowledge, the technical barriers have been properly addressed. The reviewer adds that it is doubtful that the technical barriers can be overcome to satisfaction; there will be improvement over the present state-of-the-art though.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt that all the barriers noted are obvious to any professional stamper, but the project results so far have been confusing, with no real handle on a model that predicts springback accurately in the eight AHSS and aluminum alloys selected. The reviewer wonders if this could be because of the significant differences in elastic modulus (3:1) and basic formability (fracture characteristics), Bauschinger effect, and surface properties between AHSS and aluminum alloy materials. The reviewer concludes that trying to get one model to fit all materials may be insurmountable.

One reviewer felt that the progress has been slow due to the complex nature of the problems. New expertise and new approaches are needed to solve the barriers. Another reviewer felt that progress had been made, but doubted if it would ever be satisfactory.

One reviewer saw good progress in a very challenging technology. Another reviewer felt that there had been worthwhile progress and that this project will produce results that are potentially of immediate application.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Some reviewers felt that the results would be implemented as they were developed. One reviewer felt that if problems were solved by the team the technology would be used by industry.

Another reviewer said that due to the importance of die face engineering in the stamping of AHSS and aluminum alloy sheet, some of the technologies (hard data from the testing part of the project) or some of the software will probably get into the marketplace, but more by diffusion than direct input.

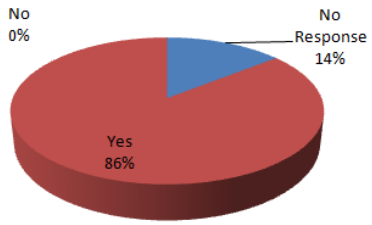
One reviewer said that it looks OK - this topic (springback and optimal die shape) will always be a problem with metal forming.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Most responding reviewers found the resources to be sufficient. One reviewer said that predicting springback of aluminum sheet continues to be a challenge. The reviewer added that continued involvement of LS-DYNA is essential to the success of the program.

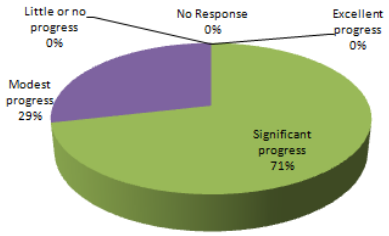
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Die-Face Engineering Project for Advanced Sheet-Forming Materials

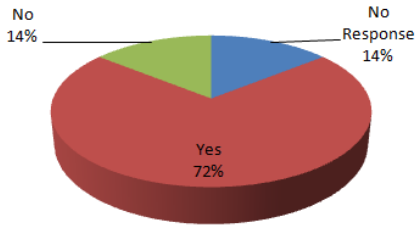
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



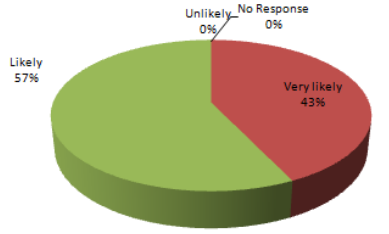
Question 3: Characterize the technical accomplishments and progress toward goals.



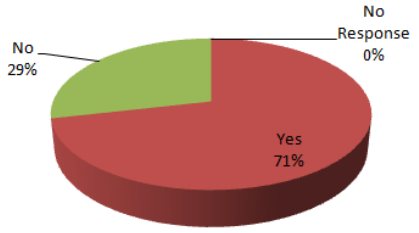
Question 2a: Are the goals of the project technically achievable?



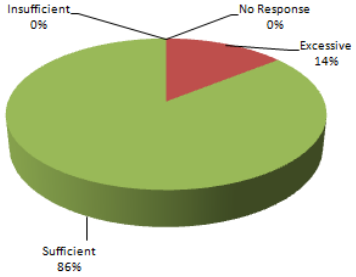
Question 4: How likely is the project team to move technologies into the marketplace?



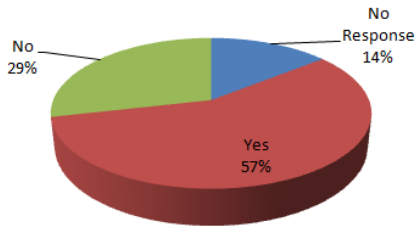
Question 2b: Have the technical barriers been identified and addressed?



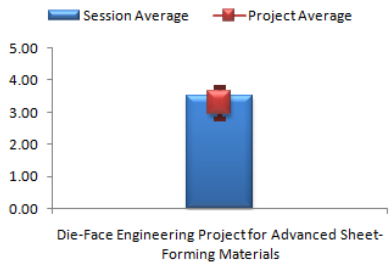
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Dynamic Characterization of Spot Welds in AHSS (Phil Sklad, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that this knowledge was needed to permit the use of AHSS which will lead to lighter structures. A number of reviewers commented that knowledge of spot welds was crucial for the integration of advanced high strength steels into vehicle bodies. One reviewer added that crash behavior of spot welded AHSS is obviously an important consideration in this regard.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer states that project is not really to develop technologies to overcome barriers; rather it is developing a needed understanding of behavior. Another reviewer comments that understanding spot welding at high strain rate (similar to crash situations) is very important to achieve optimum weight reduction. The reviewer continues that technical barriers were well defined. One reviewer says that there are some tough technical and computational issues here, but the team is knowledgeable and seems to have done a good identification of the issues. A reviewer said that the approach of modeling for steel is transferable to other light weighting metals.

One reviewer said that there is a need to know how AHSS materials behave in crashes to establish a model, but the model depends of the physical properties of the AHSS. The reviewer continues that the relation between the two aspects needs to seriously improve. Another reviewer commented that spot welding studies are generally never-ending as new variables are introduced, e.g., GA or GI coatings. The reviewer adds that if the work so far is only on bare surfaces, the technical barrier posed by coating needs attention.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that the experimental data have been adequately incorporated into a model for a particular AHSS, but queried whether the model is applicable to coated AHSS spot welds, to spot welds in Al, Mg, and other types of AHSS.

One reviewer comments that significant progress has been made. The reviewer suggests more research work is needed especially in modeling work. Another reviewer felt that good fundamental work to understand and model spot welds. This work is worthwhile for spot welds of other materials, e.g. aluminum.

One reviewer commented that the project builds on previous experience of spot welds. Phase 1 data set is not due until May 2008 Gate review. The reviewer adds that preliminary results indicate good progress toward meeting target dates.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that the models are readily transferable. Another reviewer commented that it was a valuable initial effort that needs more development before it can be moved into the marketplace for reasons given above.

One reviewer is confident that modeling of spot welds is likely to be employed by OEMs. Another commented that the Big Three modeling and simulation experts are overseeing the project direction. One reviewer felt the project was necessary but would take time.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

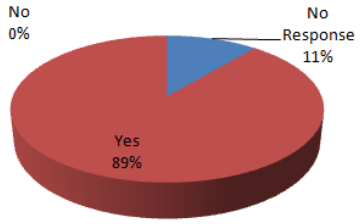
Most responding reviewers felt that funding was sufficient. One reviewer felt that more manpower should be considered to accelerate the development of the understanding of the crack properties of the AHSS, to develop a more complete model.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

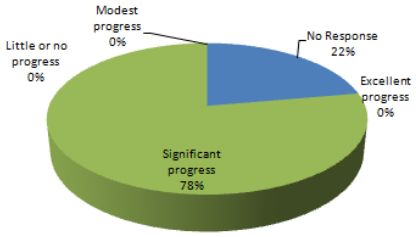
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Dynamic Characterization of Spot Welds in AHSS

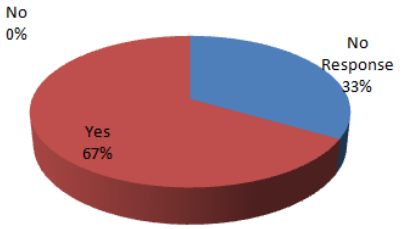
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



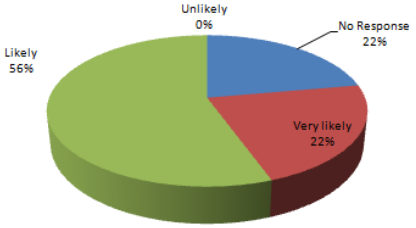
Question 3: Characterize the technical accomplishments and progress toward goals.



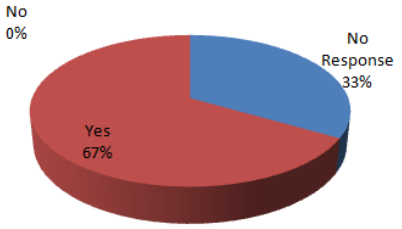
Question 2a: Are the goals of the project technically achievable?



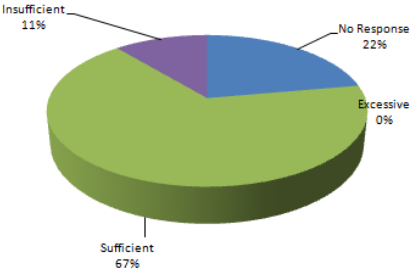
Question 4: How likely is the project team to move technologies into the marketplace?



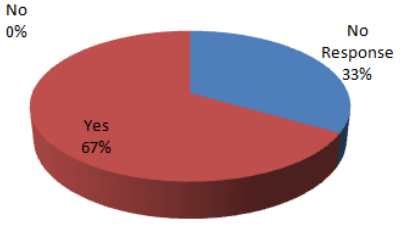
Question 2b: Have the technical barriers been identified and addressed?



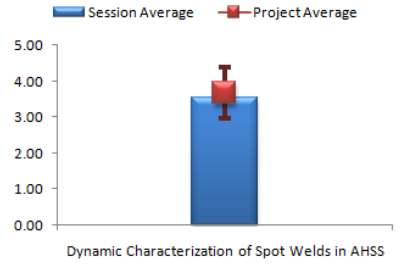
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Enhanced Resonance Inspection for Light-Metal Castings (Cam Dasch, of General Motors Corporation)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer answered yes, it supports objectives but somewhat indirectly. The reviewer notes that as structures are optimized and become lighter, they will be made of more critical materials using more complex processes. There will be less redundancy or "fat" in the vehicle and so the contribution of each component and each joint to the overall structure will be much more critical than it is now. The reviewer concluded that this work is very worthwhile and a key enabler of many of the other projects on new materials.

Another reviewer commented that enabling non-destructive technology to accelerate the use of light weight materials in transportation industry is supportive. A different reviewer felt that weight reduction will lead to higher utilization of material properties leaving less room for flaws, stating that as such this fits in the DOE objective for petroleum displacement.

A reviewer felt that quality control and repeatability are essential for scale up of light metal castings. One said that the project will enable use of resonance inspection of light weight castings where very high accuracy is needed in identifying discrepant parts. The procedure can reduce the mass of parts that are currently overdesigned for added safety margin.

One reviewer stated that light metal (metal (Al and Mg) castings represent the bulk of light metal usage in automotive applications. The reviewer believes that optimizing design of these castings by RI would support petroleum displacement.

A reviewer commented that the project has potential for improved inspection at reduced cost. The reviewer adds that therefore it will reduce the overall cost of light metal casting which need to be inspected and thus enable more applications. Similar to another comment, the reviewer states that it can reduce the cost and weight of castings which are "overengineered" to account for possible defects. The reviewer concludes that in turn, this will lead to reduced vehicle weight and improved fuel economy.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that the deployment strategy is well-defined. Barriers were identified and addressed. Another reviewer commented that there is close cooperation with USAMP. The reviewer adds that weight reduction will lead to higher utilization of material properties leaving less room for flaws, as such this fits in the DOE objective for petroleum displacement.

One reviewer commented that it was a bit hard to tell based on the presentation, although it looks good and the fact the OEMs are involved is critical, since they put the cars together and must therefore be involved and accept whatever is developed.

A reviewer commented that the enhanced resonance inspection of light metal castings enables early defect detection and potential fractures. Another states that the project is based upon a fundamentally good idea.

One reviewer states that the strategy to deploy RI appears to work on simple geometries -- all within work scope. The reviewer continues that it appears as though this project is essentially complete (remarkable after only a few months of work) so the implementation stage is about to begin. The reviewer concludes that now it appears as though it is now a business process decision rather than a research project.

One reviewer expressed concern that technical barriers have been identified but not fully addressed yet. The reviewer did state that it was a good start. The reviewer did not feel the effort is deep enough to include the full range of new light weight materials and joining methods. The reviewer continued that there is a need to identify and prioritize key barriers and focus on resolving a “select few".

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer commented on the excellent connectivity with collaboration partners including OEM non-destructive test experts, castings experts, casting suppliers and major modal analysis suppliers The reviewer continued that the project has already demonstrated simple geometry measurements, simple geometry FE analyses, mode shape comparisons, local change sensitivity, and automotive aluminum knuckle castings.

One reviewer stated that the project has made substantial progress made in the short time the project has been running (less than a year). Another felt that this is the sort of challenging, but high benefit project DOE should undertake. A reviewer commented that the project has been stretched longer time-wise due to limited funding.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer felt that the technology and inspection procedures are readily transferable to a high volume production environment. Another reviewer commented that if the development is ultimately successful, given the potential advantages, implementation is highly likely.

One reviewer felt that it appears that the right people are involved; including manufacturing people that will be responsible for implementation (who were initially "naysayers"). Another reviewer said that acceptance will depend on extension of RI technology to more complex parts and on production part demonstrations. The reviewer continued that there were just a few small steps left before full adoption for connecting rods - but it seemed to the reviewer that it would be better to use this on some sort of lightweight component like a wheel or a lower control arm. The reviewer concludes that other than that, for con-rods, the major issues are (largely) not technological in nature but more in the realm of business process decisions.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Most responding reviewers felt that there needs to be increased funding. One added that there may be more applications then just castings, but if not the casting applications would be very large.

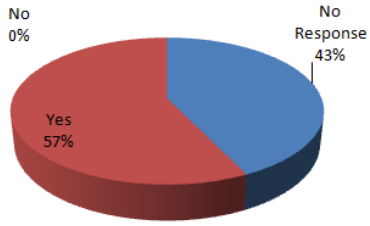
Another reviewer felt that it needs to be to be scaled up for huge volume testing. The reviewer concludes that the project should be accelerated because of the very high likelihood of deployment.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

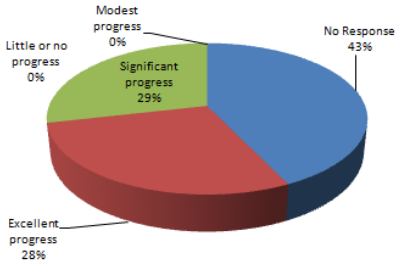
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Enhanced Resonance Inspection for Light-Metal Castings

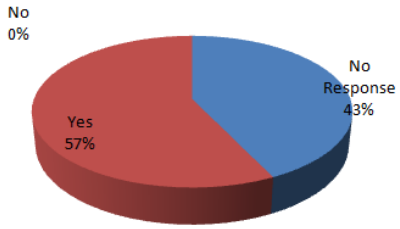
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



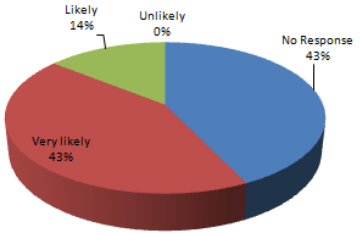
Question 3: Characterize the technical accomplishments and progress toward goals.



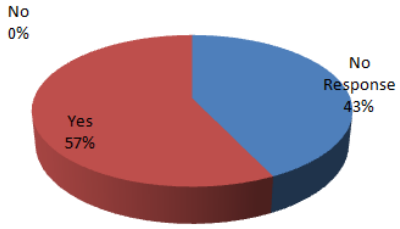
Question 2a: Are the goals of the project technically achievable?



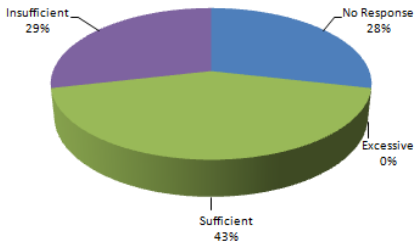
Question 4: How likely is the project team to move technologies into the marketplace?



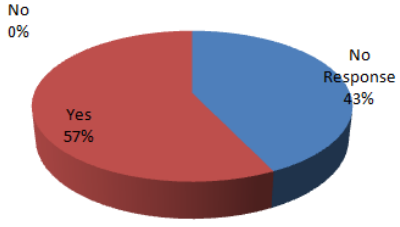
Question 2b: Have the technical barriers been identified and addressed?



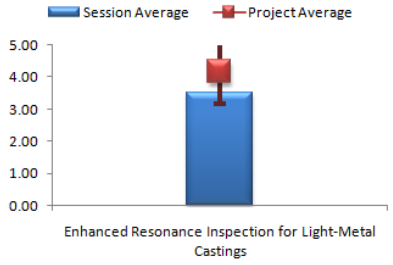
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Focal Project 4 – Floor Pan (Gerry Olszewski, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer says that lightweighting the vehicle with dissimilar materials is not possible without resolving joining issues. The reviewer says the project addresses this issue head on. A reviewer highlighted weight reduction in the floor pan and seat. A number of other reviewers also mentioned weight reduction as supporting DOE objectives.

A reviewer cited the development of manufacturing processes to reduce the production cost of composite panels which have a significant weight reduction potential. Another reviewer commented that the project could provide information needed to support fabrication of large structural composite structures

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer says that mass reductions are excellent compared to baseline steel but costs have not met target. Another reviewer states that the selection of the underbody and second row seat applications give immediacy to the project, while the technology deployment of different materials and processes should settle questions about best candidates for these parts.

Two reviewers commented on the contribution from OEMs and National Labs as being key to the study and key to product deployment, as well as providing good feedback. One reviewer noted a well developed plan.

A reviewer noted that a composite underbody in a "multi-material" vehicle is a questionable application. The reviewer states that large components of glass fiber composites such as this have already been demonstrated in a previous focal project so this effort doesn't seem to provide enough additional technology development to be worth the trip. The reviewer feels that no results were shown which indicate that this is a good application for composites vs. other possible alternatives. The reviewer adds that the seat structure work seems much more innovative and worthwhile.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer notes that significant mass savings were demonstrated with SMC and DLFT compounded materials for underbody. The reviewer adds that SMC with glass fabric and high elongation core won out as a material and process system for underbody. The reviewer also says there was significant progress made on the seat back in structural analysis and costing out of options.

Two reviewers felt that the weight saving gains were modest at best. Two different reviewers noted concern with crash requirements and repair costs. A reviewer wondered how the life cycle of the vehicle will be affected by repair costs.

A reviewer felt that significant barriers are still there, but within the timeframe of the FreedomCAR program these barriers can be solved. One reviewer felt that good progress had been made in designing parts, but the reviewer questions grouping of projects, as well as the validity of cost model

comparison basis. The reviewer is unclear whether or not the seat meets side impact requirements (as we see in ASP FGPC simulation).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer sees progress towards mass reduction and meeting the most technical requirements, but sees the project as shy of its goals. The reviewer felt that without major cost reduction or subsidy, costs are too high to be implemented by auto manufacturers. Another reviewer saw weight and cost savings are promising but need work to get to the targets. A different reviewer said that due to the small amount of weight saving, transformation to the market will be strongly dependent on the potential cost saving.

Structural composite underbody technology is a proven weight saver and looks promising. The seat back has more competition from alternative light weight materials. A reviewer notes that this team has done similar technology development with other components which are already introduced in the market place; similar transfer of technology will take place.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

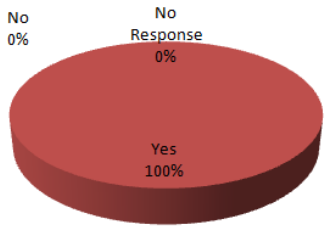
A number of reviewers found the resources to be sufficient. One found the work promising. Another reviewer felt more work needed to be done to overcome the prohibitive high costs.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

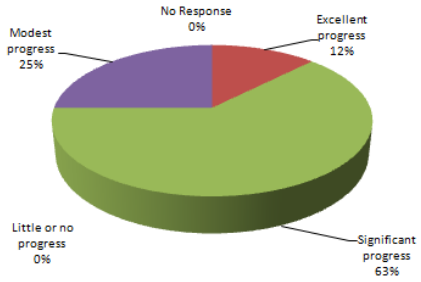
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Focal Project 4 – Floor Pan

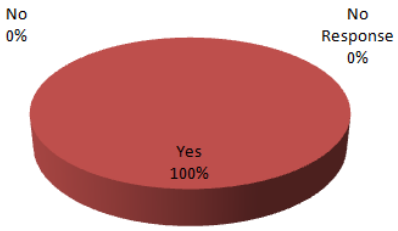
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



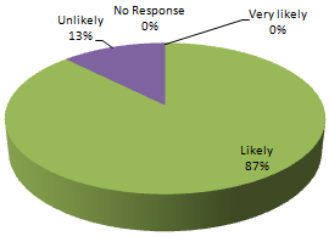
Question 3: Characterize the technical accomplishments and progress toward goals.



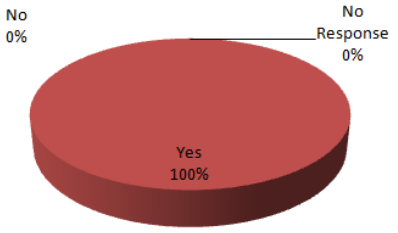
Question 2a: Are the goals of the project technically achievable?



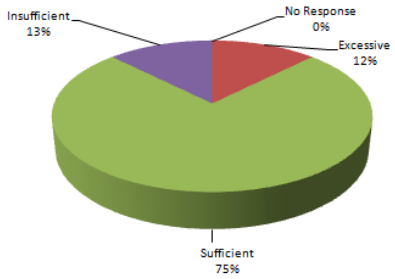
Question 4: How likely is the project team to move technologies into the marketplace?



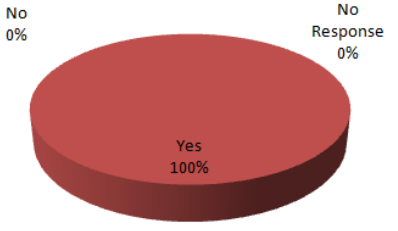
Question 2b: Have the technical barriers been identified and addressed?



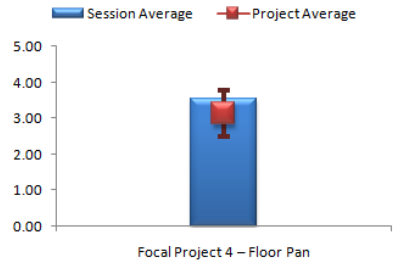
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Friction Stir-Spot Welding of AHSS (Phil Sklad, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Two reviewers stated that since welding destroys the microstructure, friction stir spot welds could overcome joining challenges. A number of reviewers spoke positively of this being an enabling technology for advanced high strength steels. One reviewer felt that the project would "only directly" support objectives.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer stated that although the project was technically feasible, it would require major retooling investments for high volume body shop production. It is simply not feasible to replace all of the robotic and fixturing tooling and controls to make this technique economically feasible, although there may be some select areas of application. A reviewer commented that the project seems pretty reasonable. Another reviewer states that the technology is realized by joined research of co workers from several suppliers. One reviewer concluded that since FSW is used more and more, technical deployment will gradually take place.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt that although technical barriers with regard to the materials have been well addressed, manufacturability in high volumes has many unaddressed challenges that are outside the scope of the project. Another reviewer stated that friction stir spot welding will potentially lead to some weight reduction but it will be limited. One aspect which should not be overlooked is testing the welds at low temperatures.

One reviewer commented that lower cost tooling materials had been identified and tested, and welds characterized. A different reviewer commented that from what they could tell the work is going well - but more work on tool cost and production rate is warranted.

A reviewer said that since technical barriers are not negligible, outcomes may be delayed or not reached. Two reviewers felt that the progress rate was slow, but acceptable due to the technical barriers faced. One reviewer suggested more creative ideas were needed to get around the barriers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A pair of reviewers felt that unless the process is cost-effective, it is unlikely to be used by industry. Another reviewer stated that considering the difficulties surrounding FSSW of AHSS and even mild steel, the technologies developed on this project so far don't show a breakthrough that would generate market interest.

A different reviewer commented that at this time it was only applicable for select low volume applications. The reviewer continued a major pilot application would be necessary to validate high volume manufacturability. Another reviewer said the process will be gradually implemented.

One reviewer said that assuming successful development and that process speed is sufficient, this is a promising joining method which may be implemented for selected applications.

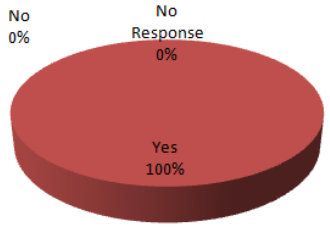
A reviewer commented on the excellent collaborative work OEM and steel producers that will help smooth transfer technology into production. Another reviewer felt that it was too early to say much given the status of the work.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All the responding reviewers felt funding was sufficient.

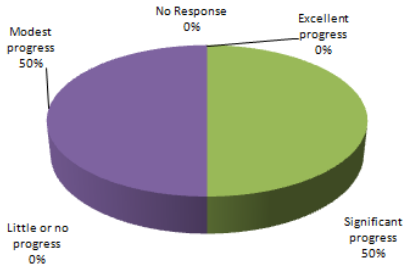
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Friction Stir-Spot Welding of AHSS

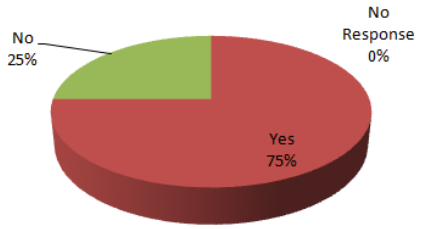
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



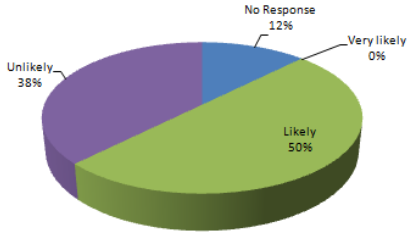
Question 3: Characterize the technical accomplishments and progress toward goals.



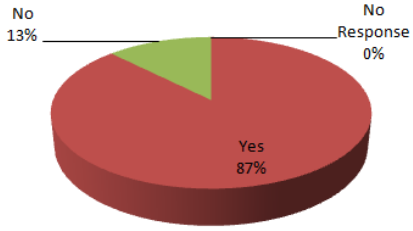
Question 2a: Are the goals of the project technically achievable?



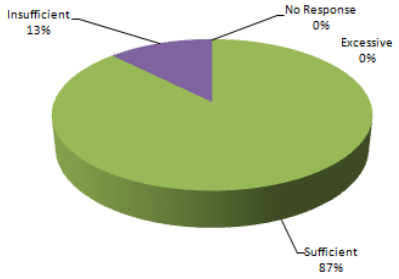
Question 4: How likely is the project team to move technologies into the marketplace?



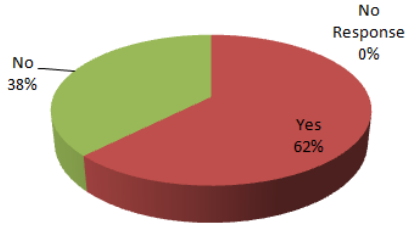
Question 2b: Have the technical barriers been identified and addressed?



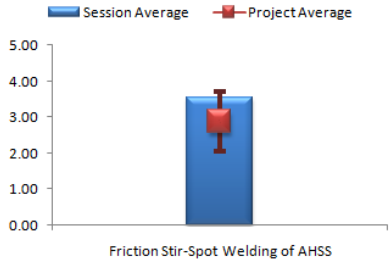
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Future Generation Passenger Compartment Validation (Roger Heimbuch, of Auto Steel Partnership)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that total mass savings directly support overall DOE objectives. A number of reviewers commented that higher strength steel means lower weight, which leads to fuel economy.

One reviewer felt that lightweighting leads to improved fuel economy, but added that a high strength steel structure is not likely to save as much weight as other alternatives, nor will it approach the FreedomCAR goal.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that there are so many issues that the project must address that it is difficult to assess - but it looks like a pretty good treatment of the issues. The whole issue of mass compounding is very worthwhile in this context especially as so many new materials and processes are being considered simultaneously. If mass compounding effects are not considered, it is possible that a good material/process opportunity may be discarded prematurely.

Another reviewer felt that the scope and achievements of this project in addressing, attacking, and achieving project goals are commendable. A different reviewer stated that all technical challenges were identified. The project strategy is to solve the technical barriers, and the deployment strategy is well defined.

One reviewer believed that given enough work, the issues will be addressed but not likely within this generation of projects. Another reviewer commented on good cooperation with the enabling team which means a large active group is working on this project.

One reviewer cited the demonstration and validation program to deploy advanced high strength steel in automobiles. Another reviewer described the project as well explained.

A lack of availability of thin HSS (described as a barrier in the presentation) is not going to be solved by this project, said one reviewer. The reviewer continues that it is not possible to achieve FreedomCAR weight savings by thinning gauges because automotive structures are substantially controlled by stiffness, not strength.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer found that DOE technical barriers had been met and exceeded, which is remarkable considering the range and scope of the multi-pronged project. Another reviewer commented that significant progress has been made within a short time, but significant technical challenges are still to be overcome. One reviewer felt that development of a recursive optimization design/weight lightening process. This should be quite innovative.

One reviewer commented that there appears to be good progress in design, establishing and dealing with material limitations (in meeting production requirements); extensive modeling and simulation,

and good work in mass compounding. Another reviewer states that the project has successfully developed design guidelines and demonstrated the weight savings potential of AHSS for such applications as passenger compartment and rear chassis structures.

One reviewer focused upon the demonstrated weight savings up to 30%, and noting that within the project the steel material properties were not taken as a given but some challenging targets were set. The reviewer continues that given proof to need for HSS above the current available. The reviewer adds that this project could be a guideline for future developments of new steel grade. The reviewer concludes that after mass compounding the result came to a potential of 40% weight saving, and that this type of weight saving is impressive, seen in relation to the fact that the introduction of these solutions in the industry will have relative low impact on the existing manufacturing infrastructure.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer comments on the good results and even better reporting and dissemination of results -- the latter is a specialty of A/SP. Another reviewer believes that since all the stakeholders (OEM and suppliers) are involved in this project, once the development is done it will be easily accepted by the industry.

The partners all seem to be committed and the OEM's certainly need to take out weight. The key things are not just physical property enhancement but they must also develop reliable design tools so that real products can be developed.

In the same vein a reviewer concludes that technology transfer is highly likely given the road show and seminars organized by the team, and that transfer to the market of this technology would be appropriate One reviewer says that the group's focus appears to be on identifying tools and methods that can be applied immediately; all OEMs and steel companies are actively involved.

Another reviewer comments that applications of HSS in a passenger compartment are likely; however, it is questionable that a collaborative project of this scale is appropriate or required to facilitate this. The reviewer adds that AHSS application in the passenger compartment structure will happen based upon the design decisions of the individual OEMs. The reviewer continues that it is questionable that the specific body structure design developed in this project will be the basis for an actual product design.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

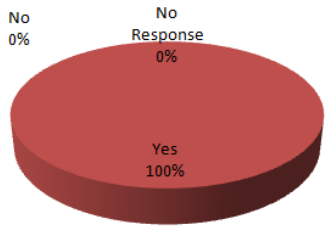
Most reviewers who responded found the funding sufficient. One reviewer felt that project benefits do not justify the very high ($1 million per year) level of funding; design of a body structure made of steel is not a precompetitive activity.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

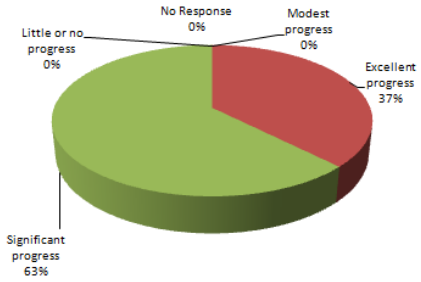
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Future Generation Passenger Compartment Validation

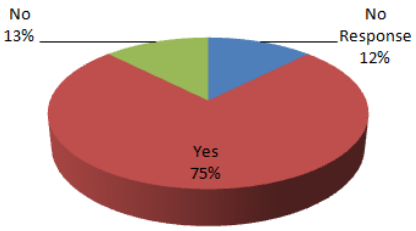
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



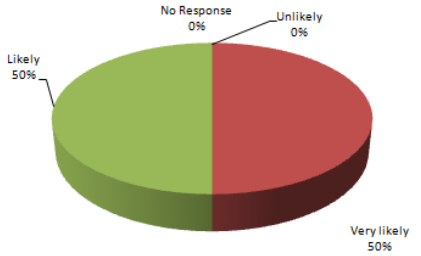
Question 3: Characterize the technical accomplishments and progress toward goals.



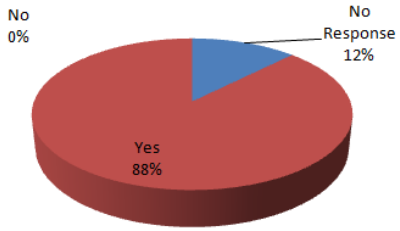
Question 2a: Are the goals of the project technically achievable?



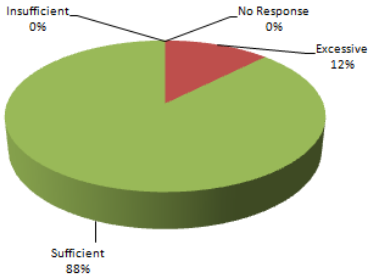
Question 4: How likely is the project team to move technologies into the marketplace?



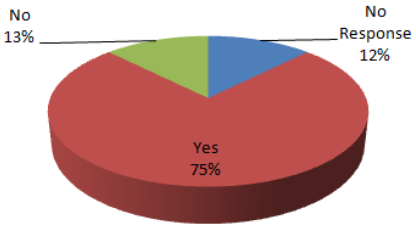
Question 2b: Have the technical barriers been identified and addressed?



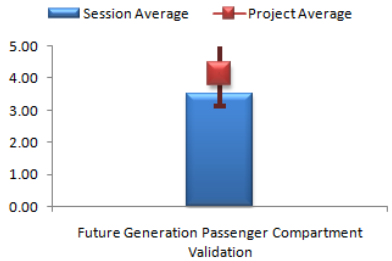
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High Strength Stamping (Roger Heimbuch, of Auto Steel Partnership)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented that testing of weld fatigue and stamping springback are critical to acceptance in high volume production. Another reviewer commented that OEMs must be able to avoid or compensate for springback before they can implement AHSS in numerous applications. The reviewer adds that this work will help, and will thus help reduce the mass of vehicles through increased use of higher strength steels.

One reviewer said that understanding stamping and joining characteristics of high strength steel and developing guidelines and modeling techniques will promote the use of high strength steels, lower weight of automobiles and save fuel.

Many reviewers commented on the potential for lowering vehicle weight with increased strength. One of these reviewers added that better strength is the justification for AHSS. The reviewer continues that it is asserted that improved formability compared to "conventional" HSS will open up more applications thus leading to greater weight reduction.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that while the modeling, experimental work, and tech transfer all are aimed at a production part (B pillar) that is likely to use a lighter-gauge steel, the lessons learned applicable to other parts like the rear rails. Another reviewer felt that the project would be deployed as soon as technology is developed satisfactorily.

A reviewer commented that the projects focus on material fatigue characteristics and stamping springback. The reviewer adds that analysis has uncovered other challenges including fracture formation.

One reviewer felt that this is a characterization project. The reviewer felt that some of this work should be done by the material suppliers; also, some of the work, e.g. springback prediction, is included in other projects. The reviewer suggests confining the work on this to one project.

One reviewer says that the question is tough to answer definitively; there are LOTS of technical issues. The reviewer continues that it does look like a pretty good cut at the difficulties has been taken and progress appears to be occurring. Another reviewer felt that the modeling work is not satisfactory for most of the AHSS steels, more technical barriers exist. The deployment strategy is not clear.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt that the analytic objectives were fulfilled and surfaced additional challenges beyond the scope of the project. Another reviewer stated that the work is good solid data gathering and defines do's and don'ts. One reviewer stated that this was an on time project with demonstrated deliverables.

One reviewer commented that the project has developed an understanding of stamping characteristics. One said that the project pertained to DOE goals not only on light weighting but also on safety.

A reviewer commented that due to the complex nature of the technical barriers, the progress is slow. One reviewer felt that it was a little too early to be too definitive but it looks good.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that if the barriers can be solved, then it will be utilized by the suppliers and OEMs. Another reviewer was confident that this project and the other AHSS related activities will be successful and will be widely adopted.

One reviewer commented that A/SP have been very focused on designing their projects to move quickly toward the marketplace. The reviewer continues that no doubt, the pressure from competitive light material projects makes the steel industry act firmly to protect their market.

A reviewer saw good OEM involvement; with lessons being learned and implemented in production immediately; very good tech transfer activity at A/SP. One reviewer felt that empirical data can be used to validate predictive models, adding that additional fracture data produced additional incremental data beyond original project expectations. The reviewer continued that there was good documentation of results that have effected changes in several parts on existing vehicle programs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

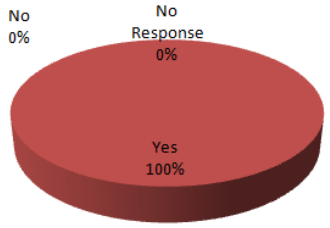
Many of the responding reviewers felt funding was sufficient. One reviewer commented on the great support from all sides. Another reviewer was concerned that funding may be insufficient and that the project should be expanded.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

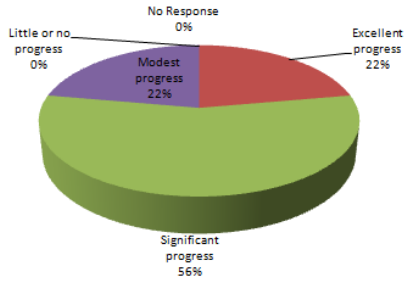
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High Strength Stamping

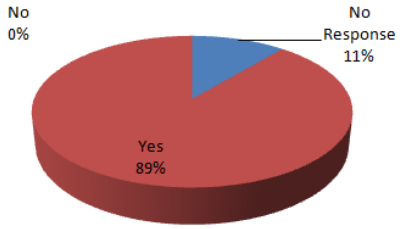
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



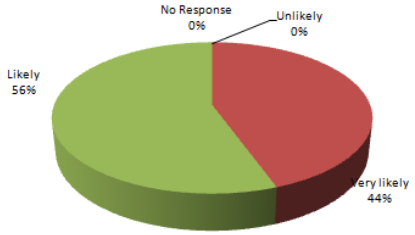
Question 3: Characterize the technical accomplishments and progress toward goals.



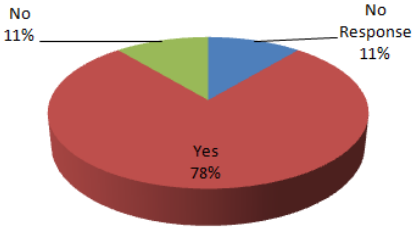
Question 2a: Are the goals of the project technically achievable?



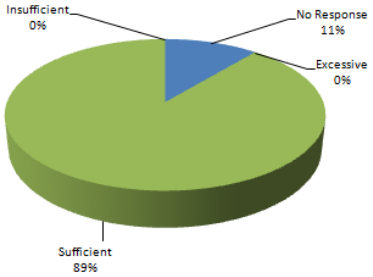
Question 4: How likely is the project team to move technologies into the marketplace?



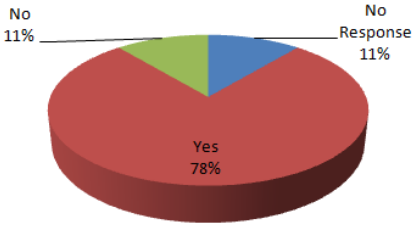
Question 2b: Have the technical barriers been identified and addressed?



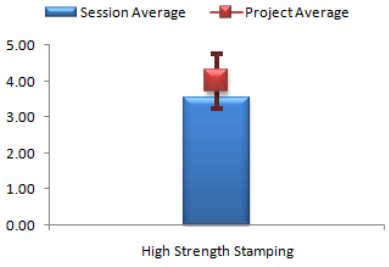
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Integrity Magnesium Automotive Castings (HI-MAC) (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer comments that in addition to weight reduction, light weighting is also an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles. The reviewer adds that that the project is well structured and flows seamlessly into similar projects. The reviewer adds that this is an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles.

A number of reviewers state that HI-MAC will enable lower vehicle mass by use of cast Mg in highly loaded components, thereby supporting petroleum displacement objectives.

One reviewer felt that development of this manufacturing process is critical in achieving the magnesium components with lower cost and weight. Utilizing these magnesium components will help to improve fuel economy with competitive cost with other light weighting materials.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer states that a major technical barrier is oxidation in both castings and sheet magnesium. The reviewer continues that the barrier is well recognized and characterized, the first step in overcoming the barrier. The reviewer adds that Mg castings are already in use and Mg sheet forming has been determined to be technically feasible. The reviewer gives the example of the Chevy Corvette engine cradle as a proven deployment. The reviewer concludes that the project is well aligned to support the other projects through a life-cycle approach from basic research to deployment.

As reviewer says that as aluminum casting processes have advanced to achieve high integrity, applying these processes to magnesium is the smart thing to do.

A number of reviewers felt the project was well defined, with readily identifiable deliverables and milestones. One reviewer added that there are already links being made with production parts. A number of reviewers commented on the strong links to universities and suppliers. One reviewer went on to state that critical aspects limiting current application were being addressed.

One reviewer felt that while barriers are likely to be overcome, they will not be overcome for every application. One reviewer felt that the success of addressing all barriers was not certain.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer noted that General Motors has deployed magnesium castings in the Chevy Corvette. A reviewer commented on the four new casting processes for Mg and associated production cells have been selected and Mg castings made, all within time and budget targets.

One reviewer said that technical barriers and deployment strategies are well defined. The reviewer continues that the program has demonstrated significant progress to overcome technical barriers.

A reviewer noted that prototype cells are up and running for LPPM, squeeze casting and ablation, making good progress, making parts only 14 months after project approval. A different reviewer said

that the progress made so far met all the deliverables as planned in the original timeline, suppliers have spent significant amount of resources to develop this technology.

A reviewer said that a 65% weight saving is possible over cast iron structural parts. The target of zero cost increase is dependent on price of Mg. One reviewer felt that the project was progressing as well as possible. The reviewer adds that the group is very large and, is a reason for the project not to move faster. The reviewer continues that casting of Mg is already more difficult than envisioned and is likely to be more involving than the participants were bargaining for. One reviewer is very supportive of the whole magnesium effort.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer mentioned an excellent technology transfer strategy. Cost is still a major factor in Mg sheet acceptance in automotive manufacturing. Although technically feasible, until cost drops under $2/lb in today's dollars for sheet Mg, economic feasibility is questionable in high volume. Projects have also aligned OEMs, suppliers, Universities, and international partners to maximize R&D, application, and deployment leverage.

Another reviewer talked about squeeze casting of Mg having already been done (outside this project) successfully, although not for performance critical automotive applications. Lessons learned on the Mg Corvette engine cradle will offer synergistic support to efforts on this project. The ablation casting of Mg components may be a stretch.

Another reviewer said that some of the developments have been undertaken by the industry, further developments will be also utilized by the industry. The suppliers have been involved in this program; it will go to the marketplace.

Some reviewers mention the engagement of the team helping move the technology into production. One reviewer commented on how small scale production facilities are already up and running. The reviewer adds that this will certainly be beneficial for the transfer to the market.

One reviewer notes that if the project is successful it is likely that more applications of Mg will follow. The reviewer continues that there are additional challenges (outside the stated scope of the project) which also need to be addressed for most applications: supplier infrastructure, cost (particularly for the material) and corrosion are three key examples.

A different reviewer noted that implementation will take time and will depend on a diverse supply of raw materials.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Some of the reviewers felt funding is sufficient. One added that the program should be ready with more funds if needed. A reviewer said that use of magnesium components is technically feasible if joining challenges with dissimilar materials can be resolved and costs can be driven down to acceptable levels. Additional funding should be provided to accelerate resolution of joining and forming challenges. Warm forming shows good potential and should be accelerated. Crashworthiness has limited fracture behavior analysis and should be expanded. Portions of this project have progressed beyond fundamental research into demonstration and deployment phases, however fundamental research challenges remain. Although the Pidgeon Process is more polluting than electrolytic processes, the Pidgeon Process should be further explored to bring down costs but needs

to be coupled with environmental abatement opportunities. These projects represent some of the greatest opportunities for success and should be expanded and exploited to the maximum extent possible.

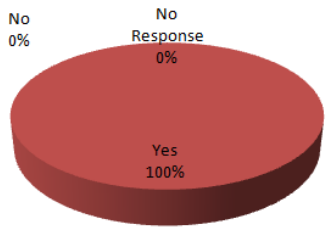
One reviewer commented that funding is more than sufficient. The reviewer adds that in fact, $800,000 of government funding per year seems a bit high considering that there is matching industrial funding from 46 participants. The reviewer asks if each of these participants is actually adding value and contributing to the execution of the tasks of the project. A separate reviewer recommends continued support of this program.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

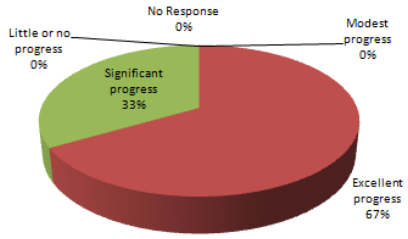
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Integrity Magnesium Automotive Castings (HI-MAC)

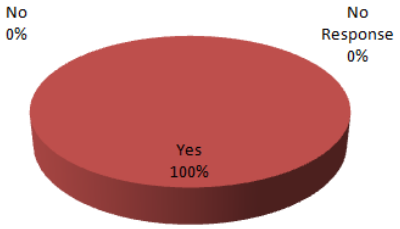
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



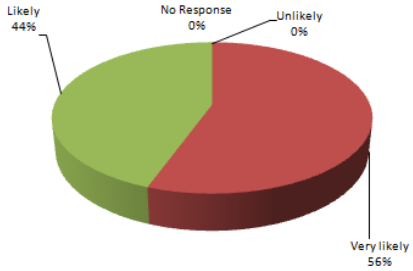
Question 3: Characterize the technical accomplishments and progress toward goals.



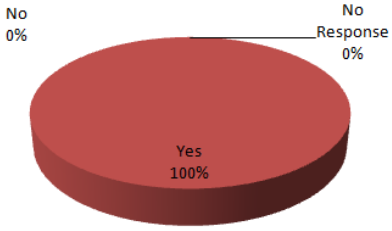
Question 2a: Are the goals of the project technically achievable?



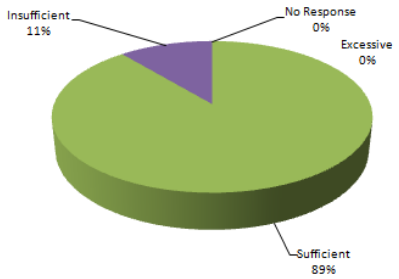
Question 4: How likely is the project team to move technologies into the marketplace?



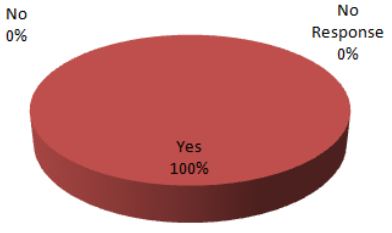
Question 2b: Have the technical barriers been identified and addressed?



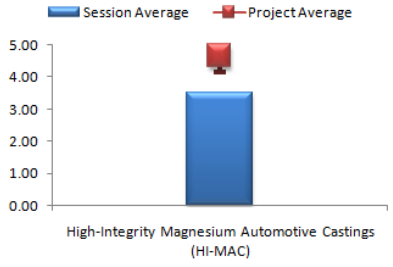
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Volume Processing of Composites (Gerry Olszewski, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented on lighter structures supporting objectives. Many reviewers responded that weight reduction supports DOE objectives, one of whom added that cost reduction and productivity improvement is important. One reviewer commented that high process is not only relevant to the auto industry, it is essential.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer responded that the combinatorial approach to multiple processes will yield the highest likelihood of success. The reviewer continued by stating that overcoming bond line read through (BLRT) remains a challenge for manufacturing. Bond line read through was also cited by another reviewer who felt that it is a difficult problem, but that a strategy is evolving and progress is being made. The project was described, by a reviewer as being well structured.

Another reviewer felt the project had good ideas for achieving goals and had made good progress to date. One reviewer felt that working with suppliers and OEMs is the key in the development of this study. This is the best way to deploy the technology when developed. A reviewer was confident that this is a project, so the technologies will be shared in the supply chain.

One of the reviewers felt that many of the barriers identified in presentation are mainly commercial rather than technical, although to be sure there are many of these. The reviewer continues a number of barriers were identified, but the presentation did not provide sufficient info to enable a good answer for question 2c.

A reviewer felt that the overall goal of the program is too broad, and specific deliverables need to be defined better.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer felt the project was too new to properly assess. The reviewer did see some progress with carbon fiber SMC. Another reviewer commented that there was low risk, and that progress will follow. It was said by a reviewer that significant barriers are still there, but within the timeframe of the FreedomCar these barriers can be solved.

One reviewer stated that there were no show stoppers ahead, and that interest was shown by Big Three. Another reviewer stated that the weight saving potential is not demonstrated so it is difficult to assess based on earlier information, but joining is also part of the project. It was said by a reviewer that, with some exceptions, e.g. bond line read through, the presentation did not clearly identify progress and its significance for many of the individual items being considered.

One reviewer said that the project was making progress, but many facets of project are not related or connected (e.g., no apparent linkage between BLRT and material production methods). The reviewer continues that the project seems like a hodge podge of good things to do, but was not focused on any

particular outcome. A reviewer also felt that the project does not have specific deliverables and the progress is relatively slow.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that there was a sound analytical approach but the project is not far enough along to properly assess the ability to affect the market. Another reviewer stated that this team has done similar technology development with other components which are already introduced in the market place; similar transfer of technology will take place. One reviewer felt that the project has all the important players in the supply chain making introduction in case of success likely.

A reviewer commented that the technologies address production needs once lightweight composites (either made with glass fiber, carbon, natural fibers, or mixed fibers for reinforcement) are selected in the FreedomCAR components. Another felt the project was too specific to assess viability for production.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A number of reviewers felt that resources were sufficient. Another reviewer felt that without a full understanding of the funding distribution and plans, they must assume "sufficient". Of course, taking the project into production will always require more resources than originally planned.

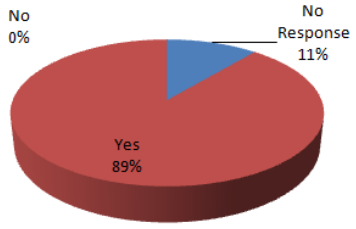
One reviewer stated that significantly more and concentrated effort will be needed to fully develop a commercially viable process for manufacturing high strength high volume composites.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

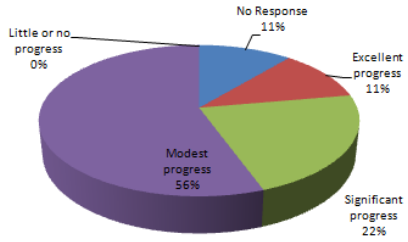
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Volume Processing of Composites

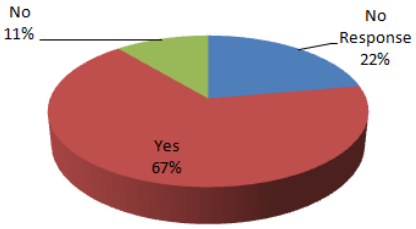
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



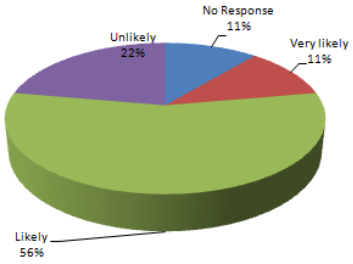
Question 3: Characterize the technical accomplishments and progress toward goals.



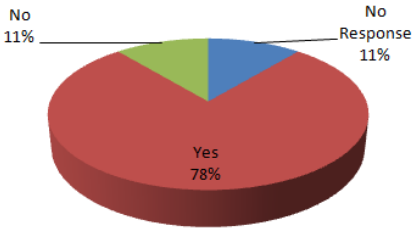
Question 2a: Are the goals of the project technically achievable?



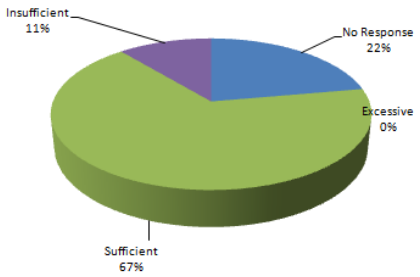
Question 4: How likely is the project team to move technologies into the marketplace?



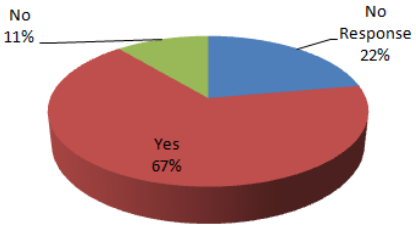
Question 2b: Have the technical barriers been identified and addressed?



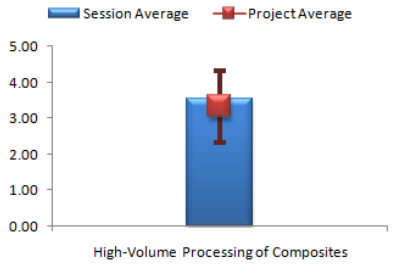
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Improved Automotive Suspension Components Cast with B206 Alloy (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many reviewers felt that the introduction of more cast components with better alloys would help to reduce more weight resulting in better fuel economy. One reviewer added that caveat that goals will be met if the weight of the B206 system is lighter than the standard approach.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer was unclear if there was a real advantage. Other reviewers felt that technical barriers and goals were well defined, but one felt that it remained to be seen if the project would be successful.

Some reviewers commented on the large group of suppliers as well as universities that were involved, and that this would lead to deployment. One reviewer felt this work was important due to the components' poor reputation. Another reviewer was concerned about the cost modeling issue.

A reviewer stated that if successful the work could even optimize designs for aluminum (in addition to replacing ductile iron), thus saving weight even in aluminum components (made with A356). One reviewer commented that SCC can be a real show stopper, and there are questions regarding the comparison of interganular corrosion test results and SCC resistance. Also, there is a question about the T7 heat treatment and its ability to improve SCC resistance while maintaining high strength. It appears that the time quoted for the T7 heat treatment may be wrong (way too short?), which can impact the economics.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the project seemed to be on target. Some reviewers felt that some of the technical challenges had been met, but others still needed to be addressed. One reviewer added that progress had been good.

A reviewer felt that the project looks pretty promising, given the issues that remain on cost modeling and other key issues (heat-treat, casting process issues around rate/water jackets etc.) that remain to be dealt with in the next short period.

A reviewer felt that the most promising technical achievement is the ability to use the advantages of the ablative casting process; however, questions about heat treatment, strength properties, and SCC resistance remain. Another reviewer said that weight saving will be relatively low in comparison to the aluminum it is replacing. In the chosen example fatigue will be the dominant failure mode. Fatigue strength will not be raised with the same amount as the tensile strength.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Many reviewers felt that once a cost effective technical solution is achieved there should be technology transfer. One reviewer felt that the designer's previous experience with the material would

possibly cause a slowdown of technology transfer. The reviewer felt that good communication was key.

One reviewer felt that it was unclear as to whether there would be tech transfer for the proposed application. The reviewer adds that it appears that not enough research has been done: is the cart ahead of the horse?

One reviewer felt that based on the poor economic model developed on this project (unanswered questions or possibly incorrect assumptions) and technical questions relative to potential show stoppers, at this time, the project does not appear likely to make a jump into the marketplace for this safety-critical component anytime soon. However, there may be automotive applications for this alloy, even in the T6 condition, where its high strength can be utilized without fear of SCC.

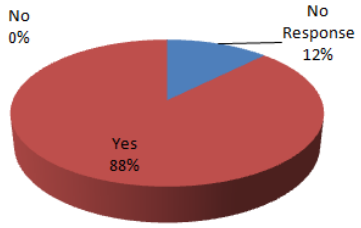
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Some of the reviewers found funding to be sufficient. One felt that if a need for more funding comes up it should be provided.

One reviewer felt that the budget for this project should be more than sufficient. Project management should look at redoing the cost model, do a better job on the heat treatment variables for T7, and get some meaningful SCC data that can clarify whether the mechanical properties/heat treatment parameters/SCC tradeoff can achieve the project goals.

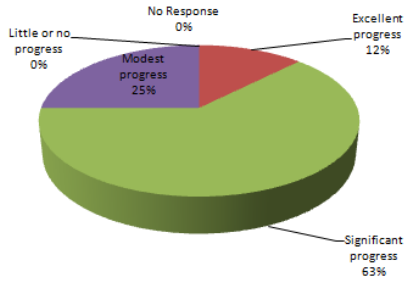
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Improved Automotive Suspension Components Cast with B206 Alloy

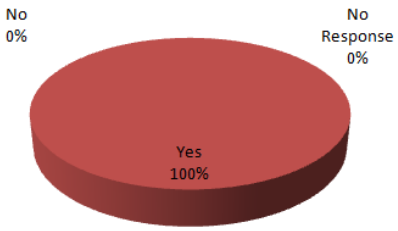
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



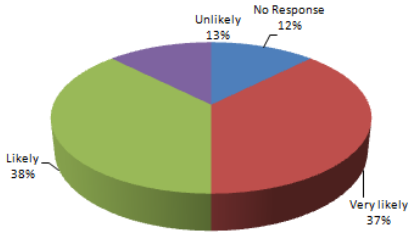
Question 3: Characterize the technical accomplishments and progress toward goals.



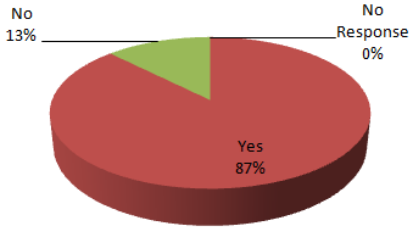
Question 2a: Are the goals of the project technically achievable?



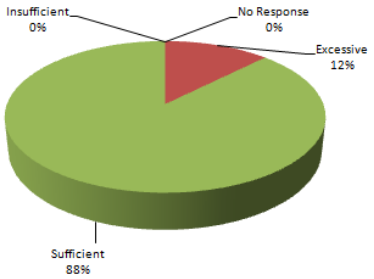
Question 4: How likely is the project team to move technologies into the marketplace?



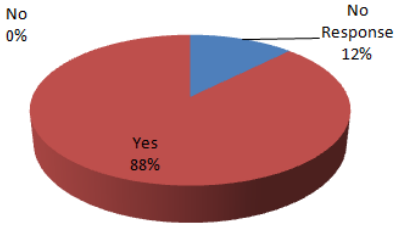
Question 2b: Have the technical barriers been identified and addressed?



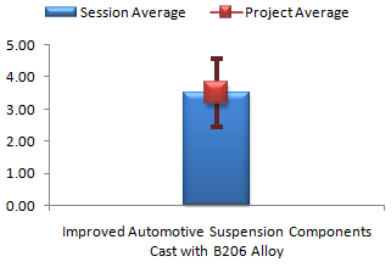
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LCCF – Bluestar MA-PAN (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers commented on carbon fibers being lighter and the need to reduce the cost of same. One reviewer said that the MA-PAN textile precursor is an important part of the overall LCCF effort and supports petroleum displacement objectives of DOE.

Another reviewer commented that the project engages a supplier as a potential source of CF for vehicle light weighting. The reviewer continues that carbon fiber structures can be significantly lighter than those using conventional (e.g. glass) fibers resulting in lighter vehicles. The reviewer adds that the problem has always been cost, which is much too high for aerospace-grade materials to be used in cars. The reviewer concludes that if this project works out then the cost issue COULD be solved or at least greatly ameliorated and large-scale use of carbon fiber vehicle structures may be feasible - but the cost barriers remain extremely high. One reviewer was adamant that this project does not qualify as a DOE project and should be stopped.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer expressed concern that the cost of fiber would not get to the target cost, citing final cost as the biggest target. Another reviewer was disappointed that the current carbon fiber manufacturers have shown no interest in the more cost effective technology, and added that getting current suppliers engaged would help accelerate commercialization and deployment of technologies.

Another reviewer stated that the key technical issues seem have been addressed and / or are under control. The reviewer adds that the real problems seem to be either commercial or cost-related. A different reviewer stated that textile manufacturers are involved as well as carbon fiber manufacturers. The reviewer concludes that deployment for textile precursors looks good.

One reviewer comments that the strategy of including the MA-PAN precursor in combination with the VA-PAN precursor for textile LCCF project hedges the bet on this class of material.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that significant progress has been made, but significant barriers still exist for achieving the cost target. Another reviewer feels that the key issue is Chinese ownership of one of the important partners: this is a concern given the issues of intellectual property protection and ownership. One reviewer states that the project brings the textile grade close to the market. The reviewer adds that the quality of the carbon fibers looks good, bringing 50% weight saving within reach. One reviewer notes timely progress in relation to difficulties in the collaboration with Bluestar (concern with Chinese ownership).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer felt that if the cost target can be achieved, then it would be used by the industry. Another felt that the commercialization of this technology is at least 5+ years away, but that it is encouraging that commercial companies are partnering in the project. One reviewer expressed

concern that the major producer will emerge as a Chinese company which will compete with US interests.

A reviewer comments that textile xx-PAN precursors make sense from technical and cost perspectives, and the interest shown by "Y" company looks promising. Another reviewer mentioned that a supplier was actively engaged.

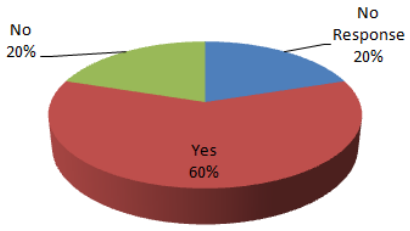
One reviewer felt that carbon fiber is still too costly for most high-volume auto applications. The reviewer also felt it was questionable to be relying on a potential supplier said to be a Chinese company. The reviewer adds that it seems that the most likely implementation path for Bluestar materials would be for the Chinese to produce the fibers themselves. The reviewer concludes that textile-based fibers will be more expensive than lignin-based, according to results of the cost model.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Several reviewers said resources were sufficient. One of these added that they would only be sufficient until the pilot plant resources are tallied. A reviewer stated that the presenters need to show a clear path as to how availability of additional funds will accelerate commercialization of this technology.

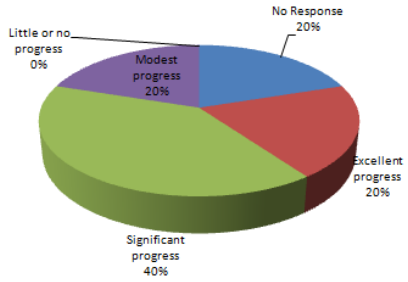
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LCCF – Bluestar MA-PAN

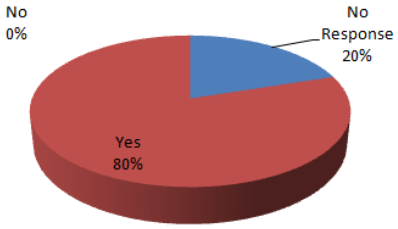
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



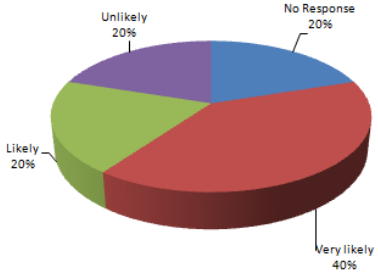
Question 3: Characterize the technical accomplishments and progress toward goals.



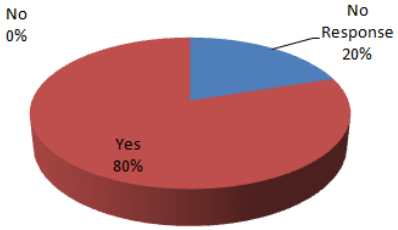
Question 2a: Are the goals of the project technically achievable?



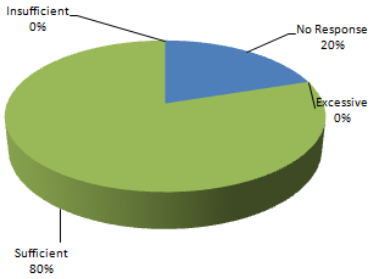
Question 4: How likely is the project team to move technologies into the marketplace?



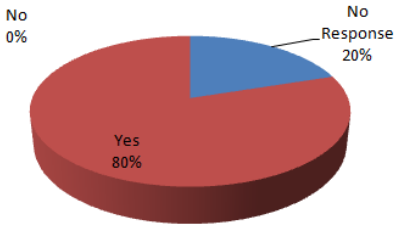
Question 2b: Have the technical barriers been identified and addressed?



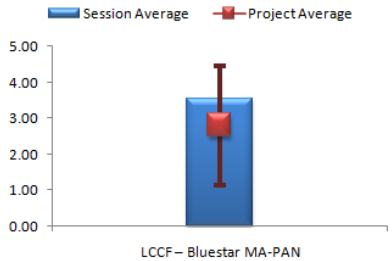
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LCCF – Commercialization of Textile Precursor Company X (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers commented on carbon fibers being lighter and the need to reduce the cost of same. A reviewer comments that textile precursors for LCCF can make light weight LCCF composites cost competitive in meeting petroleum displacement objectives.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer expressed concern that the cost of fiber would not get to the target cost, citing final cost as the biggest target. Another reviewer was disappointed that the current carbon fiber manufacturers have shown no interest in the more cost effective technology, and added that getting current suppliers engaged would help accelerate commercialization and deployment of technologies.

Another reviewer stated that the key technical issues seem have been addressed and / or are under control. The reviewer adds that the real problems seem to be either commercial or cost-related. A different reviewer stated that textile manufacturers are involved as well as carbon fiber manufacturers. The reviewer concludes that deployment for textile precursors looks good.

One reviewer notes that the process has been demonstrated using textile PAN. Working with FISIPE and Bluestar will help commercialization, although this tech transfer will go overseas. "Y" company in the US is unnamed, but the interest shown may mean the commercialization of the technology in the US may be imminent.

A reviewer felt that this project seems to be technology transfer and industrial support as opposed to technical development.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that significant progress has been made, but significant barriers still exist for achieving the cost target. Another reviewer feels that the key issue is Chinese ownership of one of the important partners: this is a concern given the issues of intellectual property protection and ownership. One reviewer states that the project brings the textile grade close to the market. The reviewer adds that the quality of the carbon fibers looks good bringing 50% weight saving within reach.

One reviewer comments that this is a tough project considering the CF market barriers imposed by the demand situation (aerospace drain of commercial CF supply). All things considered, progress was significant. Another reviewer believes that most activity has thus far not been technical development or transfer.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer felt that if the cost target can be achieved, then it would be used by the industry. Another felt that the commercialization of this technology is at least 5+ years away, but that it is encouraging that commercial companies are partnering in the project. One reviewer expressed concern that the major producer will emerge as a Chinese company which will compete with US interests.

One reviewer noted that all the interest shown in the marketplace makes it very likely that the technologies will move there and most probably evolve once commercialized. Another reviewer felt that the cost of carbon fiber composites is still too high for most auto applications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

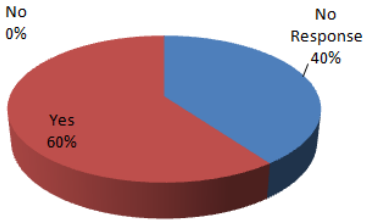
Two reviewers said resources were sufficient. A reviewer stated that the presenters need to show a clear path for how availability of additional funds will accelerate commercialization of this technology. One reviewer stated that the upgrade of the conventional pilot line will require more resources, as has already been determined by outside consultants.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

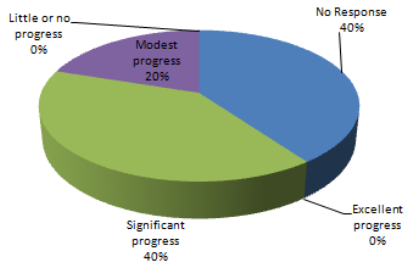
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LCCF – Commercialization of Textile Precursor Company X

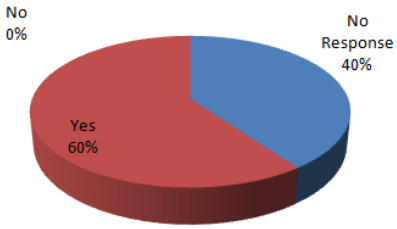
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



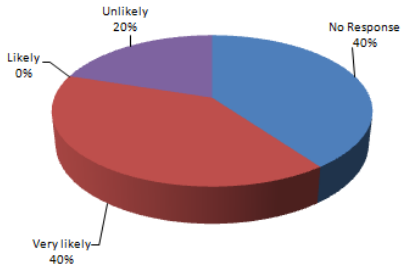
Question 3: Characterize the technical accomplishments and progress toward goals.



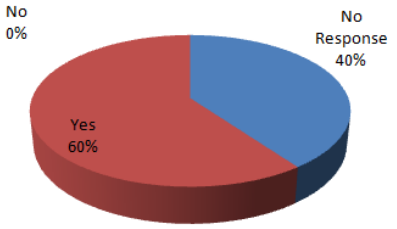
Question 2a: Are the goals of the project technically achievable?



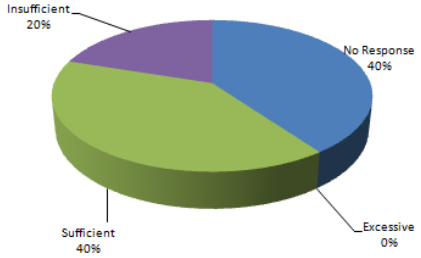
Question 4: How likely is the project team to move technologies into the marketplace?



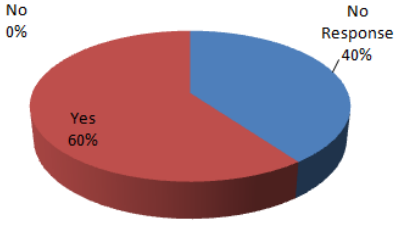
Question 2b: Have the technical barriers been identified and addressed?



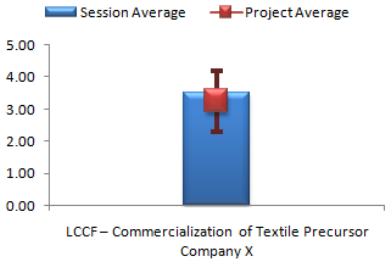
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LCCF – FISIPE VA-PAN Development (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers commented on carbon fibers being lighter and the need to reduce the cost of same. Another reviewer states that the project engages a supplier as potential source of CF for vehicle light weighting.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer expressed concern that the cost of fiber would not get to the target cost, citing final cost as the biggest target. Another reviewer was disappointed that the current carbon fiber manufacturers have shown no interest in the more cost effective technology, and added that getting current suppliers engaged would help accelerate commercialization and deployment of technologies.

Another reviewer stated that the key technical issues seem have been addressed and / or are under control. The reviewer adds that the real problems seem to be either commercial or cost-related. A different reviewer stated that textile manufacturers are involved as well as carbon fiber manufacturers. The reviewer concludes that deployment for textile precursors looks good.

One reviewer noted that FISIPE VA-PAN textile production capabilities and carbon fiber technologies developed by ORNL team have combined resources well in bringing LCCF closer to pilot plant stage.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that significant progress has been made, but significant barriers still exist for achieving the cost target. Another reviewer feels that the key issue is Chinese ownership of one of the important partners: this is a concern given the issues of intellectual property protection and ownership. One reviewer states that the project brings the textile grade close to the market. The reviewer adds that the quality of the carbon fibers looks good bringing 50% weight saving within reach. One reviewer concludes that development of VA-PAN textile precursor is still not complete but on schedule.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer felt that if the cost target can be achieved, then it would be used by the industry. Another felt that the commercialization of this technology is at least 5+ years away, but that it is encouraging that commercial companies are partnering in the project. One reviewer expressed concern that the major producer will emerge as a Chinese company which will compete with US interests.

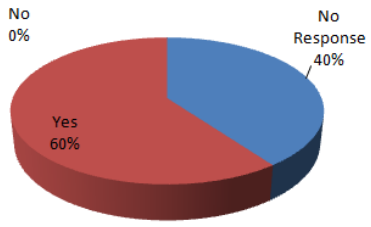
One reviewer felt that a market need was there, and this project seems to satisfy the need for LCCF. Another reviewer noted the good engagement of a supplier. One reviewer believes that even if successful, carbon fiber composites will still be too expensive for most high volume automotive applications. The reviewer adds that textile-based fibers are predicted, by the cost model, to be more expensive than lignin-based fibers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Three reviewers said resources were sufficient, and one added that this was only until further notice from the pilot plant. A reviewer stated that the presenters need to show a clear path as to how availability of additional funds will accelerate commercialization of this technology.

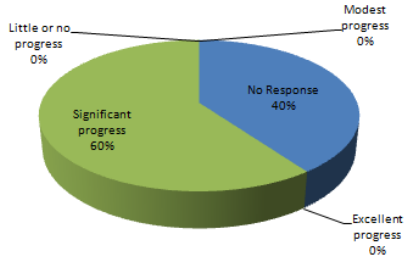
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LCCF – FISIPE VA-PAN Development

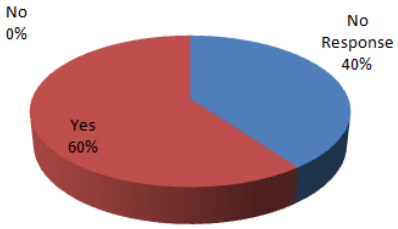
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



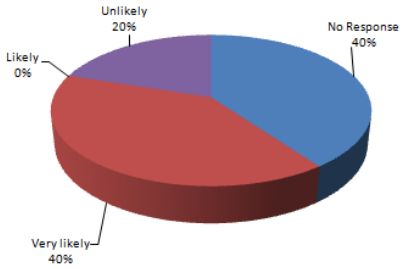
Question 3: Characterize the technical accomplishments and progress toward goals.



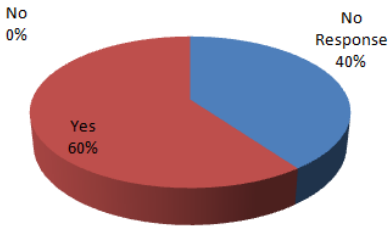
Question 2a: Are the goals of the project technically achievable?



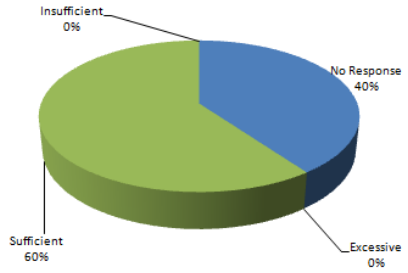
Question 4: How likely is the project team to move technologies into the marketplace?



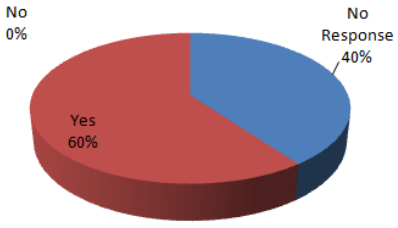
Question 2b: Have the technical barriers been identified and addressed?



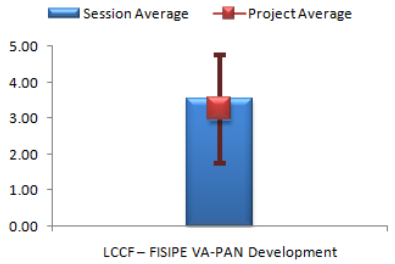
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LCCF – Precursor and Fiber Evaluation (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers commented on carbon fibers being lighter and the need to reduce the cost of the same. One reviewer felt that advanced processing does not seem to be part of the project. A reviewer stated that vehicle mass reduction can increase fuel efficiency, but the initial impact will be negligible. The reviewer believes that automakers will be reluctant to use this without large scale proven technology. The reviewer also feels that body mass reduction impact will be less because the manufacturers would not be using high strength carbon fiber.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer expressed concern that the cost of fiber would not get to the target cost, citing final cost as the biggest target. Another reviewer was disappointed that the current carbon fiber manufacturers have shown no interest in the more cost effective technology, and added that getting current suppliers engaged would help accelerate commercialization and deployment of technologies.

Another reviewer stated that the key technical issues seem have been addressed and / or are under control. The reviewer adds that the real problems seem to be either commercial or cost-related. A different reviewer stated that textile manufacturers are involved as well as carbon fiber manufacturers. The reviewer concludes that deployment for textile precursors looks good.

One reviewer noted that environmental, health and safety issues in a mass production arena, sufficient to supply ~9 million vehicles / year, are not addressed in this project Another reviewer commented that all the different carbon fiber developments at ORNL need to be evaluated and compared, and this project is aimed at doing that.

A reviewer stated that the project is to create and operate a pilot production line for carbon fibers. The reviewer adds that as such it seems to be mainly the creation of the necessary R & D infrastructure. One reviewer felt that standard processes are being used (i.e., goals are not very demanding) and technical barriers will be overcome.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that significant progress has been made, but significant barriers still exist for achieving the cost target. Another reviewer feels that the key issue is Chinese ownership of one of the important partners: this is a concern given the issues of intellectual property protection and ownership. One reviewer states that the project brings the textile grade close to the market. The reviewer adds that the quality of the carbon fibers looks good bringing 50% weight saving within reach.

One reviewer felt that the project goals have been achieved. The reviewer continues that the bar needs to be raised to set the goals even higher. The reviewer says that there is a need to know the failure modes at high-speed high-volume production.

A reviewer felt that the data had been gathered in a timely fashion, but the multipronged LCCF approach probably makes evaluation competitive. Another reviewer noted that the pilot line was built and in operation. One reviewer felt that the accomplishments will depend on the drive of the PI.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer felt that if the cost target can be achieved, then it would be used by the industry. Another felt that the commercialization of this technology is at least 5+ years away, but that it is encouraging that commercial companies are partnering in the project. One reviewer expressed concern that the major producer will emerge as a Chinese company which will compete with US interests.

A reviewer noted that Oak Ridge National Laboratory has a good relationship with textile manufacturers. The reviewer said that it was interesting that many of the companies are foreign. The reviewer believes that moving more manufacturing offshore will further weaken the U.S. economy, and move subsequent intellectual property offshore.

A reviewer notes that low cost carbon fiber has cost as its weakest leg. The reviewer feels that some of the cost targets of the auto industry do not appear reasonable in relation to the costs being projected for each of the LCCF projects. The reviewer adds that precursor cost is critical to the success of marketplace introduction, and this project team is doing a good job in assessing the potential of the various LCCF precursors.

A reviewer comments that there is little direct involvement from the automotive sector. Other sectors show more interest. The industrial partners involved are mainly interested in carbon fiber production. The reviewer believes that it is likely that the material first will be introduced in other sectors like windmills. One reviewer believes that industry should have no problem adopting the proposed technology.

A reviewer hopes that demonstrating the viability of the processes will motivate commercialization. Another reviewer comments that this project is mainly concerned with the creation and operation of a carbon fiber pilot plant. The reviewer continues that even if the overall development of lower cost carbon fibers is successful, the results of the cost model indicate that the costs will not be low enough to ensure that high-volume automotive applications of carbon fiber composites will be cost competitive for many components with other weight reduction technologies/materials.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

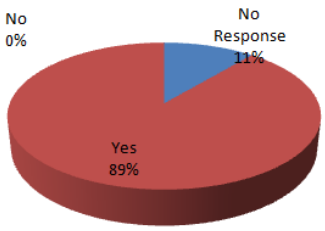
Two reviewers said resources were sufficient. One added that this would change at pilot plant commercialization, at which point more resources would be needed. A reviewer stated that the presenters need to show a clear path for how availability of additional funds will accelerate commercialization of this technology. Another reviewer commented that there was a need for quality control in high-speed, high-volume production.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

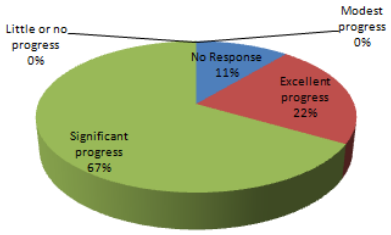
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LCCF – Precursor and Fiber Evaluation

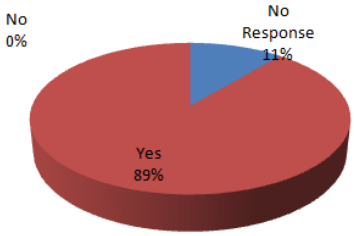
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



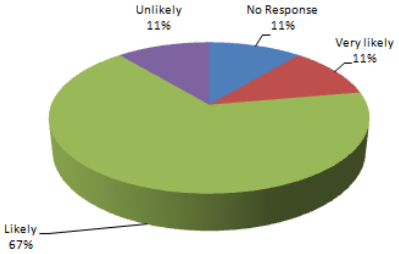
Question 3: Characterize the technical accomplishments and progress toward goals.



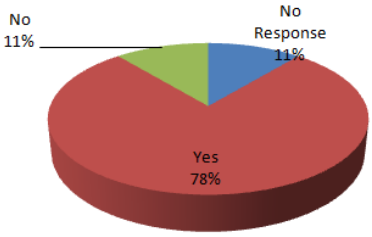
Question 2a: Are the goals of the project technically achievable?



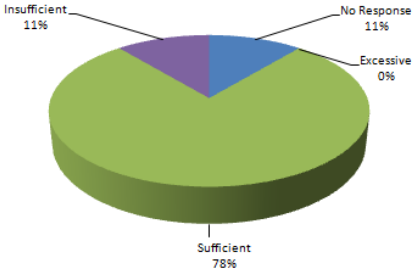
Question 4: How likely is the project team to move technologies into the marketplace?



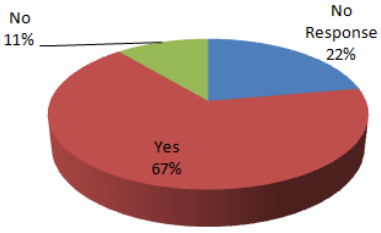
Question 2b: Have the technical barriers been identified and addressed?



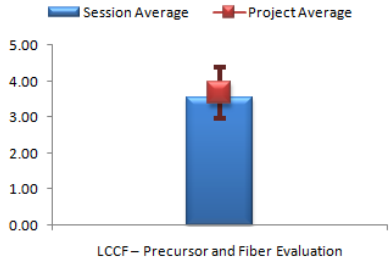
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



LCCF Precursors (David Warren, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that low cost carbon fiber has been a goal to reduce petroleum fuel consumption since the first oil crisis hit the US. The reviewer continues that the project extends beyond transportation to various markets that can also benefit and support petroleum displacement. The reviewer adds that advances made in commercial aircraft use of carbon fiber composites have upset the CF market dynamics (high CF price), thereby making the LCCF effort all the more critical. The reviewer believes the precursor approach from lignin-based (most risky) to low-cost PAN (least risky) covers the gamut of low cost precursor possibilities. A number of reviewers commented on the lower weight of carbon fiber base materials reducing the overall weight of the vehicle and leading to lower petroleum consumption. One of these reviewers added that it was also important that a renewable base material was being used. One reviewer felt that use of these materials would not compromise vehicle structural integrity or safety. A number of reviewers were concerned that the cost needs to be lower to be commercially feasible.

A reviewer felt that the presentation had not provided and insight as to how innovative the purification step is; same remark applies to spinning, especially if sub-micron diameter fibers are considered (filtering).

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Some reviewers expressed concern that the cost of fiber would not get to the target cost, citing final cost as the biggest target. Another reviewer was disappointed that the current carbon fiber manufacturers have shown no interest in the more cost effective technology, and added that getting current suppliers engaged would help accelerate commercialization and deployment of technologies. Another reviewer stated that the key technical issues seem have been addressed and / or are under control. The reviewer adds that the real problems seem to be either commercial or cost-related.

A reviewer noted that the project was hampered by the fact that one of the lignin suppliers withdrew from the project. The reviewer notes that the team found new suppliers for the base material: in this way the technology developed in this project is deployed. Another reviewer commented that the technical strategy is developed, but that there needed to be work with SWL to demonstrate and validate properties as soon as possible.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer states that significant progress has been made, but significant barriers still exist for achieving the cost target. A reviewer comments that low cost fibers will enable weight savings for several automotive components. Another reviewer feels that the key issue is Chinese ownership of one of the important partners: this is a concern given the issues of intellectual property protection and ownership.

One reviewer commented that it was difficult for them to assess the technical accomplishments in detail other than at face value (reading reports, presentations, and Q and A) because of the host of new technologies developed and the difficulties inherent in judging new technologies per se out of

pilot production. The reviewer continues that as far as achieving DOE goals, the technical progress has been significant. The reviewer observes that an "excellent" rating would require commercialization.

One reviewer commented that the team was able to continuously spin (uniform) 12 filament lignin fiber with "excellent" structural characteristics Another reviewer states that most accomplishments reported were mostly with hardwood lignin, but the point was made that it will be necessary to use soft wood lignin (lower cost, hard wood lignin will not be available). It seems that a good amount of the work will have to be repeated, validated and/or adapted for soft wood lignin. The reviewer adds that this soft-wood work seems to trail that of hard wood lignin.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer felt that if the cost target can be achieved, then it would be used by the industry. Another felt that the commercialization of this technology is at least 5+ years away, but that it is encouraging that commercial companies are partnering in the project.

One reviewer comments that the discussion at the presentations indicate that moving the technologies to the marketplace is challenging and hence unpredictable, especially considering the reluctance of current CF suppliers to support commercialization. The reviewer adds that the interest shown by Bluestar and FISIPE is encouraging as is the interest shown by X and Y and other companies. Another reviewer remarked on the industrial partners working with the team on the modification of the pulp process. The reviewer added that this was to ensure that the lignin from this process is suited as a precursor. The reviewer concludes by noting that this is a problem for finding a fiber producing company since the existing carbon fiber producers show little interest.

A reviewer states that the program seems to have a "vision" of what's needed, but the reviewer didn't see actual plans or specific actions to accomplish it. The reviewer adds that Mead Westvaco withdrew, and the reviewer concludes that the project should understand and attack the reasons to understand what's needed for a robust business case

A reviewer notes that the potential for cost reduction (based upon the results of the cost model reported by Dave Warren) is not sufficient to allow carbon fiber composites to enter widespread use in automobiles. The potential supply chain for this material, both for fiber production and component manufacturing, does not currently exist and industrial companies committed to enter the market are not yet identified. A significant number of additional technical developments are necessary in order to make carbon fiber composites feasible and affordable are necessary. The potential for success of all required developments is uncertain and there are several competing lightweight materials further along.

One reviewer notes that efforts should be made to facilitate and strengthen the whole effort. The reviewer adds that the fact that the company from NC stopped working with the group can be understood as a problem, potentially serious.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers said resources were sufficient, while a reviewer stated that the presenters need to show a clear path as to how availability of additional funds will accelerate commercialization of this technology. One reviewer said that considering the risks inherent in not just the commercialization of LCCF but also in getting auto manufacturers to switch current materials and processes over to LCCF,

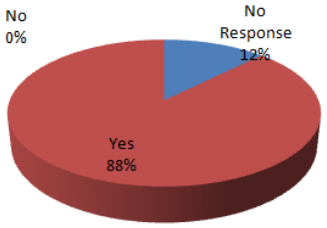
overzealous funding might perhaps be imprudent compared with funding requirements for alternative lightweight materials, i.e., by spreading risk among the lightweight materials portfolio. One reviewer felt that there had been no information given as to assessing whether funding is adequate or not. The reviewer continued that it was necessary to have a better industry approach than that presented to have any chance of becoming a success. The reviewer also felt that it was necessary to consider the environmental aspect of using soft wood on such scale and respond whether this is sustainable.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

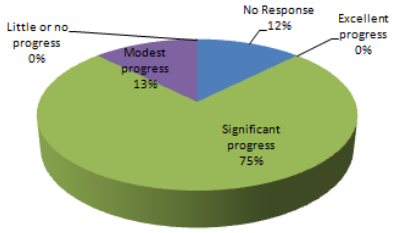
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: LCCF Precursors

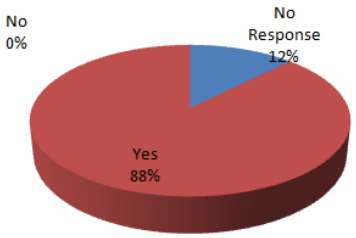
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



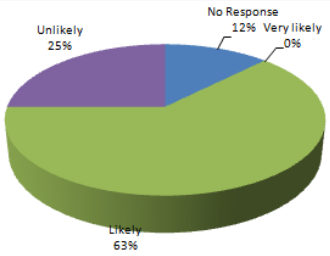
Question 3: Characterize the technical accomplishments and progress toward goals.



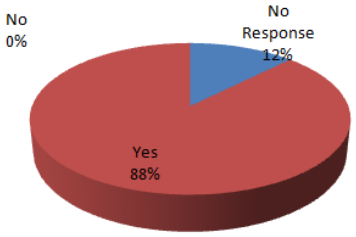
Question 2a: Are the goals of the project technically achievable?



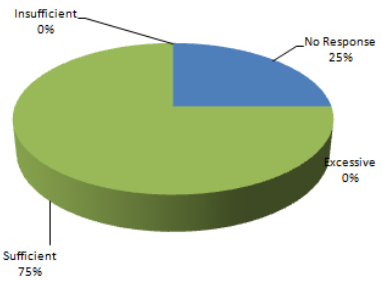
Question 4: How likely is the project team to move technologies into the marketplace?



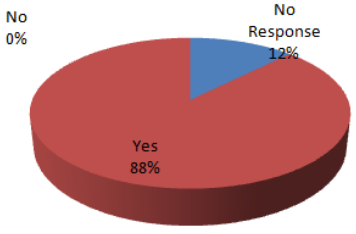
Question 2b: Have the technical barriers been identified and addressed?



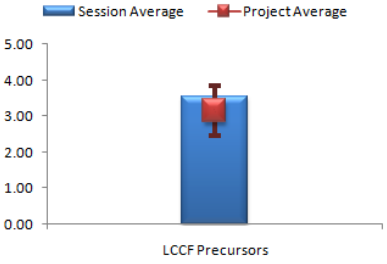
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Lightweight Rear Chassis Structures (Roger Heimbuch, of Auto Steel Partnership)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that total mass savings directly support overall DOE objectives. A number of reviewers commented that higher strength steel means lower weight, which leads to fuel economy. One reviewer commented that mass reduction goal of 25% supports petroleum displacement objectives, another felt that in general yes, but only seeking 25% mass reduction while allowing a cost premium.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that the hybrid design using a variety of HSS and AHSS, similar to the LWFES approach, will likely overcome the technical barrier of achieving 25% mass reduction at minimal cost penalty while allowing for mass compounding. Another reviewer felt that the "bar hasn't been set too high" thus almost assuring success.

One reviewer felt that it was possible to achieve modest weight reduction with high strength steel. However, much greater weight savings are possible through the use of lower density material.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that a modest weight reduction had been demonstrated. Another stated that things have gone well so far, but final assessment awaits final results to come this year.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer stated that the rear chassis project complements the other A/SP chassis projects with much good information generated to allow for smooth tech transfer and moving technologies into the marketplace. Another reviewer commented that the project appears to address items of current interest to partners, who are thus likely to implement lessons learned quickly.

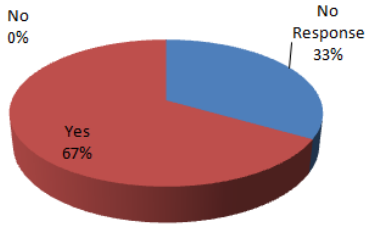
A reviewer was confident that HSS will be used in some chassis structures. It was not clear how this project will contribute. The reviewer adds that it seems that the use of HSS in this type of application will be based upon the design direction adopted by each individual OEM.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Most of the responding reviewers felt that funding was sufficient. Another commented that design studies such as this project may not be the best use of resources for the reasons noted in the above comments.

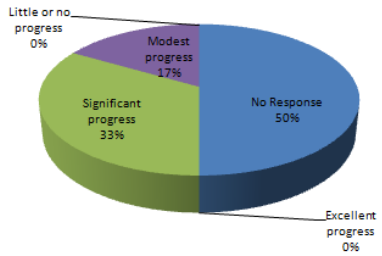
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Lightweight Rear Chassis Structures

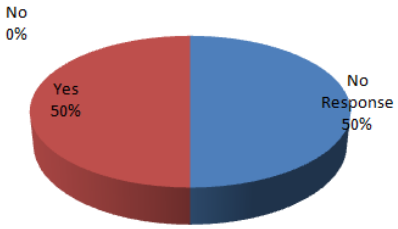
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



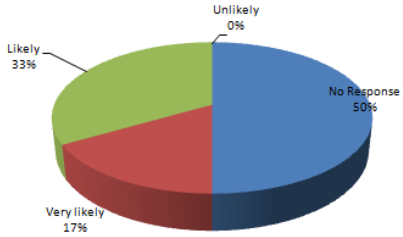
Question 3: Characterize the technical accomplishments and progress toward goals.



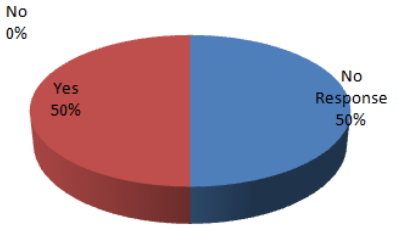
Question 2a: Are the goals of the project technically achievable?



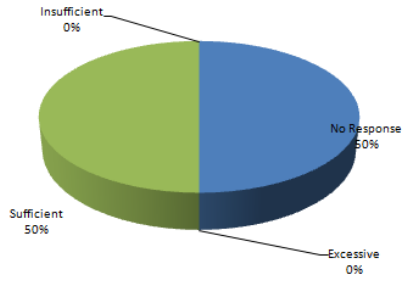
Question 4: How likely is the project team to move technologies into the marketplace?



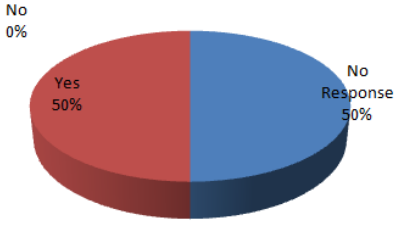
Question 2b: Have the technical barriers been identified and addressed?



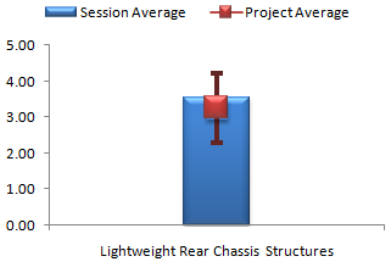
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Low Cost Titanium (Mark Smith, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Most reviewers felt that if low-cost titanium could be achieved, use of titanium parts in power train applications can significantly reduce vehicle mass while increasing durability. One reviewer commented on titanium's unique properties, which the reviewer says are applicable to weight reduction and fuel cells. The reviewer states the main issue is material cost, a view which was seconded by another reviewer.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Many reviewers felt that cost was an insurmountable obstacle, and some added that overcoming that barrier was beyond the scope of the project. One reviewer added that the basic thrust of the project was to study the influence of impurities on performance and cost with a view to relaxing the aerospace specifications for automotive issues: this is the correct approach, but continued that they were unsure that this approach will lower costs enough to enable commercial adoption on a widespread scale. A different reviewer stated that the technical barriers are well defined but have yet to be addressed.

One reviewer said that deployment is done through the consortium. Another reviewer said that it appears to be a reasonable approach to finding the lowest cost method to produce feedstocks and converting to product.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Some reviewers felt that the progress was slow because of the difficulty of obtaining low cost Ti powder of appropriate purity/composition and the difficulties posed by the direct press and sinter route. One of the reviewers continued that if Ti powder is provided as an alloy, it is too hard to consolidate; if provided as pure Ti with a need to alloy, diffusion processes must be optimized.

Another reviewer commented that the work seems to be going along pretty well: good work on a tough set of issues. One reviewer felt that the project has in itself an indirect effect on DOE's goals since it is not directly aimed at a weight reduction. The reviewer continued that it will take away a major barrier for introducing titanium in the automotive market. The reviewer concludes that the weight saving potential is large but for a limited number of components.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented that the challenges to low-cost titanium will require a major scientific breakthrough. The reviewer adds that if achievable, it could create a major paradigm shift in lightweighting both powertrains and chassis members. The reviewer adds that this redo of the technology is complicated by the sourcing of low-cost powder (which is "iffy" yet) and the costs associated with conversion of powder (which probably will require some metalworking step at high cost) into sound and reliable products. The reviewer considered it to be a stretch. A different reviewer said that if the cost of titanium can be achieved within the attempted range that it will be introduced within the automotive industry. A different reviewer gave a timeline of over five years to make this technology viable for production. A reviewer stated that in the past Clevite Gould was successful in

consolidating and making Ti alloy connecting rods and other automotive components via PM routes, apparently without success in the marketplace, due mainly to high cost.

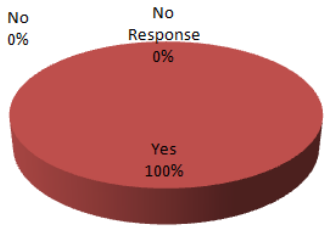
A reviewer commented that there was involvement of a material supplier. Another reviewer felt there was not enough information to be sure, since it all depends on cost/performance trade-offs which are unclear at this time.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Three reviewers found funding to be sufficient. Other reviewers felt that a need for a scientific breakthrough will probably require greater resource commitment. One reviewer saw this as a long-term research and development project. The reviewer saw a need for continued effort to bring the cost down and felt that DOE should consider funding research with titanium producers to develop improved processes for reducing the production cost. One reviewer felt that it would be worthwhile (in fact desirable) to add a component demonstration to the work. This would likely require increased funds.

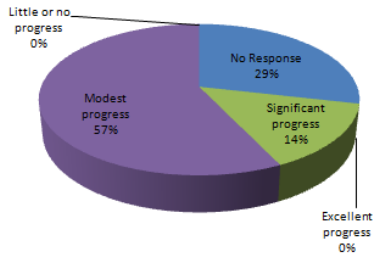
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Low Cost Titanium

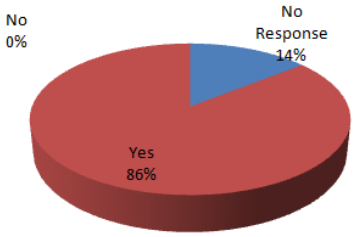
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



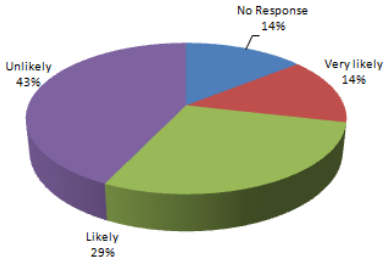
Question 3: Characterize the technical accomplishments and progress toward goals.



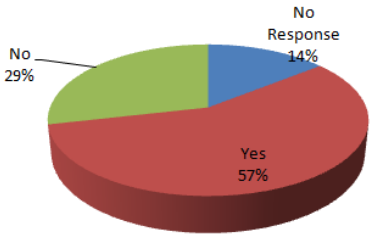
Question 2a: Are the goals of the project technically achievable?



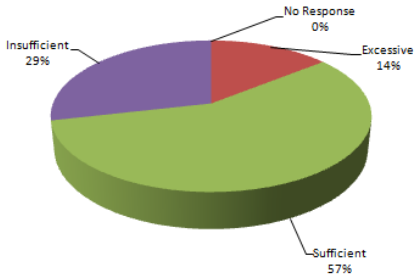
Question 4: How likely is the project team to move technologies into the marketplace?



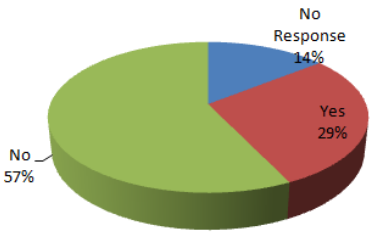
Question 2b: Have the technical barriers been identified and addressed?



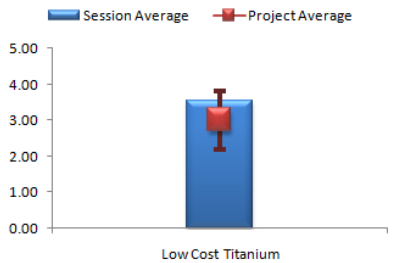
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Magnesium Front-End Design and Demonstration (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer comments that in addition to weight reduction, light weighting is also an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles. The reviewer adds that that the project is well-structured and flows seamlessly into similar projects. The reviewer adds that this is an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles.

A number of reviewers noted that weight savings are the goal, and that this will lead to improved fuel consumption. One reviewer notes that there is also substantial commercial currency as the metals industry of China is surging ahead and if the North American industry does not keep up it could wither.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer states that a major technical barrier is oxidation in both castings and sheet magnesium. The reviewer continues that the barrier is well recognized and characterized, the first step in overcoming the barrier. The reviewer adds that Mg castings are already in use and Mg sheet forming has been determined to be technically feasible. The reviewer gives the example of the Chevy Corvette engine cradle as a proven deployment. The reviewer concludes that the project is well aligned to support the other projects through a life-cycle approach from basic research to deployment.

One reviewer states that the design objectives have been met so far. A different reviewer states that there is a good spread over academia and there is a link with AMD 604 deploying the technology even outside the US.

One reviewer noted that this is a very complex, comprehensive project that goes a long way to developing solutions to the key issues. The reviewer ponders whether they can all be solved with current or near-term technology AT A FEASIBLE COST, which they reviewer says is not clear, but that is the nature of research. A different reviewer states that design seldom cannot be done ... it may not lead to anything though.

A reviewer states that Mg is a poor candidate for application in a crash-critical application such as the front end of a vehicle. The list of challenges which must all be overcome is long and it is unlikely that this will be accomplished. There is insufficient data showing that Mg will present advantages compared to other light weight alternatives in terms of feasibility, weight savings and cost. Moreover, the specific design concept selected presents a number of serious issues. There are many more promising applications of Mg to which resources could be redirected.

One reviewer notes that project goals and technical barriers are well understood and defined. The reviewer highlights the excellent international cooperative program involving US, Canada and China.

One reviewer feels that crash energy management and corrosion, as well as the cost issues and manufacturing pollution concerns are key barriers and so there are still big problems to be addressed.

The work is important, the progress is good and the outcomes are vital for the NAM auto sector but we're not there yet.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer noted that General Motors has deployed magnesium casting in the Chevy Corvette.

One reviewer comments on the exemplary Mg body on frame substructure that is unique and appears to meet all objectives of the project except for cost. Another reviewer states that the project is crucial work and very impressive progress at this early stage. The reviewer adds that 46% weight reduction is very close to the target of 50% and so things appear to be going well, given that it is still early days on this. A different reviewer adds that magnesium is used in this project as a casting. The reviewer adds that as a cast material Mg is already nowadays competitive with aluminum on a cost basis.

Major concerns are crash energy, corrosion and the trade-offs between the Pidgeon and electrolytic processes and the attendant concerns over pollution, etc. The reviewer continues that this is a politically sensitive issue as well as a major scientific concern and so there is a lot of work to be done here.

One reviewer felt that the project's technical challenges are well defined and understood. The reviewer adds that a cost effective solution may not yet be within the reach.

A reviewer states that the project started in late 2006 and the first design is expected in December 2008. The reviewer concludes that two years for this first step is very slow progress. One reviewer notes that with all magnesium parts, joining will remain a difficult task, including safety issues in case of a crash.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer notes that as Ford already has already adopted the Mg radiator support in the production of light truck front ends, lessons learned from this project should proliferate. The reviewer concludes that cost and Mg supply issues must be overcome before the technologies will easily move toward the marketplace.

A different reviewer states that the consortium is suited for bringing the project to the market. The reviewer continues that the only risk is the price of Mg. The reviewer adds that perhaps more exact the perception of the price development by the purchase departments of the OEM's.

One reviewer says that the team is doing an excellent job. However, considering the technical and cost barriers, it is unlikely that the technology will become cost effective and viable for industrial use. Another reviewer says that they are not confident that all of the technologies will be commercialized in short order - but this reviewer was certain that some will be and these all represent major opportunities for NAM industry.

One reviewer is certain that vehicle designers and manufacturing engineers will not be very positive about separately manufacturing a front end structure and assembling it onto the rest of the vehicle as opposed to making the entire body structure of one material. If large weight reduction is desired, it seems much more likely that an aluminum structure would be selected. For more modest weight reduction, high strength steel will be selected. Both of these alternatives have been developed to the point of implementation readiness.

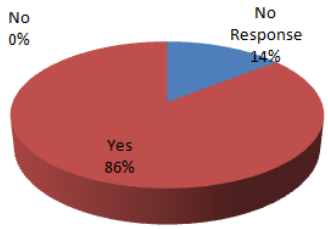
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A pair of reviewers felt that funding was sufficient; however, one of those reviewers was unsure that the project made good strategic sense. A reviewer felt that funding was sufficient, but more funding should be made available if needed. One reviewer noted the good team, effort and resources.

One reviewer noted that this was a good long-range cooperative international research program. US, Canada and China are contributing funds. DOE is leveraging resources effectively.

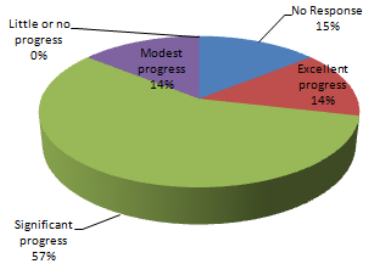
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Magnesium Front-End Design and Demonstration

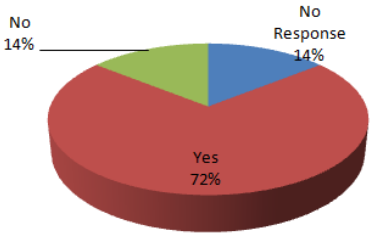
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



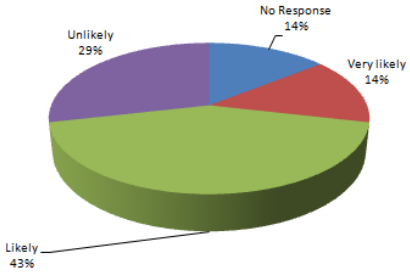
Question 3: Characterize the technical accomplishments and progress toward goals.



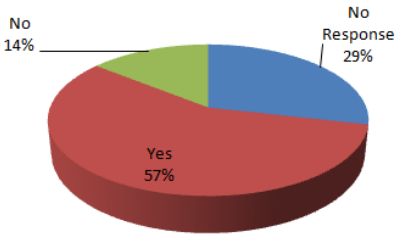
Question 2a: Are the goals of the project technically achievable?



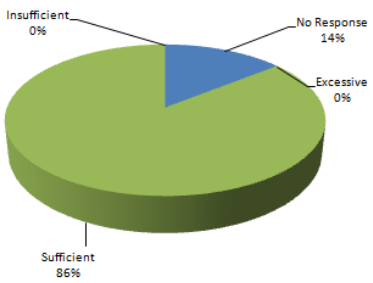
Question 4: How likely is the project team to move technologies into the marketplace?



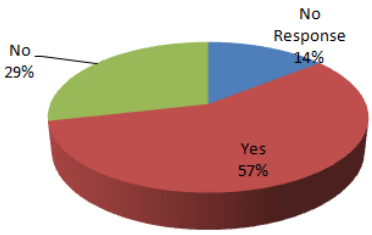
Question 2b: Have the technical barriers been identified and addressed?



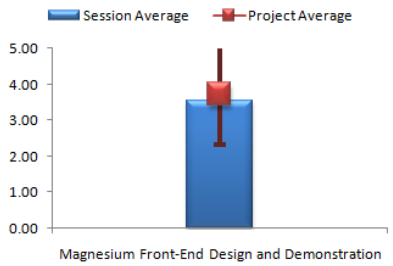
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Magnesium Front-End R&D (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer comments that in addition to weight reduction, light weighting is also an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles. The reviewer adds that that the project is well-structured and flows seamlessly into similar projects. The reviewer adds that this is an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles. Reviewers focused on lower weight meaning less fuel consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer states that a major technical barrier is oxidation in both castings and sheet magnesium. The reviewer continues that the barrier is well recognized and characterized, the first step in overcoming the barrier. The reviewer adds that Mg castings are already in use and Mg sheet forming has been determined to be technically feasible. The reviewer gives the example of the Chevy Corvette engine cradle as a proven deployment. The reviewer concludes that the project is well aligned to support the other projects through a life-cycle approach from basic research to deployment. One reviewer found that this was a well-structured project, even if it is a three-country endeavor.

One reviewer said the goals could be achieved in his optimistic view, assuming all the current Mg supply problems will be resolved at the end of this project and that this qualified project team can overcome the language, cultural, and political barriers of international cooperation, and the strategy is appropriate and likely to succeed in overcoming the technical barriers. Another reviewer commented on the good international cooperation and the close link to AMD 603.

A reviewer noted that this program is very challenging in introducing magnesium in a critical structural application. The reviewer continues that all the barriers have been identified and well organized. The reviewer adds that the deployment strategy is very good. Work with three countries is the best way to leverage the resources and also the technical expertise. The reviewer concludes that this type of collaboration is essential to solve the technical barriers with smaller resources and within shorter time frame.

One reviewer felt a lot of uncertainty, and the answer choices in the question are not really able to convey the uncertainty.

Another reviewer states that magnesium is a poor candidate for application in a crash-critical application such as the front end of a vehicle. The list of challenges which must all be overcome is long and it is unlikely that this will be accomplished. There is insufficient data showing that Mg will present advantages compared to other light weight alternatives in terms of feasibility, weight savings and cost. Moreover, the specific design concept selected presents a number of serious issues. There are many more promising applications of Mg to which resources could be redirected. Tasks addressing individual technology developments of Mg contained in this project are potentially worthwhile to enable other more promising applications of Mg elsewhere in the vehicle.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer noted that General Motors has deployed magnesium casting in the Chevy Corvette.

A reviewer commented that the interplay between AMD 603 and this project shows significant progress, although the firewall between AMD 603 (proprietary) and AMD604 (international cooperation on MFERD) may cause conflict at times. The organization of the international team of Mg researchers and task assignments is commendable. As mentioned before in reviewing AMD 602, the difficulties of forming Mg sheet are so great compared with casting and thixomolding Mg alloys, that the use of Mg sheet in the MFERD prototype will probably be minimal or nil compared with cast or thixomolded components.

Another reviewer said that AMD 604 will supply enabling technologies for AMD 603. The reviewer adds that although indirect the project has a strong relation with the achievements in 603.

One reviewer commented that the initial plan has been accomplished; however significant barriers still have to be solved. The team is comprised of well-qualified people and also the suppliers are involved. One reviewer felt that the project is in early phase. The reviewer adds that the technical development work is worthwhile for other applications of Mg. The reviewer also states that the work on the front end itself is at best premature.

A reviewer expressed concern that progress would be slower than expected due to a large number of participants.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer says that lessons learned will be useful and adopted by the Big Three. The reviewer continues that the Ford radiator support is a big achievement in proving the use of Mg in the front end of a production vehicle.

One reviewer stated that since some qualified suppliers are involved in this program, if successful the technology will be undertaken by the suppliers. Another reviewer said that the know-how developed will certainly flow to the market.

Another reviewer believed that other light weight alternatives are both better and more developed. It is unlikely that vehicle designers will select this in preference to aluminum (high weight savings at some cost penalty) or high strength steel (lower weight reduction but low cost penalty) body structures.

One reviewer felt that bonding issues needed to be mastered first.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt that apparently, there are limits on funding to outside agencies for several key project segments: crashworthiness, joining, corrosion, large casting development, etc.

Two reviewers commented that there are sufficient resources. One reviewer did not think there was enough information to be sure.

A reviewer said that their response of "sufficient" refers to the technical developments, which are worthwhile. The reviewer suggests redirecting the project to concentrate on Mg technical developments to enable other vehicle applications of Mg rather than the entire front end. The

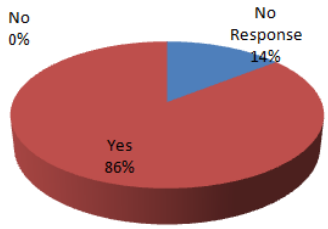
reviewer says that these are much more likely to be implemented. The reviewer concludes that it is not clear that the added technical value of working with the Chinese is worth the trip.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

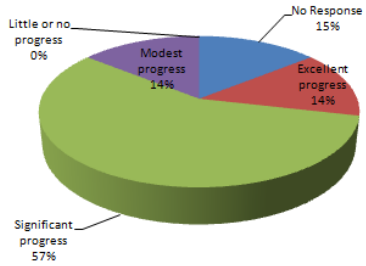
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Magnesium Front-End R&D

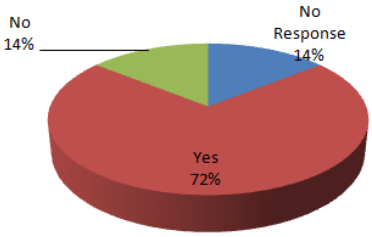
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



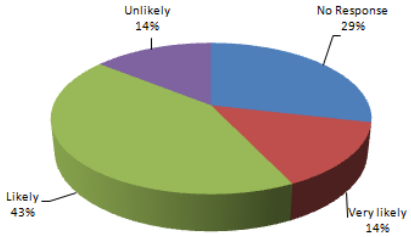
Question 3: Characterize the technical accomplishments and progress toward goals.



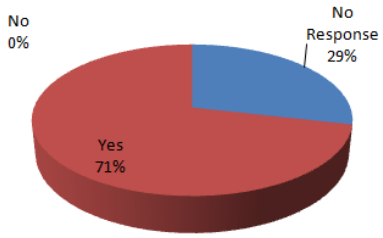
Question 2a: Are the goals of the project technically achievable?



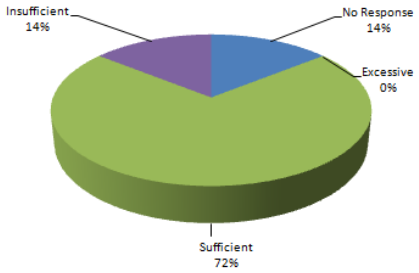
Question 4: How likely is the project team to move technologies into the marketplace?



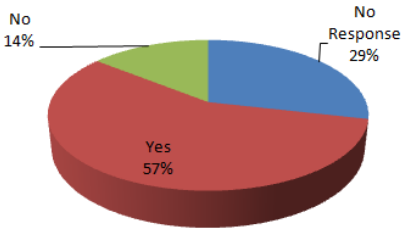
Question 2b: Have the technical barriers been identified and addressed?



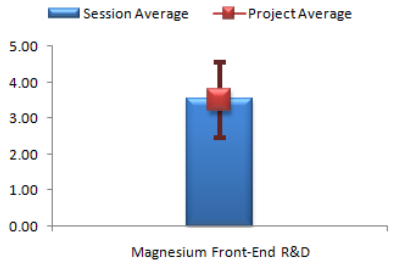
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Magnesium Powertrain Cast Components (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Most reviewers spoke of the weight reduction, and the subsequent improvement in fuel economy. One reviewer added that the application of Mg in powertrains is a breakthrough technology

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Some reviewers commented that as challenging as the technical barriers have been on this program, the work has demonstrated that they will be overcome. One reviewer felt that the group has the right people involved and it seems like a good plan. The reviewer added that the level of technology required to do this (gating system + cast-in iron bearing caps + the thermal spray cylinder bores) are substantial barriers with high costs. One reviewer felt that the project was likely to succeed given sufficient industry drive after the end of DOE funding.

A reviewer predicted wide deployment due to the large group of suppliers' institutes and OEM's working together. One reviewer felt that the goal of 15% weight reduction over aluminum is technically achievable. The reviewer suggested considering stretching the weight reduction goal to 25%.

One reviewer felt that the project is addressing most of the technical barriers. The reviewer adds that there are still commercial and practical issues, which may be outside the scope of the project, e.g. a unique coolant is required for an Mg engine; the reviewer wondered what the feasibility of introducing this into the marketplace was.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A number of reviewers stated that the program has met or exceeded goals and is ready for technology transfer to industry. One reviewer continued that the team consists of cross functional stakeholders which are probably one reason for its success.

One reviewer stated that considering the challenges, significant progress has been made. Another reviewer stated that the technical risks are not negligible and may be responsible for goals not advancing as quickly as they should. It may also be that the drive of the industry is not at the level where it should be.

One reviewer noted that the accomplishment of a workable V6 gasoline engine made of new high-temperature Mg alloys is to be applauded. The reviewer adds that this progress matches and exceeds the work being done in Europe on Mg powertrain development. One reviewer feels that there are not many alternatives for light weight powertrain components. Mg may be the best one to replace aluminum.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that this was an excellent technical program. The reviewer continued that the material is technically ready for transformation into the marketplace. The reviewer adds the issue that needs further investigation is the cost-effectiveness of the material. One reviewer noted the great technical development but added that this was only the first step on a long road.

One reviewer noted that all that could be done to introduce this technology to the market is done. The reviewer continues that a full-scale engine test with this type of experimental engine is a very strong selling point. The reviewer sees the biggest challenge being the long term availability of low cost magnesium. One reviewer stated that due to the recent problems in Mg pricing, trade barriers, and availability, there are constraints on moving the technologies into the marketplace in the near term. The reviewer continued that once pricing of Mg is stabilized, the introduction of the technologies in production will be easier. The reviewer concludes that the indirect impact of the project on the competitive materials (Al alloys and cast irons) is not clear right now. A reviewer noted that the implementation of Mg powertrain components, particularly an engine block, will be difficult.

A reviewer commented that the lightweighting opportunities offered by this technology are too great to ignore and the technology is tough, but achievable. Another reviewer notes that some of the process developments have been utilized by the industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

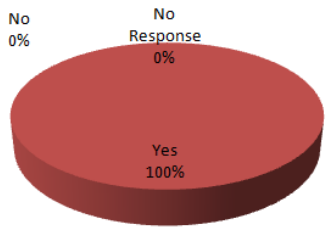
Most reviewers found the funding and resources are adequate. One felt that the program should be ready to inject funds if needed. Another reviewer commented on the enormous amount of work done when compared to the funding. The resources were sufficient to achieve the milestone as planned.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

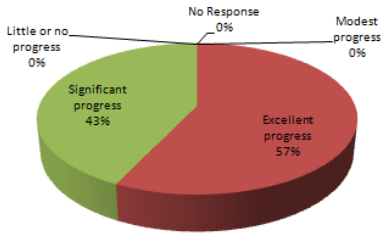
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Magnesium Powertrain Cast Components

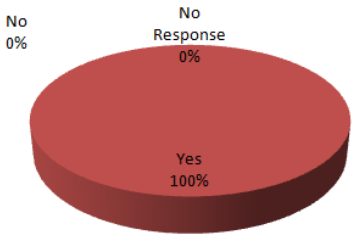
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



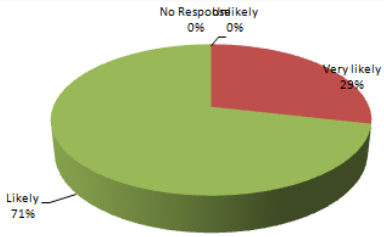
Question 3: Characterize the technical accomplishments and progress toward goals.



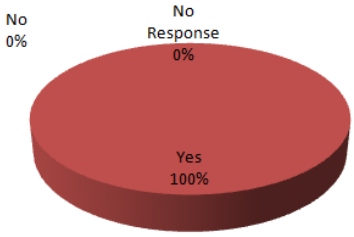
Question 2a: Are the goals of the project technically achievable?



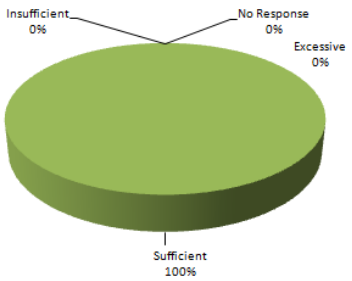
Question 4: How likely is the project team to move technologies into the marketplace?



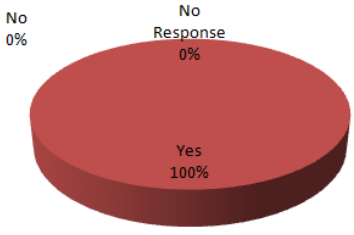
Question 2b: Have the technical barriers been identified and addressed?



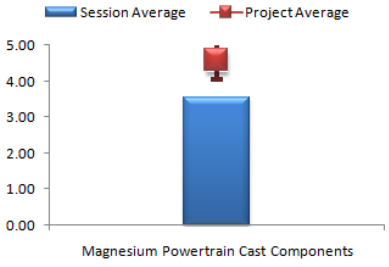
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Magnesium Research and Technology Development (Mark Smith, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many reviewers noted that magnesium was an important way to reduce vehicle weight. One reviewer felt that magnesium research and development coordination is critical due to the need for merging Chinese, Canadian, and US efforts on the MFERD project. Another reviewer saw this as a supportive project in relation to the other magnesium projects, the project is very useful in duplicating already available know-how.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that this is basically a reporting project with the added difficulty of working with scientists and engineers across borders and some with a language barrier. The reviewer adds that however, the lack of US Mg production and bricks and mortar R&D facilities, especially compared with China, may make it unlikely that the technical barriers will be overcome. The reviewer suggests considering what has happened recently in the automotive Mg supply chain with the price increase. The reviewer concludes that the project has no control other than recommendations over market forces.

A reviewer notes that many of the technologies are feasible while others are much more problematic and less likely to be used. The reviewer says that the answers to the yes/no questions cannot be filled in because they don't address this uncertainty.

Two reviewers saw the purpose of the project as getting information and know how distributed. One reviewer saw the project as a program management and tracking effort, and as such, it does not actually address technical barriers per se.

One reviewer felt that the program probably requires a higher level of funding to coordinate international collaboration, maintain information security, and concurrently build a comprehensive knowledge base to support all partners in other magnesium projects.

One reviewer said that it appears to be a give away to PNNL, and should be handled by DOE proper.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer stated that the aim of the project is management and technology transfer, not overcoming barriers, and the project has accomplished its tasks. One reviewer says it is not easy to be categorical about all of this because it isn't just one technology. Having said that, the work is progressing well and progress is being made and it warrants continued support. A different reviewer states that the project addresses many facets of activity successfully.

A reviewer states that, when compared with some of the progress made in Europe and China on automotive Mg, the rate of progress in the US lags. The reviewer adds that it appears that China will emerge as the main supplier of not only primary Mg but also structural Mg components (cast and

wrought), once the market stabilizes. The reviewer questions the tech transfer potential of this project to the Big Three, with China holding all the cards R&D-wise and manufacturing-wise.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer says that this is an information support project necessary to feed other projects. The reviewer adds that the knowledge base is essential for a suite of other magnesium projects. Another reviewer adds that some of the activities will assist in implementation of Mg. However, the reviewer adds, the likelihood that this will include a Mg front end is questionable.

A reviewer comments that Lunt (a major US Mg die caster) has gone bankrupt recently. The reviewer adds that Hydro has shuttered its Canadian Mg plant and put it on auction, and the IMA (International Magnesium Association) position is quite negative about any significant growth in the automotive Mg market in the near term. Where do we go from here, asked this reviewer. As some Mg proponents within the industry have stated, Al is our fallback position. Mg has been targeting Al all along in this market, so it is only natural that Al benefits from the recent Mg price rise.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt there were sufficient resources. Another reviewer felt that continued effort and resources are needed to develop and create a central data and knowledge base for magnesium. One reviewer felt that this should be handled by DOE proper.

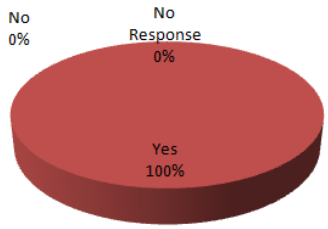
A reviewer commented that there were limited resources to coalesce international collaboration while building a consolidated knowledge base. Another reviewer felt there should be more resources and the project should be accelerated.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

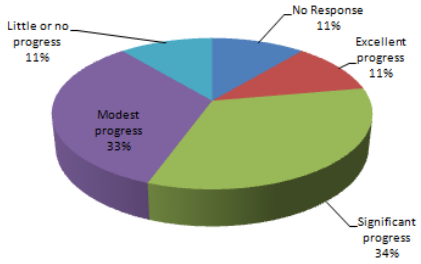
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Magnesium Research and Technology Development

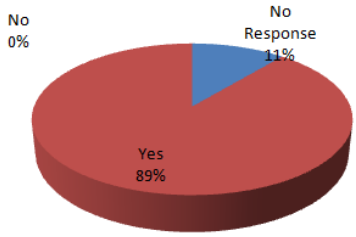
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



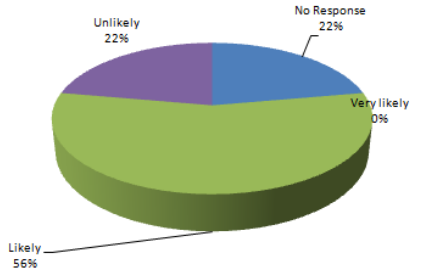
Question 3: Characterize the technical accomplishments and progress toward goals.



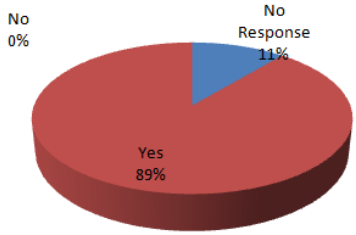
Question 2a: Are the goals of the project technically achievable?



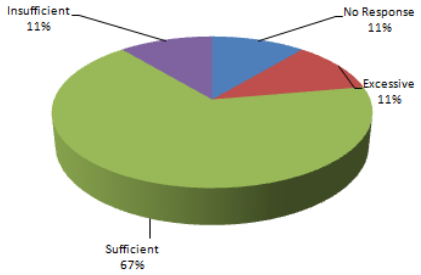
Question 4: How likely is the project team to move technologies into the marketplace?



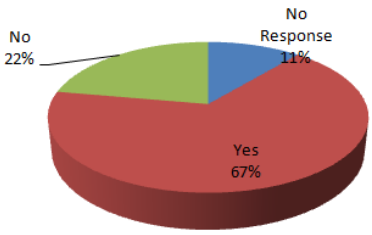
Question 2b: Have the technical barriers been identified and addressed?



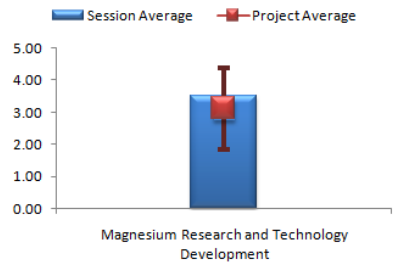
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Multi-Material Vehicle (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many reviewers commented that multi-material vehicle solutions appear most likely to succeed in terms of petroleum displacement potential. One reviewer felt that the potential of reaching 50% weight reduction was great. One reviewer felt the projects would determine the possibility and cost of 50% weight reduction, and the necessary technologies and that is important.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that MMV may be obtainable in the long run, but that in the short run it was not practical. The reviewer added that a lot of work is needed to see how these MMV's will behave in crashes. The reviewer concludes that the car industry is a mature industry, so it is unlikely that radical changes will take place abruptly. One reviewer felt that the deployment strategy is well defined, but significant work has to be done, especially joining, forming and corrosion issues.

A reviewer felt that the magnesium front end, composite underbody and steel passenger compartment concepts were unlikely and there is no evidence that these selections are the optimum ones for each application. The reviewers add that it does not seem that the goal of 50% body weight reduction will be achieved with these selections.

Another reviewer felt that it is too iffy at this stage of project; too much depends on how and when future plans are implemented. One reviewer felt that the goals of the project are too broad. A few key technical barriers need to be identified and specific plans developed to address them. One reviewer commented that the project doesn't really seem to have a deployable technology. It seems to be more of a study on what the future car will be made of rather than work on any particular technology, so it is difficult to comment on a specific deployment strategy or the feasibility of the whole effort.

One reviewer believed that while the challenges are complex, they are not insurmountable with the intensity of resource commitment commensurate with the challenges. A different reviewer commented on the large group of suppliers, institutes and universities to be involved.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Two reviewers felt that it was too early for significant results. One of the two reviewers went on to state that reconsideration of material selections at an early date would be highly beneficial and it is a serious weakness of the project that this sort of activity does not seem to be included in the plan at this point.

One reviewer commented that as challenges are identified and researched, new challenges emerge. The reviewer continued that a fresh look at vehicle architectures that can accommodate future alternative energy powertrains is required. The reviewer concludes that the project is too new to demonstrate significant progress relative to the complexity. A reviewer stated that progress would be slow.

A reviewer commented that significant progress had been made, so far, but much work needs to be done. One reviewer felt that the project is in its initial phase, but the outlook is positive. The reviewer continues that one of the issues that will play a role for accepting the multi-material vehicle will be the recyclability. The reviewer concludes that this must be addressed in this project. 30% more fuel efficient will also have an appeal in Europe.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A number of reviewers felt that if successful the MMV project would lead to technology transfer. One reviewer felt that this would occur with time.

One reviewer stated that it is unlikely that any OEM will adopt this particular vehicle concept for production. The reviewer adds that some of the components, e.g. the Mg front end, may not actually be feasible. The reviewer concludes that it is likely that OEMs may implement particular technologies which may be developed in the course of this project.

Another reviewer commented that no single material offers all the characteristics and functionality necessary to achieve maximum mass reduction while maintaining cost parity and FreedomCAR goals. The reviewer continues that an integrated combinatorial approach will most likely emerge as the optimum solution.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer commented that MMV is an interesting concept and should be continued but it remains to be seen how effective it can be. Another reviewer stated that so far, funding is iffy and so is predicting how the project will evolve in the future. Another reviewer simply said they were unsure.

One reviewer said that the funding level is insignificant as compared to the challenge. The reviewer continues that the low level of funding forces the project team to "cherry pick" a limited set of configurations based on the results of other projects which may not optimize the integrated design. The reviewer concludes that the resources should be increased to enable a total systems approach. A different reviewer stated that in order to complete the work in a timely manner, this project should be sufficiently funded.

One reviewer stated that the subject matter is too broad for the level of resources assigned ($166K). The reviewer continues that this project will need significant additional resources to address broad range of issues anticipated in using multi-materials. The reviewer suggests that alternatively, it may be more effective to assign additional resources to the teams in three "seed projects" and increase their scope to develop a full solution including integration of their specific light weight material with other light weight materials. A different reviewer commented that for the demonstration part extra budget will be needed, but this will be a separate request.

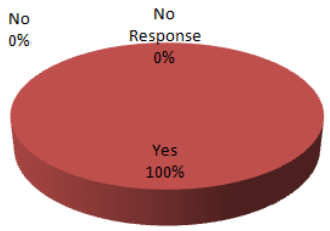
A reviewer felt that it is questionable whether the types of design exercises included in this project are appropriate for a collaborative precompetitive project. The reviewer concludes that the execution of this sort of project would be much better, with more robust results, if done by a single OEM.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

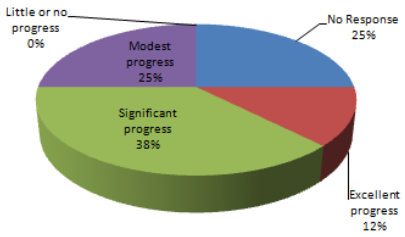
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Multi-Material Vehicle

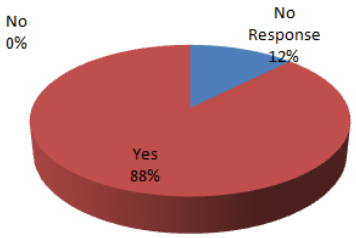
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



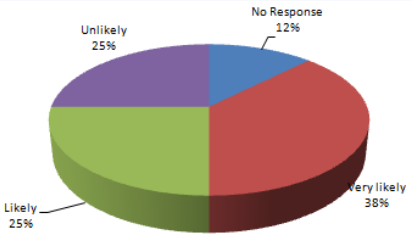
Question 3: Characterize the technical accomplishments and progress toward goals.



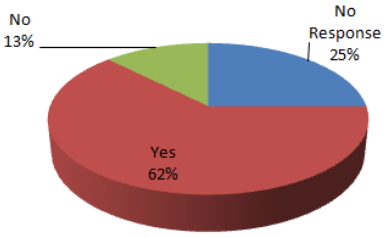
Question 2a: Are the goals of the project technically achievable?



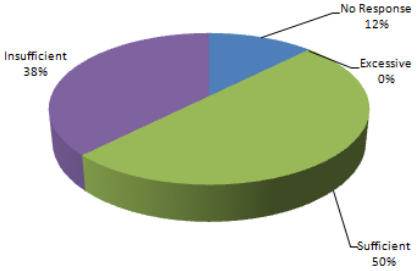
Question 4: How likely is the project team to move technologies into the marketplace?



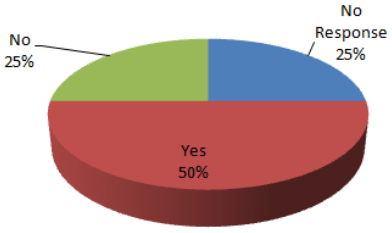
Question 2b: Have the technical barriers been identified and addressed?



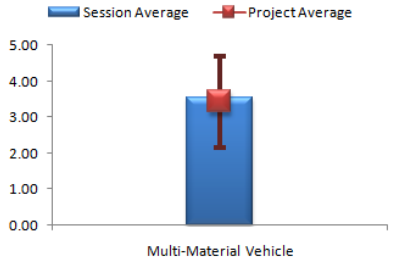
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Natural Fiber Composite Retting, Preform Manufacturing, and Molding (Mark Smith, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer noted that the project was environmentally friendly, using natural fibers and offering a lightweight material option. Other reviewers commented on the weight reduction aspect. One reviewer said that this was a very promising technology that has already been deployed in Europe and is working its way into use in NAM. Another reviewer stated that good participation from OEMs will assure relevance.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer says that the deployment strategy was well defined, adding that deliverables and milestones were identified. Another reviewer noted that the strategy of studying conventional technology of natural fiber production and applications and addressing process bottlenecks and inefficiencies is sound and has shown progress.

A reviewer notes that natural fibers can't compete with carbon fiber. The reviewer adds that agricultural/field retting techniques are in early stages of maturity. The reviewer says that this project has a lot of reach.

A reviewer feels that the exploration on a new type of affordable material with good potential for weight saving application is worthwhile. Another reviewer refers to this as a well structured project.

A reviewer comments that the whole of the polymer composite program is presented as a integrated approach in close cooperation with the OEMs. The reviewer believes that the technology will be shared throughout the industry.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A number of reviewers noted that limited progress had been made, but felt this understandable due to the project's early stage and complication of the range of natural fibers. One commented that there was a good strategy; another reviewer stated that a small amount of weight savings was to be expected.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer comments that natural fiber reinforcement for composites has drawn much attention in Europe in the past few years, as the researchers have noted, and any improvements in process and quality of natural fibers should find a ready market.

Most reviewers felt there would be industry adoption if the project proved successful and there was an industry need. One reviewer noted that there was no current consideration of bio-based manufacturing in the U.S. based auto industry at this time. One reviewer felt that the suppliers were engaged.

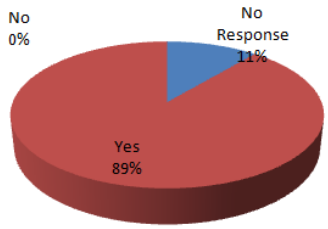
Another reviewer felt that natural fibers face serious difficulties in the making, so market penetration would be difficult in comparison to the more traditional materials. The reviewer suggests that one possible application will be in green PR for automotive manufacturer.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Most reviewers found funding to be sufficient. A reviewer notes that there has been good progress has been made at the level of funding that has been already allotted to the project, and the reviewer expects that the milestones will be achieved in a timely fashion.

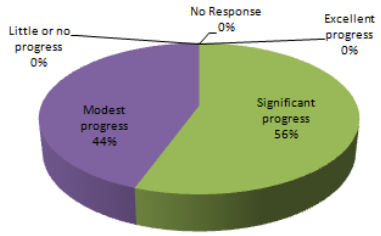
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Natural Fiber Composite Retting, Preform Manufacturing, and Molding

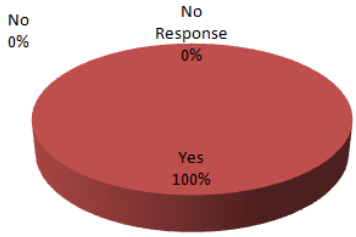
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



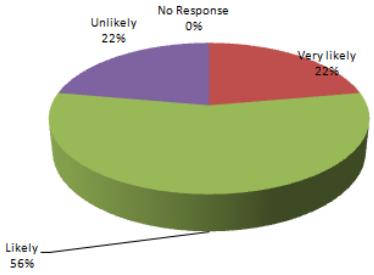
Question 3: Characterize the technical accomplishments and progress toward goals.



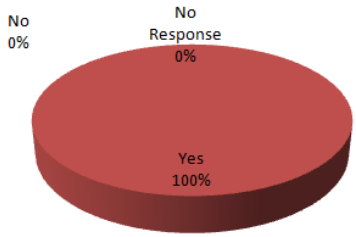
Question 2a: Are the goals of the project technically achievable?



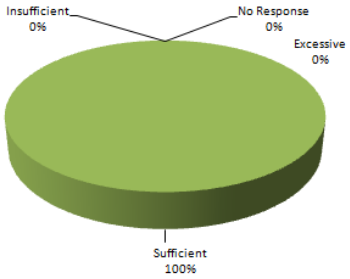
Question 4: How likely is the project team to move technologies into the marketplace?



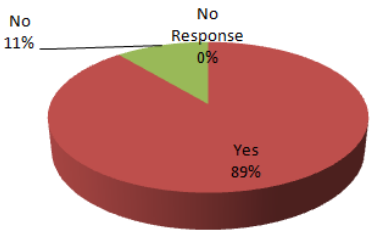
Question 2b: Have the technical barriers been identified and addressed?



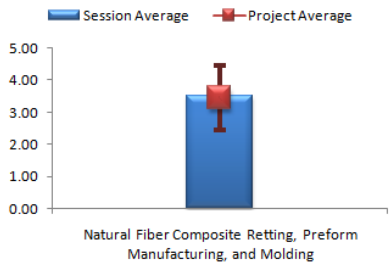
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NDE Inspection of Adhesive bonds in Metal-Metal Joints (Cam Dasch, of General Motors Corporation)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers felt that joining of dissimilar materials is necessary to maximize weight reduction in vehicles. One reviewer answered yes, it supports objectives, but somewhat indirectly. The reviewer notes that as structures are optimized and become lighter, they will be made of more critical materials using more complex processes. There will be less redundancy or "fat" in the vehicle and so the contribution of each component and each joint to the overall structure will be much more critical than it is now. The reviewer concluded that so, in this commenter's view this work is very worthwhile and a key enabler of many of the other projects on new materials.

Another reviewer commented that this work is enabling non-destructive technology to accelerate the use of light weight materials in the transportation industry. A different reviewer felt that weight reduction will lead to higher utilization of material properties leaving less room for flaws, stating that as such this fits in the DOE objective for petroleum displacement.

One reviewer commented that the NDE of adhesive bonding is important overall but especially for composites and the Mg front end. The reviewer continues that adhesive bonding raises intrinsic stiffness of components with very little weight penalty.

Another reviewer felt that adhesive bonding is an enabler for numerous (including dissimilar) light weighting materials (which cannot be joined using conventional RSW). The reviewer concludes that unless there is high confidence in the joint integrity, OEMs are reluctant to proceed with introducing new (lighter) materials.

A reviewer stated that structures made of light weight materials will employ adhesive bonding. The reviewer concludes that the ability to inspect bonds is important requirement and so this project will be an enabler for weight reduction and fuel economy improvement.

Another reviewer said that quality control of parts is critical and, even if it is not directly related to "petroleum displacement", it should be continued and enhanced.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that the deployment strategy is well defined. Barriers were identified and addressed. Another reviewer commented that there is close cooperation with USAMP. The reviewer adds that weight reduction will lead to higher utilization of material properties leaving less room for flaws, as such this fits in the DOE objective for petroleum displacement. A reviewer stated that adhesives present one of the best approaches to joining dissimilar metals while retarding corrosion. A different reviewer noted that adhesive and users have collaborated successfully on deployment.

One reviewer commented that it was a bit hard to tell based on the presentation - although it looks good and the fact the OEMs are involved is critical, since they put the cars together and must therefore be involved and buy-in to whatever is developed.

A reviewer felt that technical barriers have been identified but not fully addressed yet. It is a good start. The reviewer added that they did not feel the effort is deep enough to include the full range of new light weight materials and joining methods. The reviewer concludes that there is a need to identify and prioritize key barriers and focus on resolving a "select few". A different reviewer commented that it is not at all clear that the techniques being studied in the project will be developed into methods suitable for use on production applications at real time line speeds. The reviewer adds that inspection techniques which do not rely on scanning the bond line should be considered. The reviewer concludes that it may be that the techniques are sufficiently fast to be used off line.

A reviewer stated that car production is starting to look like a fabrication activity with in situ testing at various stages of the construction.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that ultrasonic immersion has become the gold standard on flat coupons. The reviewer continued that the ultrasonic phased array has been found to be one of the best techniques for near term. The reviewer concludes that with increased bond strength, material weight can be reduced.

Another reviewer comments that there is a good correlation between ultrasonic images and physical results on steel and aluminum coupons, the reviewer adds that the project was also demonstrated on automotive body (BIW).

One reviewer commented that there has been significant progress which has been made in a timely manner. A different reviewer said that adhesive manufacturers and users have collaborated successfully on deployment. Lab tests are impressive.

A reviewer stated that the project looks good, but each material and each type of joint often requires a different NDT procedure and/or technology, so it is hard to be entirely definitive on this. Another reviewer felt that the project had experimented with and characterized several inspection methods and down selected some. The reviewer suggests that others, such as "full field" techniques, should be investigated.

Limited resources, according to a reviewer, have slowed progress. Another reviewer commented that funding is the brake in developing such approach for the car industry; the issue is what will be the cost benefit for the consumer of such testing.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer stated that adhesives offer greater potential for dissimilar metal joining than welding. Another reviewer comments that demonstrated results so far have prompted OEM interest to automated NDT methods in production environment. One reviewer believes that if all the technological barriers are solved and become cost effective, it has a good chance that the industry will adopt it.

One reviewer commented that if it is assumed that new materials going to be adopted, it is essential that new NDT methods be developed and proven. Another reviewer said that it was likely assuming successful development. More attention is needed on development of methods suitable for in line use. A different reviewer said that the need for more advanced inspection will have a pull on the results.

It was said by a reviewer that key NDE scientists/practitioners (from automotive and aero applications) are executing the work. The reviewer adds that those in OEMs that will have to implement the results are actively engaged. The reviewer also commented that there was active participation by adhesive suppliers.

One reviewer said that cost-effective NDE techniques are needed, and therefore, the technology transfer will be quick once a reliable and cost-effective technology is available.

One reviewer wonders that if this is mandated, then the consumer will have to pay for it. Without such a mandate, will the consumer pay for that or will this kind of testing bring some cost benefit for the consumer?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Two of the reviewers found funding to be sufficient. Another reviewer felt that the funding is insignificant as compared to the challenges and variability in materials in terms of both shape and characteristics. The reviewer continues that the magnitude of this opportunity is huge and could eventually replace spot welding. The reviewer also says that the project should be expanded to a greater family of parts and materials joining and their subsequent scale-up for mass production with continuous quality control and repeatability.

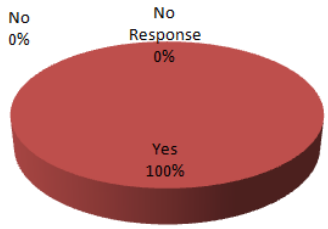
One reviewer felt that demonstrated results have prompted OEMs to be interested in automated NDT methods, and hence OEM resources should carry the project forward.

A different reviewer felt that in general NDE should be funded at higher levels to address other pertinent needs. One reviewer was unsure, stating that it will depend on how this is structured and how it can be sold, adding that implementation in a car line might be quite difficult.

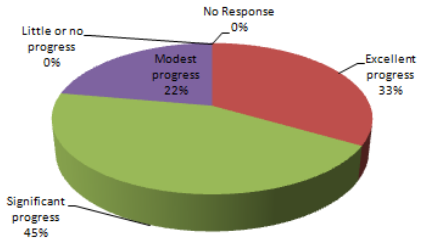
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NDE Inspection of Adhesive bonds in Metal-Metal Joints

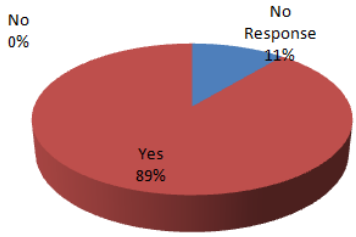
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



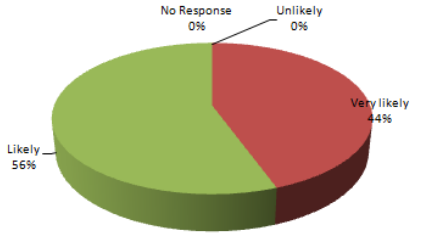
Question 3: Characterize the technical accomplishments and progress toward goals.



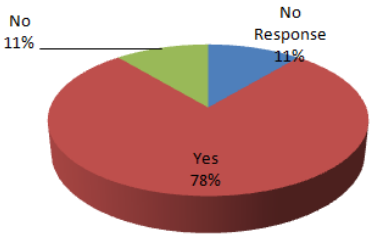
Question 2a: Are the goals of the project technically achievable?



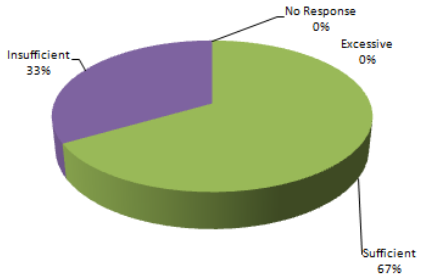
Question 4: How likely is the project team to move technologies into the marketplace?



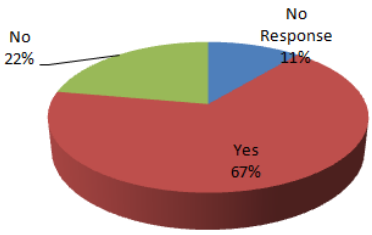
Question 2b: Have the technical barriers been identified and addressed?



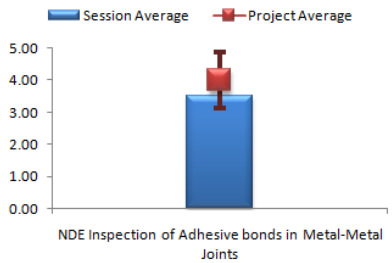
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



P4 Preform (Gerry Olszewski, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A number of reviewers noted weight reduction, and one reviewer added the material will be recyclable. One reviewer commented that the development of manufacturing methods for fiber preforms is essential to moving the technology toward deployment. A reviewer commented that the program was an enabler for composite manufacturing. Application of composites, particularly carbon fiber composites, can lead to vehicle weight reduction.

One reviewer saw limited direct benefit, and was unclear on the mass savings potential when compared to alternate materials. A reviewer said probably it supports objectives, but has very low technical risks. The reviewer added that cost is very important but the technical aspect, although present, were not explained well enough. The reviewer continued that there could be a good manufacturing story about this project (that maybe where the technical risks lie), but it was not exploited in sufficient details.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer noted that all technical barriers have been identified and the deployment strategies were well defined. One reviewer commented that the project seems to have the right people and companies involved, so if the technical issues can be addressed then commercialization will follow promptly. Another reviewer felt the project partners would ensure deployment of the technology throughout the U.S. auto industry.

One reviewer said that alternative processes explored reduced degradation of blanks. A reviewer commented that the large preforms in TP matrices will yield part consolidation benefits. The reviewer adds that plastic encapsulation of magnesium structural cast inserts in the integrated polymer/Mg front end module will solve some of the corrosion problems faced by magnesium. Good strategy all around, stated this reviewer. A reviewer felt that the project could result in substantial improvement in many aspects of the automotive parts.

A reviewer said that, while it appears to be a good project on its own, the linkage with Integrated Polymer / Mg module with P4 process is unclear. The reviewer felt that this indicates the project lacks focus, and had more funds than necessary.

Another reviewer said that heavy and medium duty trucks use significant reinforced polymers. The reviewer feels that deploying the technology for commercial vehicles where volumes are relatively low and customers are willing to pay more for weight reduction should be considered as another path for commercializing this technology.

A reviewer felt that the work to further develop composite preforming technology is worthwhile and necessary. The reviewer adds that encapsulation of Mg to protect from corrosion is a questionable idea and probably should not be included in this project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer states that significant progress has been made with this program. The reviewer is confident that further technology barriers will be solved. The reviewer adds that the cost of the final composite components is still an impediment for large scale use in the automotive industry. One reviewer said that this was an excellent project in their view.

Another reviewer felt that there was relative low weight reduction potential for P4. The reviewer adds that on the combination with magnesium casting a 50% weight saving is shown, reaching the DOE's objective.

A reviewer believes that additional work is required to drive down cost. The reviewer notes great progress in eliminating corrosion by encapsulation. The reviewer feels there is a need to take a closer look at joining dissimilar materials. One reviewer feels that the program still needs to find the best technique for advanced chopper development. Ability to vary fiber length to control cut zones is a real plus.

A reviewer comments that seat components targeted on the TP-P4 part of the project and the front end components on the integrated polymer/Mg part of the project are designed and moving along on schedule. Another reviewer feels that this project is really a done deal, provided the PI keeps at it.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer says that part of the project's developments is already being used by the industry. One reviewer is confident that the project team will bring this process to the market place.

A reviewer comments that all of the components targeted show weight reduction and potential cost benefits. The reviewer adds that performance characteristics will probably be okay.

Another reviewer says that unlike the LCCF program, technologies being investigated are very much within the reach. Therefore, it is much more likely that these technologies will move towards the marketplace more quickly. The reviewer adds that commercial trucks are more likely to be the first OEMs to transfer the technology to production. The reviewer suggests adding the 21st Century Truck Partnership on the steering team.

A reviewer states that P4 has already been implemented. The reviewer continues that improvements to the process and adaptation for use with thermoplastics will extend its applicability.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

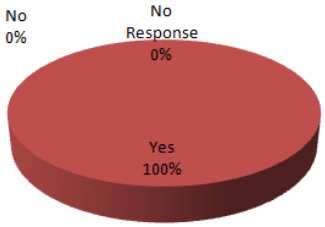
Most reviewers found the resources to be sufficient. One reviewer stated that it is necessary to fund both the development of predictive modeling for reinforced polymers as well as the development of processing technologies for reinforced polymers. Another reviewer cited excellent progress indicates adequacy of funding. Joining dissimilar materials should be covered in a separate project.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

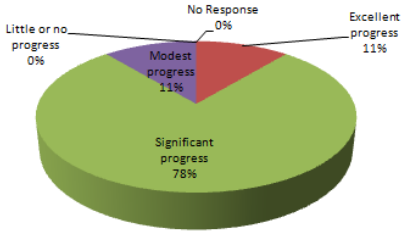
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: P4 Preform

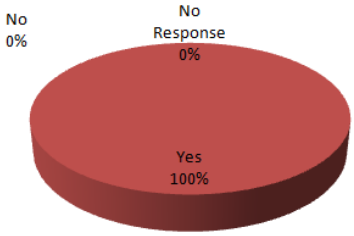
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



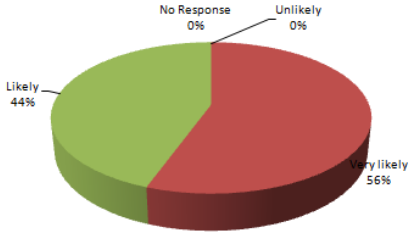
Question 3: Characterize the technical accomplishments and progress toward goals.



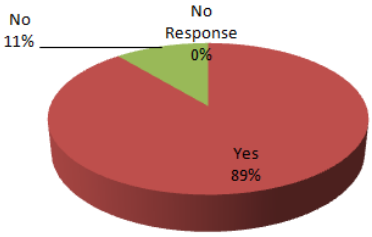
Question 2a: Are the goals of the project technically achievable?



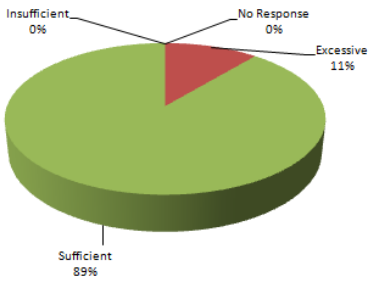
Question 4: How likely is the project team to move technologies into the marketplace?



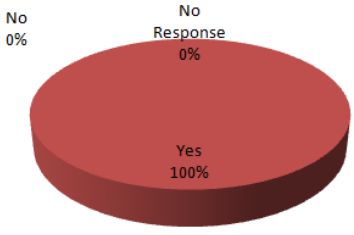
Question 2b: Have the technical barriers been identified and addressed?



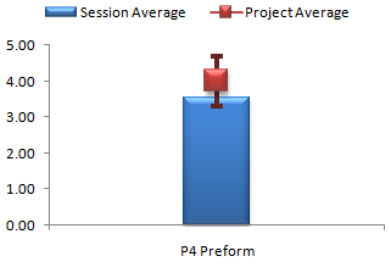
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Post-Shred Materials Recovery Technology Development and Demonstration (Ed Daniels, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer says yes, the project supports objectives because it helps to make magnesium more economically feasible and that will contribute to lighter vehicles.

A reviewer commented that proven recyclability is very important, but doesn't displace any significant petroleum resources. The reviewer adds that 40,000 tons per year of shredder residue spread across plastics and residual metals results in about half the mass in sellable material.

A reviewer felt that this project does not contribute to petroleum displacement. The reviewer adds that one of the other goals mentioned was to achieve 95% recyclability, and that this project contributes to this goal.

A reviewer states that the recycling of plastics and polymer composites effectively represents a return of petroleum to the original automotive materials stream, while making a tremendous impact on solving some of the disposal and environmental problems with post shredder materials. One reviewer comments that increased recycling was one of the goals of FreedomCAR.

A reviewer stated that end customers are becoming increasingly sensitive to using vehicles that are made out of recycled materials or are recyclable. The reviewer continues that it is thus important to address the recyclability and repair aspect of new lightweight materials.

One reviewer comments that it enables use of recycled materials, which can be used instead of some petroleum derived from virgin materials. The reviewer adds that the recycling of light materials will promote greater usage and lead to better fuel economy through weight reduction. One reviewer feels that recovery does not qualify as "petroleum displacement", at least not in the first phase of making cars. The reviewer concludes that as a source of alternate fuel, it does fit the DOE goal after all.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer calls this a well structured program. A reviewer stated that mechanical separation and thermal-chemical conversion technologies have been addressed. The reviewer adds that polymeric fractions from shredder residue were confirmed. A reviewer notes that having viewed the pilot plant at ANL and attended the reviews of the project there, the deployment technologies have already shown great progress, i.e., the strategy has worked. The reviewer believes commercialization also appears near at hand.

A reviewer states that this is the last year of the program and it has demonstrated the commercial viability of the process, currently transferring technology to the industry. Another reviewer finds that the work on this topic is quite comprehensive. One reviewer states that this project is on the basis of a CRADA. The reviewer adds that there is a good cooperation.

A reviewer comments that good technical progress has been demonstrated and leading experts are engaged. One reviewer felt that there was a need to address both technical as well as infrastructure issues.

A reviewer states that it appears that there are promising methods to separate and further process shredder residue. However, one of the things noted about this project is that, although there has been some process development, a substantial amount of the activity seems to be to experimenting with and validating developments of others. This reviewer added they did not mean to minimize Argonne's contributions in creating and operating a pilot plant and separation technology development, but one would hope that a project such as this would have developed more new and original methods of actually converting the residue fractions into useful materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer says that the project advanced the technology but can't hit regulatory targets for primary recycling. The reviewer felt that cost models still need to be developed. The reviewer continued that the business case for commercialization is still questionable. The reviewer ends by stating that current cost model shows a trade off of $4,096,000 revenues with an investment cost of $4,050,000.

Another reviewer comments that the progress in separating polyolefins has already resulted in their recovery into prototype auto parts. The reviewer adds that thermo chemical reduction of some polymer fractions into fuels has been demonstrated technically. The reviewer concludes that all these accomplishments are progress toward DOE goals.

One reviewer sees that a significant advancement has been made on shredder residue that was proven to be commercially viable. The reviewer adds that this initiative is used as a platform for future recycling initiatives.

Another reviewer comments that the only thing that is slowing this down is the fact that magnesium application in vehicles is still rather limited but that is expected to change very sharply soon as a result of GHG and CAFE concerns over vehicle weight.

A reviewer states that recycling investigation is needed to ensure that future options are sustainable. A different reviewer feels that cost effectiveness needs to be established.

One reviewer sees good results from the pilot plant. Another reviewer describes the project as a well thought out process.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer states that there are strong relationships with recyclers and post shredders. The reviewer adds that the business case for commercialization is still questionable in the absence of good cost models. Another reviewer feels that there are some economic issues for some recycling projects, but in future that will be solved because prime material cost are going up, so the recycled materials will be more attractive.

A reviewer states that the project has received high praise from the SPE and other organizations, while a validation plant is being planned. One reviewer believes that if magnesium is adopted widely, then these technologies will be required.

Another reviewer states that recycling will be a necessity and there is interest from the industry within this project. The reviewer adds that future shredded cars will show a different composition. The reviewer concludes that for the transfer to the market the work would be helpful, as insight was given on the effect on the profitability.

A reviewer states that the probability of transferring technology developed under the CRADA to market place is usually high. The reviewer adds that as long there is an infrastructure and the technology is cost effective, it will be used.

One reviewer believes that technologies will be implemented in the marketplace if they turn out to be a good economic business proposition, i.e. a commercial company can invest in it, operate it and make a return provide a profit after the investment and operating costs are covered. This remains to be demonstrated and the presentation was a bit thin on providing a hint about commercial viability.

One reviewer questions the cost model; for instance counting $1/lb of recuperated material is overly optimistic. The reviewer continues that from their involvement with wTe, most of the material will not sell for more than a few cents per pound because, when the plant will be operational, the feed to transform it will have to be purchased. The other figures also appear too optimistic. The reviewer would not be surprised that this would not be economical.

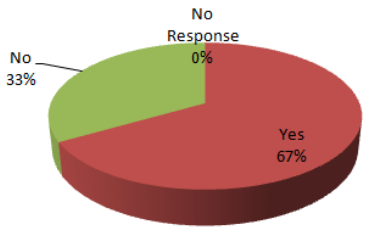
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Some reviewers thought the resources adequate. A reviewer states that the project has made excellent progress toward recycling most of the material. The reviewer says that a small amount of inorganics remain, consisting primarily of PCBs. Another reviewer says that the validation plant will probably raise the costs beyond the plan and, if successful, will greatly raise the project profile.

One reviewer questions the need to fund a large scale demonstration. The reviewer believes that what needs to be done first is cost modeling. A different reviewer believes the presented numbers are too optimistic and the process will cost much more then claimed.

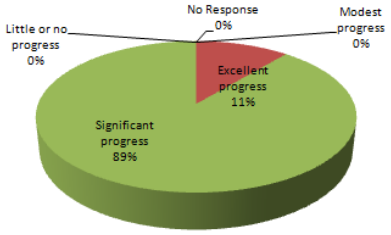
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Post-Shred Materials Recovery Technology Development and Demonstration

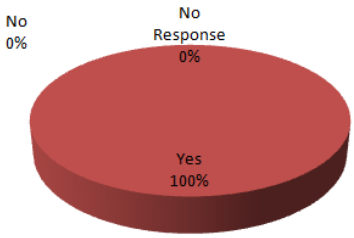
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



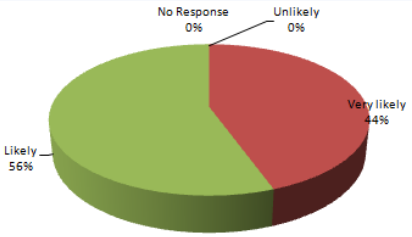
Question 3: Characterize the technical accomplishments and progress toward goals.



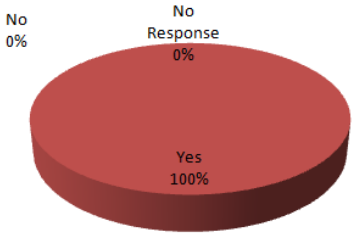
Question 2a: Are the goals of the project technically achievable?



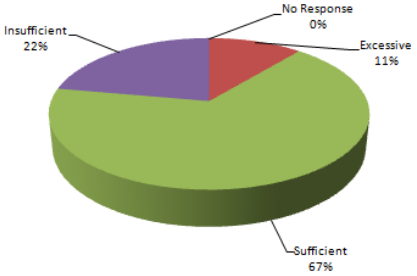
Question 4: How likely is the project team to move technologies into the marketplace?



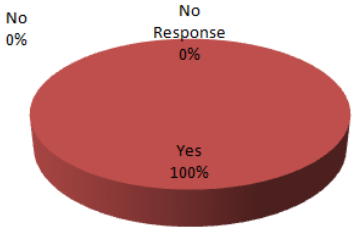
Question 2b: Have the technical barriers been identified and addressed?



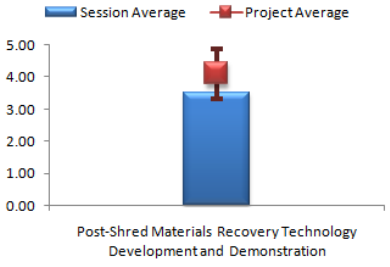
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Powder Metal Performance Modeling of Automotive Components (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer commented that powder metallurgy must be seen in combination with the project on low cost titanium. It will help to introduce this type of materials. The methodology is not limited to Ti but can be more widely used to reduce weight.

A reviewer states that modeling work is essential to determine the viability of the project and also to determine the importance of powder metal use for weight reduction and performance validation. Another reviewer stated that predictive modeling of performance properties based on manufacturing process history will shorten the life cycle to implement new components.

A reviewer states that powder metallurgy will allow making some parts cheaper than from other techniques and enable new powder materials. Another reviewer says that the project supports low cost Ti and general applicability to PM parts, which in turn supports petroleum displacement. Another reviewer says that PM can reduce mass through optimizing parts, and significantly reduce cost (and therefore increase usage) of net shape parts by reducing design iterations and performance testing.

A reviewer said that yes, this work supports DOE objectives if PM parts can be low enough in cost and reliable enough. The reviewer adds that having said that, it is hard to see how the weight savings of PM parts will be really large. The reviewer concludes that perhaps other properties such as high temperature resistance can be exploited on new powertrain technologies.

One reviewer comments that this is a useful study but it only marginally supports the DOE objective of petroleum displacement. The reviewer continues that the study is aimed at developing a model to predict the performance properties of sintered metal components. The reviewer concludes that design optimization may lead to some weight reduction but that appears to a secondary objective of the project.

One reviewer says that it is not clear whether or how much this project contributes to reduction in use of petroleum. The reviewer continues that the weight savings potential as applied to conventional PM components (as described in the presentation) would seem to be minimal - insufficiently small to be able to quantify any fuel economy improvement through weight reduction.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that since this is widely used elsewhere, implementation in the car industry should not be too difficult, provided adequate testing takes place. Another reviewer stated that the deployment strategy is well defined, and that barriers were identified. A different reviewer stated that in the team academic and OEM's are combined.

One reviewer stated that reductive models can be successful when validated against empirical data. The reviewer added that a good plan is in place to overcome each major challenge. Another reviewer

suggested that a model based on a current PM component (bearing cap) will serve as a baseline for future PM lightweight components.

One reviewer stated that it was difficult to determine from presentation the likelihood that all barriers will be overcome.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A number of the reviewers stated that the many obstacles still remained, with some feeling that progress had been relatively slow. One reviewer felt that the models might not work when applied to materials other then the baseline. The reviewer continued that no correlation was made so far with final properties, physical or mechanical of current PM part, so this is hard to judge.

One reviewer commented that technical risks do exist here and results may not come as quickly as expected. One reviewer felt that significant progress had been made over the last three years, while another felt things were moving along OK.

A reviewer felt that the anticipated weight saving will be limited to a relatively small amount of parts, and the total effect will be limited.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A number of reviewers stated that if the modeling is successful there will be a very high demand for it to produce low-cost metal powders. Another reviewer stated that some of the powder metal applications are already in production for weight reduction. One reviewer felt that given the success in the heavy truck industry, they suspected that this will work OK.

One reviewer saw a high chance for technology transfer if the modeling was successful, but thought the chances that the work could be successfully applied for other future light weight material systems is low. A different reviewer said that with the understanding that this project builds on a previous project involving Al and Ti PM and tries to develop a universal PM processing model, something likely will move into the marketplace, although what this will be is uncertain.

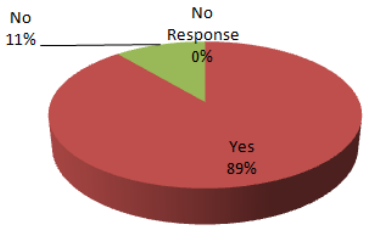
One reviewer stated that the technology transfer is not started but is an integral part of the project.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer found funding to be excessive, and one found it sufficient. Another reviewer saw great potential for expansion to other metal powders such as titanium. The reviewer adds that this will require a much greater commitment of resources. A different reviewer stated that funding is sufficient for model development; insufficient for final correlation of analytical model results with experimental results.

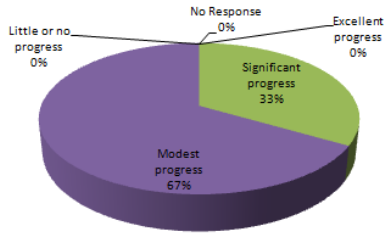
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Powder Metal Performance Modeling of Automotive Components

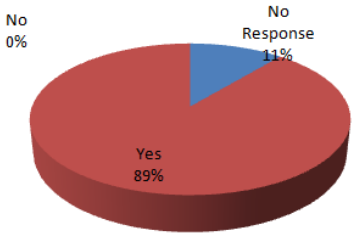
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



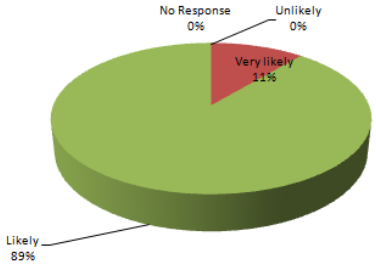
Question 3: Characterize the technical accomplishments and progress toward goals.



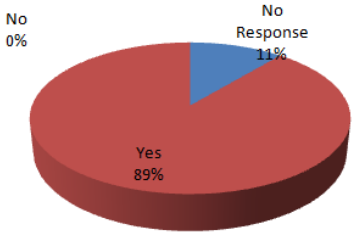
Question 2a: Are the goals of the project technically achievable?



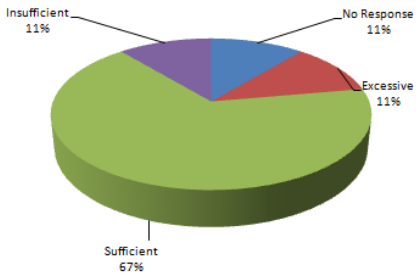
Question 4: How likely is the project team to move technologies into the marketplace?



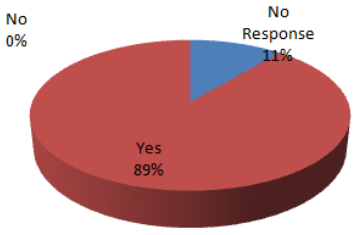
Question 2b: Have the technical barriers been identified and addressed?



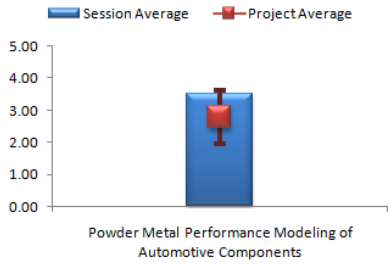
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Predictive Modeling of Polymer Composites (Mark Smith, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A few reviewers felt that the development of low cost carbon fiber is essential to achieve 50 percent mass reduction to meet the FreedomCAR goal. One reviewer felt that there is a potential for lighter vehicle structures through the use of CF structures, but the cost, logistics of supply, production rate and producability must be addressed as well.

A reviewer states that new thermoplastic materials may have good weight reduction potential for future body parts such as structural members, panels, bumpers, etc., if joining and crash worthiness challenges can be overcome. Predictive modeling is an important aspect of validation. Fiber orientation understanding is fundamental to evaluating material properties.

Another reviewer notes that composites have lightweighting potential compared with steel and thermoplastic composites offer recycling potential all supporting petroleum displacement. A different reviewer feels that this project will help to understand the behavior of composite structures for future applications of CF in the automobile as a lightweighting material. The reviewer adds that it will help to reduce more weight thus improving higher fuel economy.

One reviewer comments that current fiber reinforced composites incorporated in automotive applications only use 25% of the theoretical available strength. This project aims at a better understanding of the material properties and influencing the fiber orientation. This would lead to better use of the material properties and as such save weight.

A reviewer comments that this is very useful technology that makes production of LFT parts possible. Another reviewer found the project to be very important, that no practical progress in LFT can be achieved without predictive modeling, especially properties related to fiber orientation.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer notes that the process of validating predictive modeling results against empirical results is sound. Another reviewer saw the combination of experimental work and computer process simulation as having been commendable. The reviewer commented that, although this work involves injection molding, could the model be modified and used for pultrusion of thermoplastic composites?

One reviewer notes that some of the technical barriers are very difficult to predict in various conditions, and this cannot be overcome. A reviewer felt that this looks very promising: the group seems to have the right people involved, but the commercialization of the design tools is fundamental to getting this knowledge into use. Another reviewer notes that the fact that this was a joint program involving National Labs, universities and OEMs is a great idea and should be encouraged. The reviewer adds that this approach usually leads to faster commercialization.

A reviewer notes that this is a very complicated model. With time, goals can be achieved and technical barriers can be overcome (maybe after the official end of the project). It would be good if DOE could go all the way to results. The reviewer feels that this could be a very enabling modeling effort.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer notes that this is a focused program with a very enabling team. A reviewer notes that the four year project duration from initial assessment to tool validation is reasonable for the complexity. Some schedule delays have curtailed progress. While the progress will most likely fulfill its objectives with glass fiber, it is doubtful that the project will have sufficient time to fully integrate the complexities of carbon fiber.

A reviewer comments, "so far so good." The project needs until 2009 to demonstrate full potential on a complex part. A reviewer adds that predictive modeling has been undertaken for a long time: some progresses have been made, but still a lot of challenges remain.

A reviewer says that this work is promising and appears to be going well. Fiber orientation and distribution is notoriously hard to predict reliably and yet it is a key task. A reviewer notes that the problem has already been noted in the automotive industry for a long time. The reviewer feels that serious effort is needed to improve the supply chain especially in the case of SMC. Since this is not within the scope, the weight reduction will be limited. Another reviewer says there has been good progress in many areas, and in coordination of the results.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer comments that the models are non-proprietary. The reviewer continues that predictive tools are a major path toward low-cost validation. The reviewer sees a very solid plan for tool validation. The subject matter is very relevant to auto industry. A number of reviewers felt that the projects make up would lead to deployment.

One reviewer commented that realizing that this program is addressing injection molded components, and predicting properties of traditional (short fibers) SMC is a difficult task. Because of this, the reviewer feels that fiber reinforced polymers (thermosets or thermoplastics) are hardly used for structural applications. The reviewer concludes that controlling processing technology and predicting component properties will be of great benefit in more effectively utilizing fiber reinforced polymers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

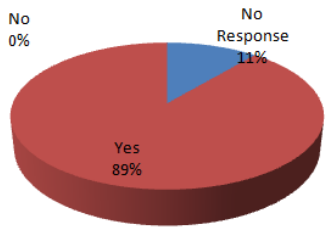
Most reviewers felt that funding was sufficient. Some added it appears likely to need additional funding to validate the work and to develop a high volume manufacturing process. One reviewer noted that the combination of NFS grantees, in-kind work, and member participation is an excellent collaboration model. The reviewer feels that it is doubtful that additional funding will accelerate results unless carbon fiber is addressed in parallel.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

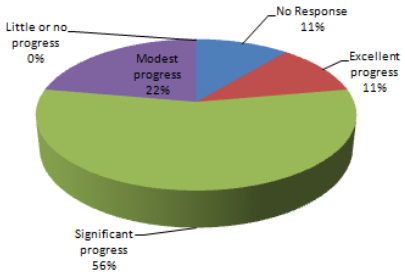
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Predictive Modeling of Polymer Composites

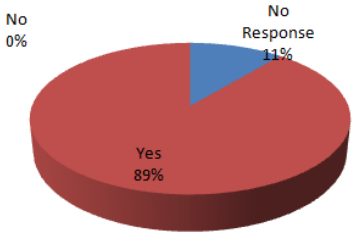
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



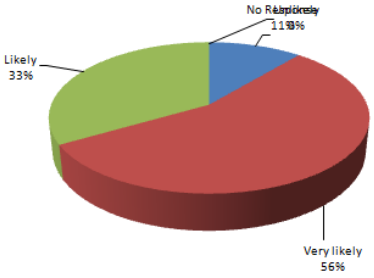
Question 3: Characterize the technical accomplishments and progress toward goals.



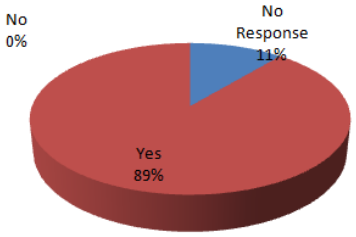
Question 2a: Are the goals of the project technically achievable?



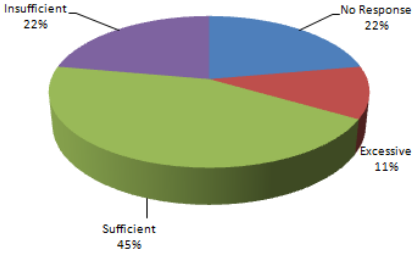
Question 4: How likely is the project team to move technologies into the marketplace?



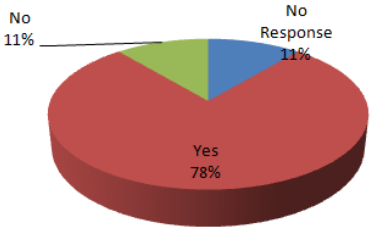
Question 2b: Have the technical barriers been identified and addressed?



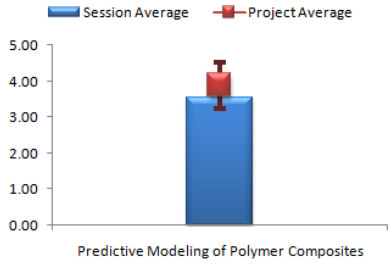
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Predictive Modeling of Polymer Composites (Mark Smith, of Pacific Northwest National Laboratory)

Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

A few reviewers felt that the development of low cost carbon fiber is essential to achieve 50 percent mass reduction to meet the FreedomCAR goal. One reviewer felt that there is a potential for lighter vehicle structures through the use of CF structures, but the cost, logistics of supply, production rate and producability must be addressed as well.

A reviewer states that new thermoplastic materials may have good weight reduction potential for future body parts such as structural members, panels, bumpers, etc., if joining and crash worthiness challenges can be overcome. Predictive modeling is an important aspect of validation. Fiber orientation understanding is fundamental to evaluating material properties.

Another reviewer notes that composites have lightweighting potential compared with steel, and thermoplastic composites offer recycling potential, all supporting petroleum displacement. A different reviewer feels that this project will help to understand the behavior of composite structures for future applications in the automobile as a lightweighting material. The reviewer adds that it will help to reduce more weight thus improving higher fuel economy.

One reviewer comments that currently fiber reinforced composites employed in the automotive world only use 25% of the theoretical available strength. This project aims at a better understanding of the material properties and influencing the fiber orientation. This would lead to better use of the material properties and thus save weight.

A reviewer comments that this is very useful technology that makes production of LFT parts possible. Another reviewer found the project to be very important, and that no practical progress in LFT can be achieved without predictive modeling, especially properties related to fiber orientation.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

A reviewer notes that the process of validating predictive modeling results against empirical results is sound. Another reviewer saw the combination of experimental work and computer process simulation as having been commendable. The reviewer adds that although this work involves injection molding, this reviewer wondered if the model could be modified and used for pultrusion of thermoplastic composites.

One reviewer notes that some of the technical barriers are very difficult to predict in various conditions, and this cannot be overcome. A reviewer felt that this looks very promising: the group seems to have the right people involved but the commercialization of the design tools is fundamental to getting this knowledge into use. Another reviewer notes that the fact that this was a joint program involving National Labs, universities and OEMs is a great idea and should be encouraged. The reviewer adds that this approach usually leads to faster commercialization.

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Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer comments that the models are non-proprietary. The reviewer continues that predictive tools are a major path toward low-cost validation. The reviewer sees a very solid plan for tool validation. Subject matter is very relevant to auto industry. A number of reviewers felt that the projects make up would lead to deployment.

One reviewer commented that realizing that this program is addressing injection molded components, and predicting properties of traditional (short fibers) SMC is a difficult task. Because of this, the reviewer feels, fiber reinforced polymers (thermosets or thermoplastics) are hardly used for structural applications. The reviewer concludes that controlling processing technology and predicting component properties will be of great benefit in more effectively utilizing fiber reinforced polymers.

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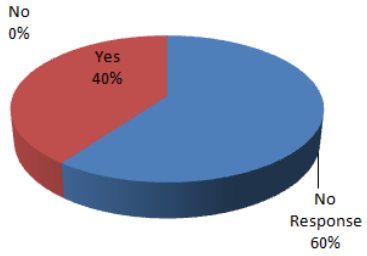
Most reviewers felt that funding was sufficient. Some added it appears likely to need an additional funding to validate the work and to develop a high volume manufacturing process. One reviewer noted that the combination of NFS grantees, in-kind work, and member participation is an excellent collaboration model. The reviewer feels that it is doubtful that additional funding will accelerate results unless carbon fiber is addressed in parallel.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

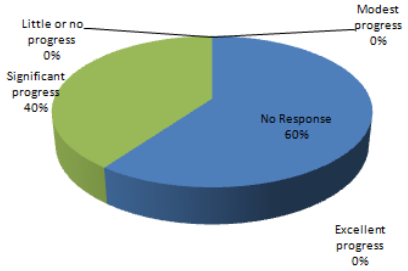
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Predictive Modeling of Polymer Composites

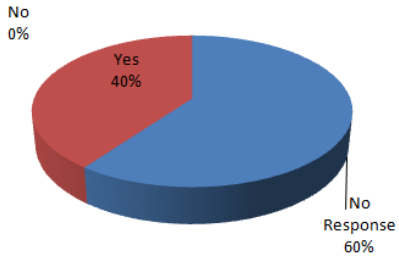
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



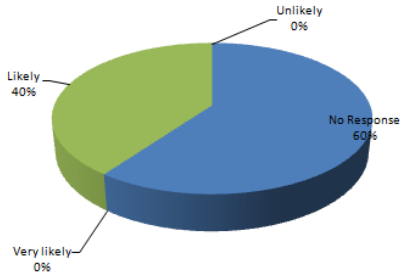
Question 3: Characterize the technical accomplishments and progress toward goals.



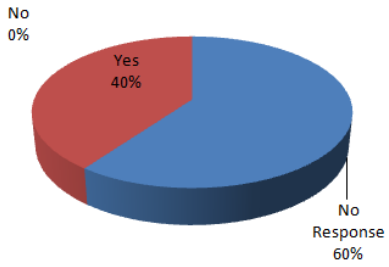
Question 2a: Are the goals of the project technically achievable?



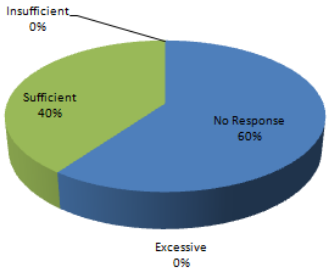
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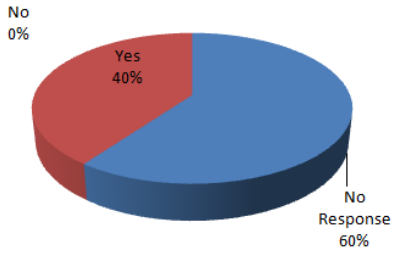
Question 2b: Have the technical barriers been identified and addressed?



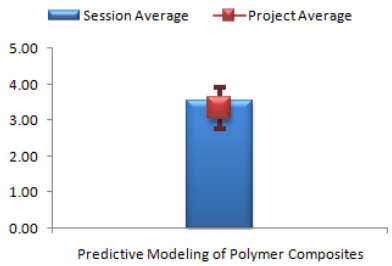
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Predictive Modeling of Polymer Composites (National Science Foundation)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer states that new thermoplastic materials may have good weight reduction potential for future body parts such as structural members, panels, bumpers, etc., if joining and crash worthiness challenges can be overcome. Predictive modeling is an important aspect of validation. Fiber orientation understanding is fundamental to evaluating material properties.

Another reviewer notes that composites have lightweighting potential compared with steel, and thermoplastic composites offer recycling potential, all supporting petroleum displacement. A different reviewer feels that this project will help to understand the behavior of composite structure for future applications in the automobile as a lightweighting material. The reviewer adds that it will help to reduce more weight thus improving higher fuel economy.

One reviewer comments that currently fiber reinforced composites employed in the automotive world only use 25% of the theoretical available strength. This project aims at a better understanding of the material properties and influencing the fiber orientation. This would lead to better use of the material properties and thus save weight.

A reviewer comments that this is very useful technology that makes production of LFT parts possible. Another reviewer found the project to be very important, that no practical progress in LFT can be achieved without predictive modeling, especially properties related to fiber orientation.

One reviewer notes that these composites are an important class of light weight material supporting the petroleum displacement objectives.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer notes that the process of validating predictive modeling results against empirical results is sound. The reviewer adds that although this work involves injection molding, he wondered if the model could be modified and used for pultrusion of thermoplastic composites.

One reviewer notes that some of the technical barriers are very difficult to predict in various conditions, cannot be overcome. A reviewer felt that this looks very promising: the group seems to have the right people involved but the commercialization of the design tools is fundamental to getting this knowledge into use. Another reviewer notes that the fact that this was a joint program involving National Labs, universities and OEMs is a great idea and should be encouraged. The reviewer adds that this approach usually leads to faster commercialization.

A reviewer notes that this is a very complicated model. With time, goals can be achieved and technical barriers can be overcome (maybe after the official end of the project). It would be good if DOE could go all the way to results. The reviewer feels that this could be a very enabling modeling.

A reviewer comments that the allocation of project parts to six different universities with different specialties is smart. Use the best brains for the respective project goals. One reviewer notes very good complements between experimental researches and modeling; more on a "theoretical" aspect than

what DOE should; again excellent complement to introduce a more physical approach to modeling; should provide better results.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer notes that the process of validating predictive modeling results against empirical results is sound. Another reviewer saw the combination of experimental work and computer process simulation as having been commendable. The reviewer adds that although this work involves injection molding, the reviewer wondered if the model could be modified and used for pultrusion of thermoplastic composites.

A reviewer felt that this looks very promising: the group seems to have the right people involved but the commercialization of the design tools is fundamental to getting this knowledge into use. Another reviewer notes that the fact that this was a joint program involving National Labs, universities and OEMs is a great idea and should be encouraged. The reviewer adds that this approach usually leads to faster commercialization.

A reviewer notes that this is a very complicated model. With time, goals can be achieved and technical barriers can be overcome (maybe after the official end of the project). It would be good if DOE could go all the way to results. The reviewer feels that this could be a very enabling modeling.

A reviewer notes that the modeling work seems to be proceeding well. Because of the diversity of models (to cover the different manufacturing processes) it is difficult to tell how good they are until there is experimental confirmation.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer comments that the models are non-proprietary. The reviewer continues that predictive tools are a major path toward low-cost validation. The reviewer sees a very solid plan for tool validation. The subject matter is very relevant to auto industry. A number of reviewers felt that the project make up would lead to deployment.

One reviewer commented that realizing that this program is addressing injection molded components, and predicting properties of traditional (short fibers) SMC is a difficult task. Because of this, the reviewer feels, fiber reinforced polymers (thermosets or thermoplastics) are hardly used for structural applications. The reviewer concludes that controlling processing technology and predicting component properties will be of great benefit in more effectively utilizing fiber reinforced polymers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

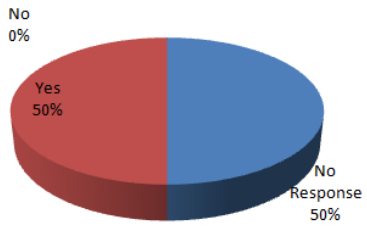
Most reviewers felt that funding was sufficient. Some added it appears likely to need an additional funding to validate the work and to develop a high volume manufacturing process.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

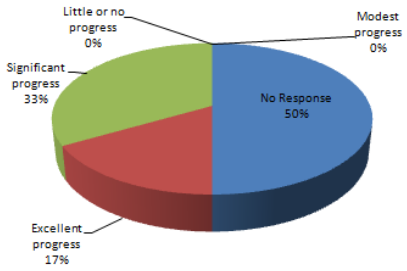
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Predictive Modeling of Polymer Composites

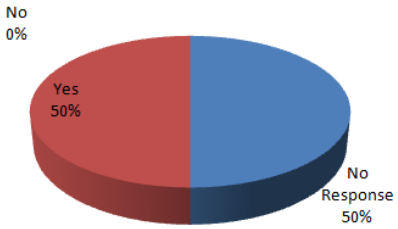
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



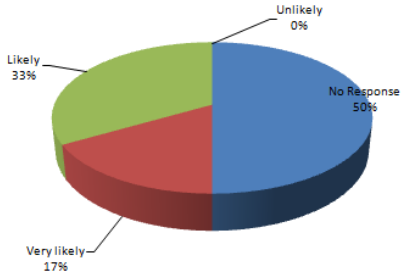
Question 3: Characterize the technical accomplishments and progress toward goals.



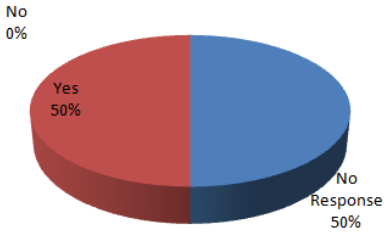
Question 2a: Are the goals of the project technically achievable?



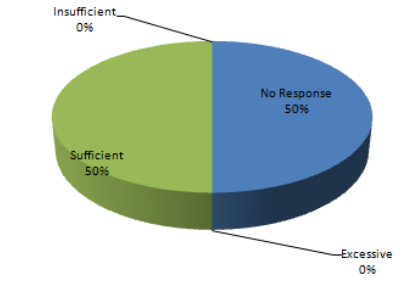
Question 4: How likely is the project team to move technologies into the marketplace?



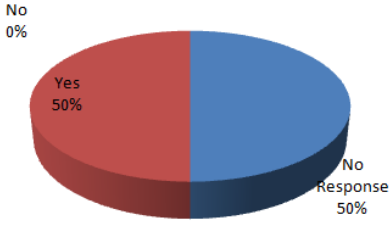
Question 2b: Have the technical barriers been identified and addressed?



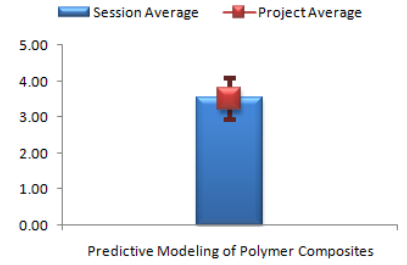
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Results of FY 2007 Automotive Lightweighting Materials Deep-Dive Peer Review (Subi Dinda, of Automotive Materials & Mfg Tech)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer states that the technology of the projects appears to be very good, but the economic analysis of some of them seems rather weak and/or quite optimistic. In the reviewers view, the cost modeling on most of the more "exotic" projects deserves a careful look, especially those related to recycling, carbon fiber and titanium. The reviewer concludes that while the technology COULD serve the DOE objective, the actual roll-out of a given project may not because it simply does not make sense from a commercial point of view.

A reviewer felt that it provides an objective evaluation of the quality of work underway to address the needs in vehicle light weighting. A reviewer states that this is a review and evaluation of the entire light weight materials program. It is not a technology development program and so the answer to this question is based upon the conclusion that it is beneficial to the program rather than on an assessment of the specific value of a technology development project to reduce petroleum usage.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer was concerned that some of the projects are simply NOT viable and/or would lead to such tiny benefits that they are simply not worth pursuing at the expense of more promising work. A reviewer noted that recommendations have been reviewed and considered by industry and government program leadership.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Most reviewers felt that this question did not apply.

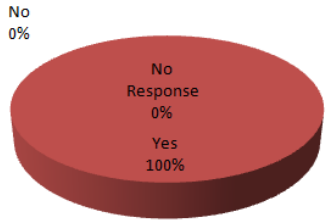
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer felt that some projects would be viable, some not. Another reviewer felt that the question applies and another felt that resulting recommendations will likely be embraced and acted upon by program leaders.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer felt all projects were reasonably well resourced.

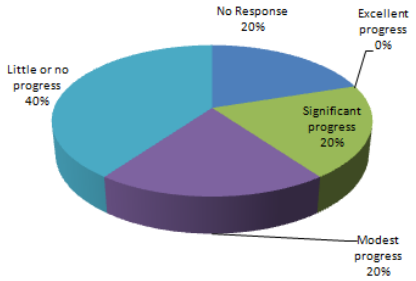
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Results of FY 2007 Automotive Lightweighting Materials Deep-Dive Peer Review

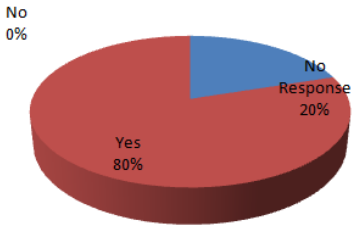
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



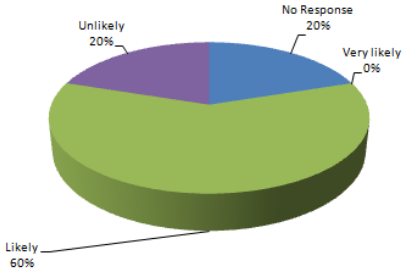
Question 3: Characterize the technical accomplishments and progress toward goals.



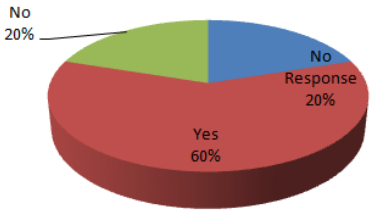
Question 2a: Are the goals of the project technically achievable?



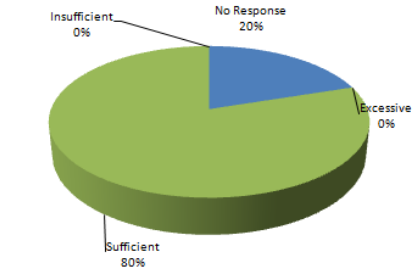
Question 4: How likely is the project team to move technologies into the marketplace?



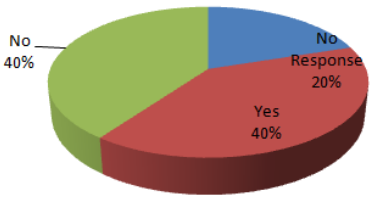
Question 2b: Have the technical barriers been identified and addressed?



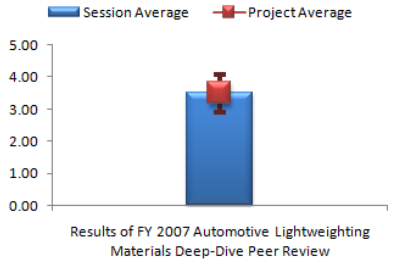
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Sheet Steel Joining (Roger Heimbuch, of Auto Steel Partnership)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that enabling technology from this project will advance the use of HSS and AHSS in automotive vehicles to help in petroleum displacement. Another commented that it facilitates increased use of HSS to achieve weight reduction. One reviewer felt that it was necessary research, but not directly related to "petroleum displacement".

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer commented that weld modeling results have been fed into welding standards. The reviewer continues that there are excellent publications in all areas. The reviewer adds that the mass efficient architecture for roof strength looked at a worst-case scenario and determined mass (de)compounding is possible. Another reviewer commented that excellent higher steels are currently unavailable in the smaller gauges required and noted that all projects have met targets to date.

One reviewer believed that the mix of welding processes chosen, the experimental work, and the modeling efforts are all focused on optimizing the joining process and properties of welded automotive components made of AHSS. Another reviewer commented that the project seems to be primarily data generation, not research. The reviewer felt that it was questionable that government funding should be used to generate this type of data. This should be the responsibility of the material suppliers and/or users.

A reviewer stated that deployment is questionable but the research is necessary to understand how to optimize the car structure.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer commented that it is a supportive project. Together with the other projects in this program, it will have a significant contribution: on its own the contribution is limited. Another reviewer stated that the project had generated a great deal of useful data, but was unsure whether this is an appropriate activity for a government research project.

One reviewer said that higher strength steels are currently unavailable in the smaller gauges required. The reviewer added that many of the sub-projects are already complete, and that all projects have met targets to date.

A different reviewer says that “so far, so good” and that project results in 2008 should provide more answer to questions about AHSS weld joint reliability.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer was confident that results and test procedures are readily transferable. The reviewer continues that all sub-projects followed the same common analytical process. The reviewer adds that all projects combined resulted in substantial weight reductions of about 30% at cost parity. The

reviewer also stated that the web site, the road shows to OEMs, the seminars, and the publications disseminate results. The reviewer concludes that future validation is to take place on hybrid concept.

One reviewer stated that A/SP does an outstanding job of education and tech transfer, and this project is no exception.

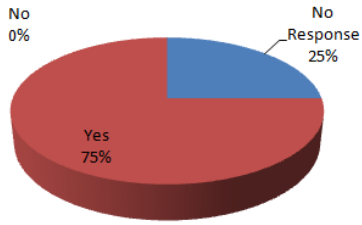
Another reviewer did not see how this kind of research and model building can be considered as technology transfer.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All responding reviewers felt that funding was sufficient. One reviewer added that the research progress was in line with funding.

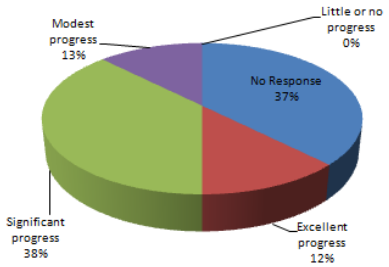
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Sheet Steel Joining

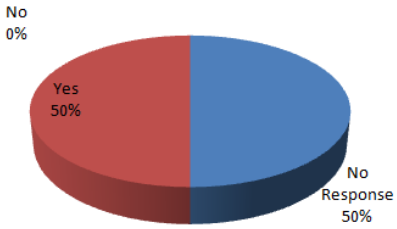
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



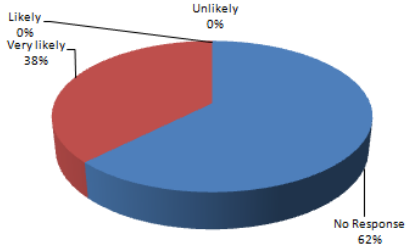
Question 3: Characterize the technical accomplishments and progress toward goals.



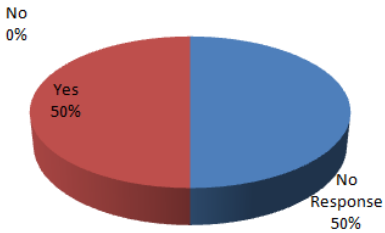
Question 2a: Are the goals of the project technically achievable?



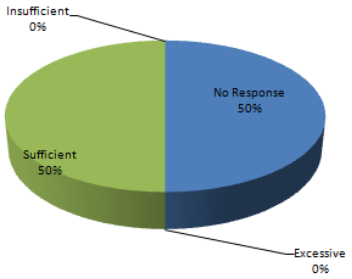
Question 4: How likely is the project team to move technologies into the marketplace?



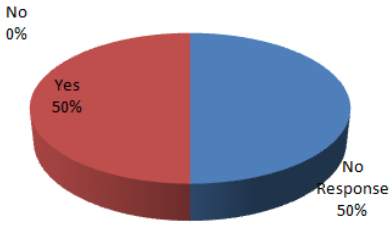
Question 2b: Have the technical barriers been identified and addressed?



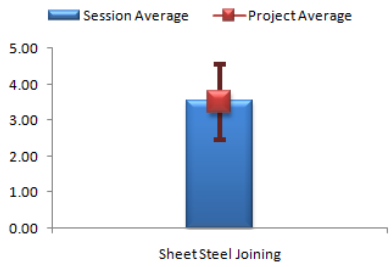
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Strain-Rate Characterization/Strain-Rate Characterization Technology Development (Phil Sklad, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer stated that weight reduction using high strength steel is enabled by design optimization. The reviewer added that the project advances analytical models for assessing strain under loading.

Another reviewer commented that strain rate characterization of AHSS in crash situations is important as an enabling technology that assists the introduction of these "lightweight steels". In the same vein, another reviewer said that this project would help to understand the characteristic of Advanced High Strength Steels at high strain rate. The reviewer continued this will help to introduce more AHSS to reduce weight and cost, thus meeting the FreedomCAR goal. Two reviewers felt it was supportive of weight reduction.

A different reviewer felt that the project generates needed data on HSS, use of which can reduce weight and thus improve fuel economy. Similarly another reviewer said that the project develops modeling to optimize use of AHSS, to minimize the amount of material used for required performance (rather than adding material as a "safety factor").

One reviewer commented that AHSS facilitates the development of lightweight vehicle structures but only if the design rules are accurate and have high fidelity and these design rules are based on accurate materials characterization.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer said that the work on the project is exemplary, covering not only experimental testing procedures of some complexity but also a good amount of modeling work. Another said the technical strategy is very concise, clear and well defined. Another reviewer was pretty confident that this will work out. A reviewer commented that there is direct exchange of the results over the steel manufacturers and OEM's.

Another reviewer commented that the goals of both programs are to remove barriers, resolve issues and develop models to help industrial utilization of advanced high strength steel. A reviewer stated that this is a project to determine properties and characterize behavior (as opposed to overcoming barriers). The reviewer continued that the information generated is needed to validate design models.

One reviewer said that technical risks existed in the sense that no optimized design modeling exists for AHSS, continuing that an improvement in crash worthiness could be seen, which implies a better knowledge of strain/ stress behavior in these materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that data is measured from multiple sources using both strain gages, as well as optical measurements. Another reviewer commented that although the safety tests as proposed are

important, they are not representative of what would occur in reality. Therefore, this should be improved to be more representative.

A reviewer said that the test methodologies were developed and employed to generate data and compare with and validate model results. Another reviewer commented that it was difficult to assess this project's accomplishments; it is, however, essential for further introduction of AHSS. The reviewer continued it is positive that there is an open database on material properties.

One reviewer stated that significant progress has been made, but more work is needed to solve the remaining technical barriers. Another reviewer said that the only reason for the less than top rating is that this project is contingent on the AHSS steels project and so it really isn't an independent piece of work. One reviewer commented that excellent results speak for themselves.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A reviewer said that test procedures are readily transferable. Another reviewer commented that once the technology is developed, it will be used by the industry. The reviewer continued that the OEMs are involved in this project and they will utilize the development. Another reviewer said that the built up knowledge is directly used in the industry.

One reviewer said that this is a research project, so only some aspects of this research will be implemented. Another reviewer said that this is an enabling project that is crucial for success of AHSS structures in crash situations, and one would expect that the auto companies now using AHSS have great interest in the conclusions and using them in their structural designs. One reviewer said that all stakeholders are a part of the team.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Three reviewers commented that the funding is sufficient. Another reviewer said that some findings and tests have already been implemented by some OEMs in crash test simulations.

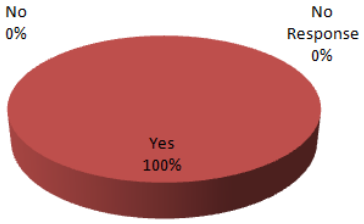
One reviewer commented that this was a good R&D team coupled with sufficient lab and financial resources that make for a job well done on this project. The reviewer continued by noting that as the tests developed, this project could be used to evaluate high strain rate effects on Al and possibly Mg materials, more resources would be needed to extend the scope of work to these materials.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

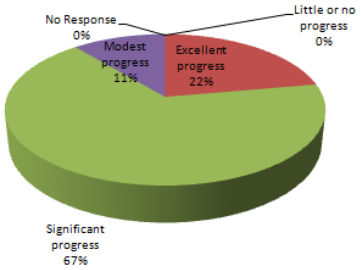
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Strain-Rate Characterization/Strain-Rate Characterization Technology Development

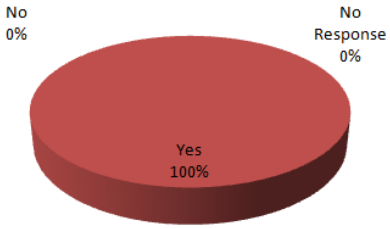
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



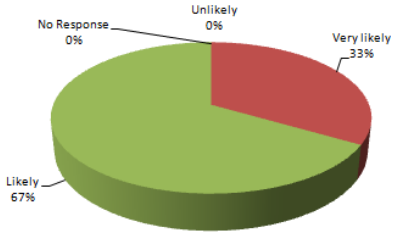
Question 3: Characterize the technical accomplishments and progress toward goals.



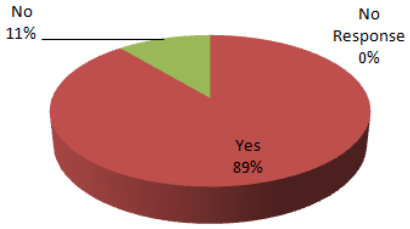
Question 2a: Are the goals of the project technically achievable?



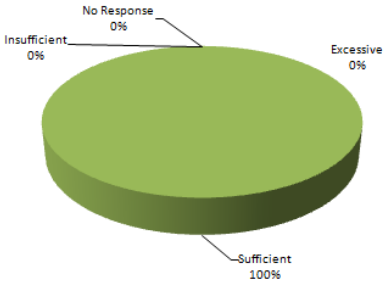
Question 4: How likely is the project team to move technologies into the marketplace?



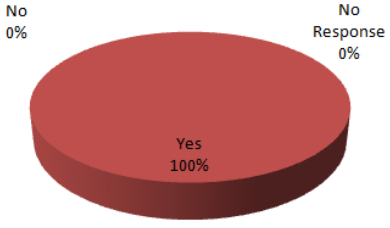
Question 2b: Have the technical barriers been identified and addressed?



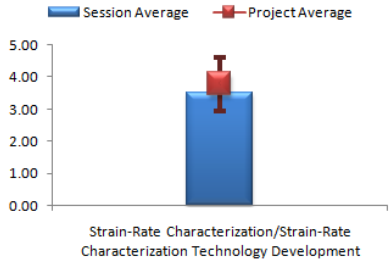
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Tribology (Roger Heimbuch, of Auto Steel Partnership)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
A reviewer responds that this is an enabling technology for moving AHSS deeper into automotive applications, indirectly supporting petroleum displacement. Another reviewer says that the project is enabling more introductions of AHSS steels for lightweighting to improve fuel economy. Another reviewer stated that any improvement in lubricant responds to "petroleum displacement". One reviewer was unsure how this contributes to DOE goals.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that this would probably be deployed as it comes to fruition. Another reviewer commented that the design of the experiments and selection of materials for study are sound. Another reviewer felt that the project strategy is very clear and deployment strategy is well defined.

One reviewer felt that the goals are vague, i.e. investigate, assess variables, test materials, etc. Another reviewer commented that data generation and characterization of lubricants do not seem to be objectives to overcome barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer commented that this seems like a very empirical approach. Another believes that the results should be directly applicable.

One reviewer commented that although the project set-up is proceeding rapidly, we must await the results of the extensive testing planned on this project. The reviewer found things relatively timely so far. Another reviewer stated that significant progress had been made, but felt that more work has to be done.

A reviewer wondered whether this was really an appropriate activity for a government funded project, after noting that the project has generated data.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that key suppliers (steel companies) and OEMs are involved, so after successful completion of the project it will be adopted by the industry. Another reviewer commented that good tribology results generally have a way of finding a place in the marketplace, as the implementation of better die/lubricant/work piece results are always of interest to automakers and suppliers. The reviewer concludes AHSS pose tribological challenges, but not insurmountable ones.

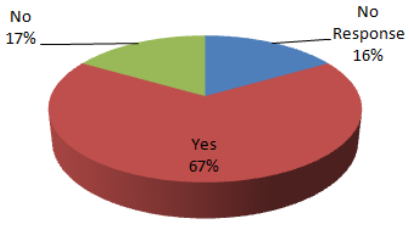
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All responding reviewers found funding to be sufficient.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

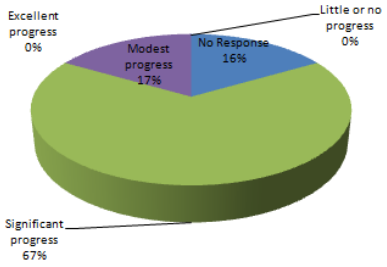
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Tribology

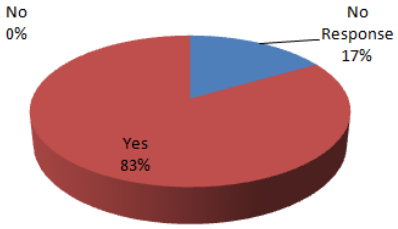
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



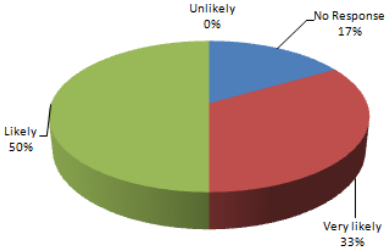
Question 3: Characterize the technical accomplishments and progress toward goals.



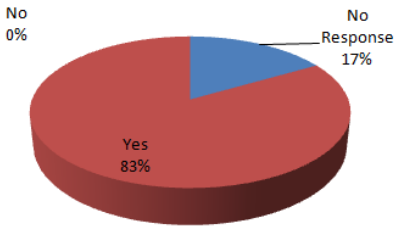
Question 2a: Are the goals of the project technically achievable?



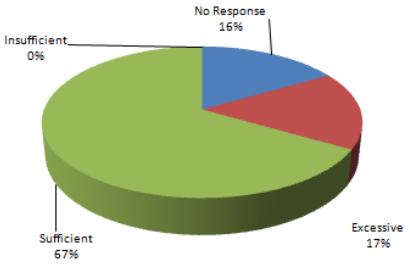
Question 4: How likely is the project team to move technologies into the marketplace?



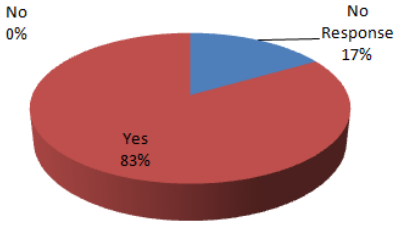
Question 2b: Have the technical barriers been identified and addressed?



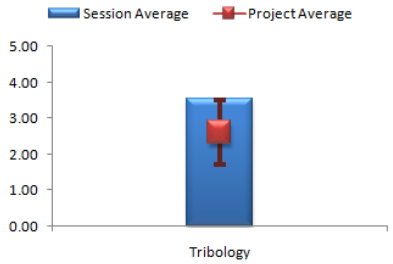
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Ultra-Large Casting Demonstrations (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Many reviewers focused on weight savings leading to fuel savings. One of the reviewers added that it may be about to do just that in the F-150 radiator support if issues such as crash energy management and manufacturing processes can be sorted out.

A reviewer states that the ability to make ULC Mg structural components by the subliquidus thixomolding process not only solves the lightweighting issues surrounding FreedomCAR but addresses costs by part integration.

Another reviewer commented that integration of features into ultra large casting can reduce mass, fabrication costs, etc. which will motivate more extensive use of lighter cast metals.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
A reviewer felt that this may very well be adopted reasonably soon as it has been shown that it can work, although some barriers still exist in the areas of crash, cost, corrosion, and likely manufacturing. Another reviewer says that the results speak for themselves. The reviewer adds that the achievement reached on the ULC front end components including the shot gun is laudable.

One reviewer found that the deployment strategies were well defined. Deliverables and milestones were well defined. Another reviewer mentioned that the technical barriers were defined. The reviewer adds that preventing interfacial corrosion issues when mixed metals are used will require innovative technical solutions. A reviewer says that given that this project is nearly done, it seems certain that follow-on work will be needed to address those issues. One reviewer said that the consortium is widespread so deployment is ensured through the consortium.

A reviewer stated that obtaining lower-cost castings with the same mechanical properties (ductility) as those available with expensive die casting processes (vacuum die casting) is a very tough challenge. The reviewer adds that the results reported thus far for this project suggest that this barrier (achieving equivalent properties) will not be overcome. Another reviewer stated that some technical barriers may be overcome, but the reviewer doubts it.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
A reviewer comments that optimizing the process parameters for the thixomolding to make a structural Mg component with structural performance in critical front end components looks to be the main technical barrier, which was achieved. Another reviewer states that they have gone all the way from simulations to prototype parts and assemblies. A different reviewer states that the team is well on the way to reaching the technical milestones.

One reviewer comments that the project has produced some large castings and these types of casting may be useful for some applications. The reviewer adds that the results indicate that ductility equivalent to that produced using expensive casting methods (which is a key objective of the project)

has not been achieved. The reviewer suggests that the goal of producing a lower cost casting which can replace the expensive castings may remain elusive. The reviewer concludes that nevertheless, the development/validation of the methods for large castings is useful.

A reviewer says that the project aims at weight savings through integrating parts. Weight savings over 50% against traditional steel designs are likely, meeting the DOE's goals. The reviewer adds that the reduction of part count is beneficial for keeping cost as low as possible. Another reviewer says that significant progress has been made and remaining technical challenges will be met.

One reviewer comments that while quite promising, the actual applications for this work need to be chosen carefully to take advantage of the weighting opportunities without getting into problems with cost, crash or manufacturing issues.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A commentator notes that the experiences at Ford on the production of a magnesium radiator support augur well for the technologies developed on this project.

One reviewer comments that the lessons learned from earlier projects on aluminum were taken into account. The reviewer believes that market transformation for magnesium looks more promising than in the case of aluminum. The reviewer adds that integration and reduction of part count bears the risk that repair cost after an accident become high. The reviewer believes that this should be taken in consideration when looking for the optimum.

Some reviewers felt that the fact that key suppliers and OEMs were involved meant a good chance of the technologies being utilized by industry. A reviewer stated that the success of this program will make aluminum castings more cost-effective and will make technology transfer more likely.

One reviewer stated that the casting technologies validated in this project will be used in some applications even if the major barrier of finding an alternative, low cost replacement process for the expensive casting method is not developed. One reviewer concluded that technology transfer would probably take place depending on the applications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

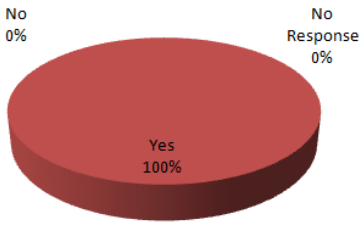
Most responding reviewers felt the funding was sufficient. One reviewer felt that resources were sufficient for the magnesium portion of the project but not if aluminum was maintained as a project goal for ULC components.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

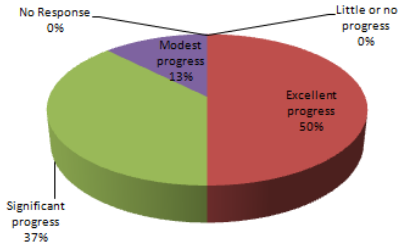
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Ultra-Large Casting Demonstrations

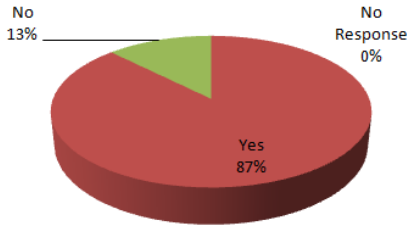
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



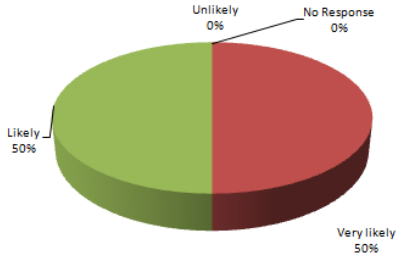
Question 3: Characterize the technical accomplishments and progress toward goals.



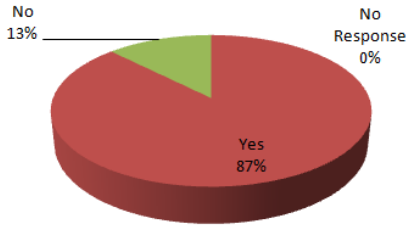
Question 2a: Are the goals of the project technically achievable?



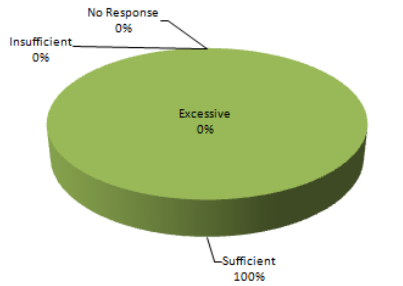
Question 4: How likely is the project team to move technologies into the marketplace?



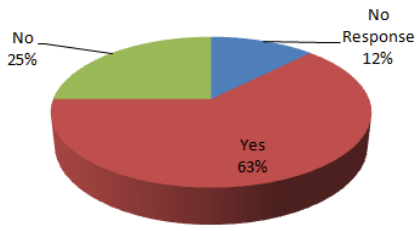
Question 2b: Have the technical barriers been identified and addressed?



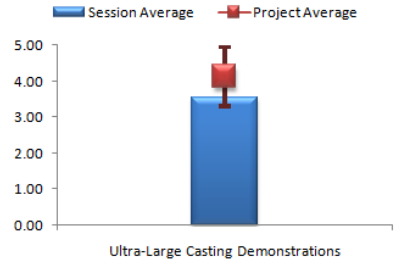
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Warm-Forming Magnesium Sheet (Eric McCarty, of Chrysler LLC)

Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

A reviewer comments that in addition to weight reduction, light weighting is also an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles. The reviewer adds that that the project is well-structured and flows seamlessly into similar projects. The reviewer adds that this is an enabler of alternative propulsion systems including electric vehicles, hybrids, and fuel cell vehicles.

Many reviewers noted that lower weights reduce fuel consumption One reviewer stated that due to the difficulties of room temperature forming of Mg sheet, warm forming of Mg sheet may be the only option in utilizing Mg sheet within the lightweighting goals of FreedomCAR.

One reviewer notes that the metallurgy of magnesium are not nearly as promising for sheet components and so it is not nearly as promising as for casting applications.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

A reviewer states that a major technical barrier is oxidation in both castings and sheet magnesium. The reviewer continues that the barrier is well recognized and characterized, the first step in overcoming the barrier. The reviewer adds that Mg castings are already in use and Mg sheet forming has been determined to be technically feasible. The reviewer gives the example of the Chevy Corvette engine cradle as a proven deployment. The reviewer concludes that the project is well aligned to support the other projects through a life-cycle approach from basic research to deployment.

One reviewer says that warm forming of AZ31 sheet has been successfully practiced by the aerospace industry for years, but this project builds on the work done previously, and the background has been incorporated into the current project on the door inner. The reviewer notes that technical barriers include process optimization (warm forming temperature window, lubrication, tool material/coating, etc.): these have been clearly identified and are being addressed.

One reviewer believes that most of the technical challenges have been identified, but there are still many other challenges that have not been identified. A different reviewer felt that technical barriers are well defined but not addressed yet. The reviewer adds that the program is likely to address technical barriers but the material and the process may not be cost-effective. A different reviewer also expressed concern over cost effectiveness.

Two reviewers commented on the good linkage with suppliers and universities.

A reviewer noted that this set of questions need to be revised to include an "uncertain" category. Basically, there is a whole set of very tough problems associated with magnesium sheet and it is not entirely clear that they are surmountable, or at least doable at a cost that makes sense relative to steel.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

A reviewer noted that General Motors has deployed magnesium casting in the Chevy Corvette. One reviewer commented that Mg sheet will lead to significant weight saving: only the cost issue will remain a challenge. On the somewhat longer term it will be an important competitor for steel sheet. The reviewer continues that next to the material price also the production cost for magnesium sheet will be an important issue to focus on. It would be a good thing when there was more insight given in the investment cost for producing magnesium in the proposed method.

Concern was expressed over the cost effectiveness. One reviewer felt that while some of the challenges have been addressed, more work is still needed. A different reviewer felt that the progress reported in the presentation was a bit thin thus far, adding that this may be because of the early stage of the project.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

A number of reviewers expressed concern over the cost ineffectiveness of wrought magnesium that the technology may not be adopted by industry. One of these reviewers added that the team was addressing the project in an efficient way.

A reviewer noted that sheet suppliers are actively involved as is a prototype shop, ensuring results will be viable for implementation.

One reviewer commented that considering the problems/difficulties mentioned and the fact that there is a viable alternative to Mg sheet components (composites, Al sheet, even Mg die castings and thixomoldings) it is unlikely that the auto industry will opt to take the technology developed here into the marketplace. Another reviewer also talked of unlikely implementation due to cost and the range of applications of aluminum sheet or steel sheet.

A reviewer noted that this is a high risk program, the probability of success at this time is low, and technology transfer in the near future is unlikely.

One reviewer stated that this is definitely the least promising of the magnesium projects (and that is NOT intended to either discourage people or as a comment on the abilities or dedication of the research team). The reviewer continued that in the end, it may just be that the best material for sheet applications for mass-market cars will remain steel - but again, we are not quite there yet.

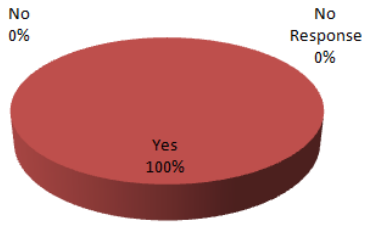
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers found the resources as sufficient. One reviewer said that insufficient resources include not only financial resources but also material supply resources, the latter grossly insufficient. A reviewer found resources sufficient, but that if need arose more funding should be injected. The final comment was that progress was shown in a gate stage manner. This showed that progress and cost are in line. This was one of the few projects that presented their progress in this manner.

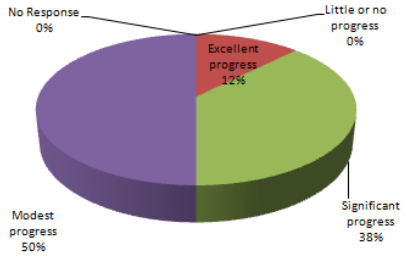
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

Project: Warm-Forming Magnesium Sheet

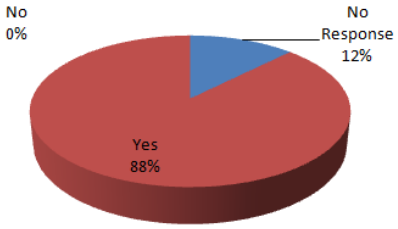
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



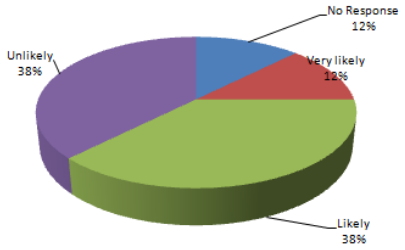
Question 3: Characterize the technical accomplishments and progress toward goals.



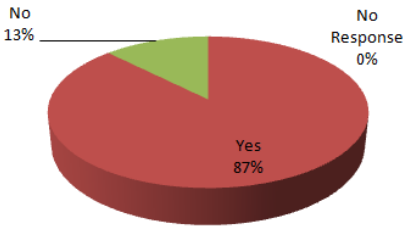
Question 2a: Are the goals of the project technically achievable?



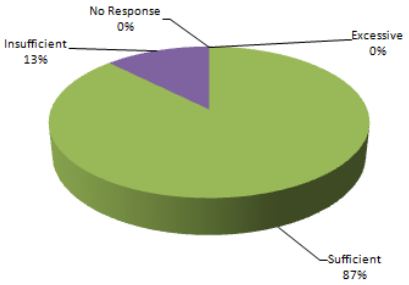
Question 4: How likely is the project team to move technologies into the marketplace?



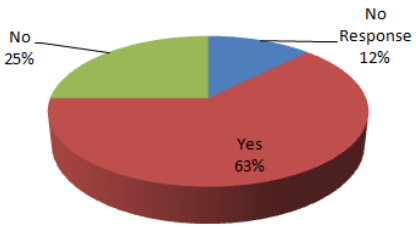
Question 2b: Have the technical barriers been identified and addressed?



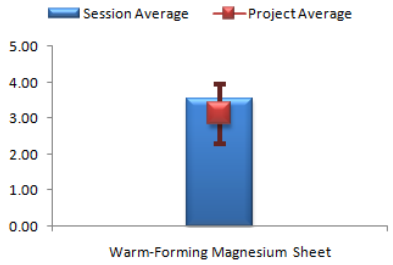
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



12. Propulsion Materials

Introduction

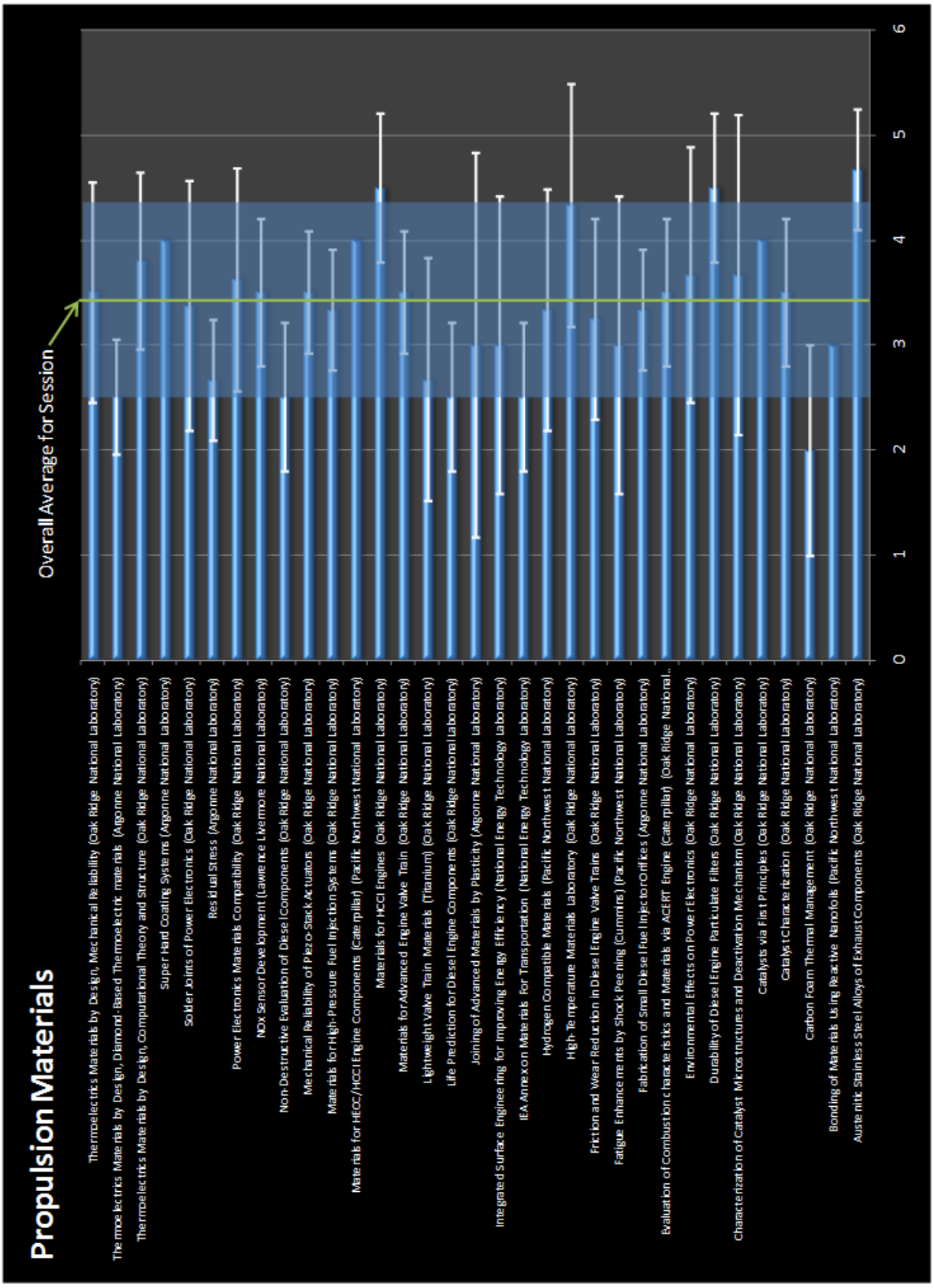
Propulsion materials research is critical to bringing advanced high-efficiency powertrains to the marketplace. The use of innovative materials in specialized applications throughout the powertrain can help to improve system efficiency and reduce emissions. Applications include engines, electrical drive systems, fuel systems, charge air systems, thermal management systems, exhaust aftertreatment systems, and engine accessories. DOE researchers and industry partners work together to identify the types of materials technologies required for advanced engines. These include material compositions and properties, as well as manufacturing processes, component cost, life prediction, and durability. In addition, propulsion materials research develops "enabling technologies" to ensure the success of new power electronics, advanced internal combustion engines, hybrid systems, and emission reduction technologies.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
12-5	Austenitic Stainless Steel Alloys of Exhaust Components (Phil Maziasz, Oak Ridge National Laboratory)	4.67	0.58
12-8	Bonding of Materials Using Reactive Nanofoils (Xin Sun, Pacific Northwest National Laboratory)	3.00	0.00
12-10	Carbon Foam Thermal Management (Nidia Gallego, Oak Ridge National Laboratory)	2.00	1.00
12-13	Catalyst Characterization (Thomas Watkins, Oak Ridge National Laboratory)	3.50	0.71
12-15	Catalysts via First Principles (C.K. Narula, Oak Ridge National Laboratory)	4.00	0.00
12-17	Characterization of Catalyst Microstructures and Deactivation Mechanism (Larry Allard, Oak Ridge National Laboratory)	3.67	1.53
12-20	Durability of Diesel Engine Particulate Filters (Thomas Watkins, Oak Ridge National Laboratory)	4.50	0.71
12-22	Environmental Effects on Power Electronics (A. Wereszczak, Oak Ridge National Laboratory)	3.67	1.21
12-25	Evaluation of Combustion characteristics and Materials via ACERT Engine (Caterpillar) (Ron Graves, Oak Ridge National Laboratory)	3.50	0.71
12-27	Fabrication of Small Diesel Fuel Injector Orifices (George Fenske, Argonne National Laboratory)	3.33	0.58

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
12-30	Fatigue Enhancements by Shock Peening (Cummins) (Dean Paxton, Pacific Northwest National Laboratory)	3.00	1.41
12-32	Friction and Wear Reduction in Diesel Engine Valve Trains (Peter Blau, Oak Ridge National Laboratory)	3.25	0.96
12-35	High-Temperature Materials Laboratory (Edgar Lara-Curzio, Oak Ridge National Laboratory)	4.33	1.15
12-37	Hydrogen Compatible Materials (Jim Holbery, Pacific Northwest National Laboratory)	3.33	1.15
12-40	IEA Annex on Materials For Transportation (Stephen Hsu, National Energy Technology Laboratory)	2.50	0.71
12-42	Integrated Surface Engineering for Improving Energy Efficiency (Aaron Yocum, National Energy Technology Laboratory)	3.00	1.41
12-44	Joining of Advanced Materials by Plasticity (Jules Routbort, Argonne National Laboratory)	3.00	1.83
12-47	Life Prediction for Diesel Engine Components (Nate Phillips, Oak Ridge National Laboratory)	2.50	0.71
12-49	Lightweight Valve Train Materials (Titanium) (Nate Phillips, Oak Ridge National Laboratory)	2.67	1.15
12-52	Materials for Advanced Engine Valve Train (Phil Maziasz, Oak Ridge National Laboratory)	3.50	0.58
12-55	Materials for HCCI Engines (G.Muralidharan, Oak Ridge National Laboratory)	4.50	0.71
12-57	Materials for HECC/HCCI Engine Components (Caterpillar) (Glenn Grant, Pacific Northwest National Laboratory)	4.00	0.00
12-60	Materials for High-Pressure Fuel Injection Systems (Peter Blau, Oak Ridge National Laboratory)	3.33	0.58
12-63	Mechanical Reliability of Piezo-Stack Actuators (A. Wereszczak, Oak Ridge National Laboratory)	3.50	0.58
12-66	Non-Destructive Evaluation of Diesel Components (Nate Phillips, Oak Ridge National Laboratory)	2.50	0.71
12-68	NOx Sensor Development (Robert Glass, Lawrence Livermore National Laboratory)	3.50	0.71
12-70	Power Electronics Materials Compatibility (B.L. Armstrong, Oak Ridge National Laboratory)	3.63	1.06
12-75	Residual Stress (Jules Routbort, Argonne National Laboratory)	2.67	0.58
12-77	Solder Joints of Power Electronics (G. Muralidharan, Oak Ridge National Laboratory)	3.38	1.19
12-82	Super Hard Coating Systems (Ali Erdemir, Argonne National Laboratory)	4.00	0.00
12-85	Thermoelectrics Materials by Design, Computational Theory and Structure (David Singh, Oak Ridge National Laboratory)	3.80	0.84

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
12-87	Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials (Dieter Gruen, Argonne National Laboratory)	2.50	0.55
12-92	Thermoelectrics Materials by Design, Mechanical Reliability (A. Wereszczak, Oak Ridge National Laboratory)	3.50	1.05
	Overall Session Average and Standard Deviation	**3.40**	**1.00**


Propulsion Materials
Overall Average for Session
Thermoelectrics Materials by Design, Mechanical Reliability (Oak Ridge National Laboratory)
Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials (Argonne National Laboratory)
Thermoelectrics Materials by Design, Computational Theory and Structure (Oak Ridge National Laboratory)
Super Hard Coating Systems (Argonne National Laboratory)
Solder Joints of Power Electronics (Oak Ridge National Laboratory)
Residual Stress (Argonne National Laboratory)
Power Electronics Materials Compatibility (Oak Ridge National Laboratory)
NOx Sensor Development (Lawrence Livermore National Laboratory)
Non-Destructive Evaluation of Diesel Components (Oak Ridge National Laboratory)
Mechanical Reliability of Piezo Stack Actuators (Oak Ridge National Laboratory)
Materials for High-Pressure Fuel Injection Systems (Oak Ridge National Laboratory)
Materials for HECC/HCCI Engine Components (Caterpillar) (Pacific Northwest National Laboratory)
Materials for HCCI Engines (Oak Ridge National Laboratory)
Materials for Advanced Engine Valve Train (Oak Ridge National Laboratory)
Lightweight Valve Train Materials (Titanium) (Oak Ridge National Laboratory)
Life Prediction for Diesel Engine Components (Oak Ridge National Laboratory)
Joining of Advanced Materials by Plasticity (Argonne National Laboratory)
Integrated Surface Engineering for Improving Energy Efficiency (National Energy Technology Laboratory)
IEA Annex on Materials for Transportation (National Energy Technology Laboratory)
Hydrogen Compatible Materials (Pacific Northwest National Laboratory)
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Characterization of Catalyst Microstructures and Deactivation Mechanism (Oak Ridge National Laboratory)
Catalysts via First Principles (Oak Ridge National Laboratory)
Catalyst Characterization (Oak Ridge National Laboratory)
Carbon Foam Thermal Management (Oak Ridge National Laboratory)
Bonding of Materials Using Reactive Nanofoils (Pacific Northwest National Laboratory)
Austenitic Stainless Steel Alloys of Exhaust Components (Oak Ridge National Laboratory)
0
1
2
3
4
5
6

Austenitic Stainless Steel Alloys of Exhaust Components (Phil Maziasz, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first response stated that the use of this alloy will definitely benefit development of high-efficiency engines with advanced emission controls. Another reviewer added that it allows higher exhaust temperatures; this opens the way for more efficient engines. One other person commented that the group developed and commercialized CF8C-Plus cast stainless steel for exhaust components to provide higher temp capability and durability.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the current phase of this project is mostly deployment, while another noted that the project was executed in close cooperation with foundries and an OEM. One final respondent stated that the group has developed alloys and extensively tested them to qualify for diesel exhaust component applications. They have also worked with ORNL in generating short- and long-term creep and fatigue data. The reviewer also noted that CAT and ORNL work together to attract industrial end users.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that high-temperature alloys are needed for turbochargers and emission control devices, and this requirement becomes more severe with high-efficiency engines. Another person stated that, although the project is very successfully moving forward, its effect on petroleum displacement is relatively small.

One individual indicated that there was clear problem definition. The first commercial heats were done only 1.5 years after the initial lab-scale heat. CF8C performed more than 10 times better in creep life than the SiMo Cast iron. The reviewer also commented on Ni-Resist and the extensive test data being collected.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the need and application of this alloy is obvious for turbochargers and exhaust manifolds, while another commented that the developed material will be used on the short term. One final reviewer commented on the CRADA with CAT, and that they are in the process of commercialized the new material. The reviewer adds that, to date over one million pounds of CF8C-Plus steel have been cast for regeneration housings by CAT. There is one patent between CAT and ORNL, and they have applied for a new ASTM alloy grade to support commercial licensing interests.

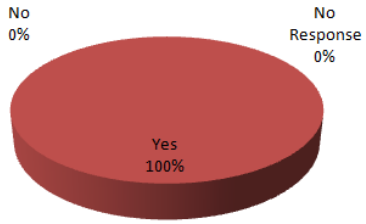
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the level of funding appears to be reasonable to support the deployment to a turbocharger application.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

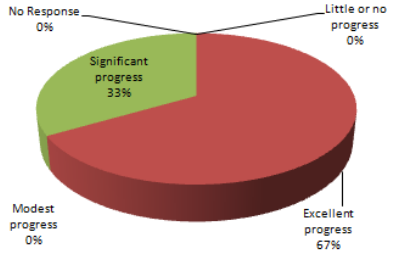
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Austenitic Stainless Steel Alloys of Exhaust Components

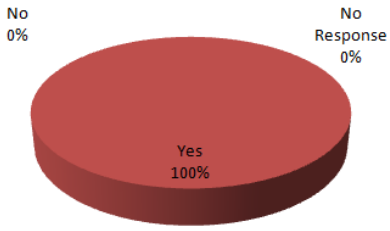
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



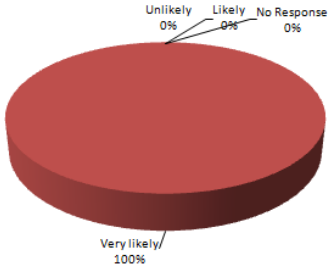
Question 3: Characterize the technical accomplishments and progress toward goals.



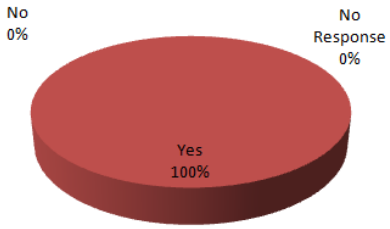
Question 2a: Are the goals of the project technically achievable?



Question 4: How likely is the project team to move technologies into the marketplace?



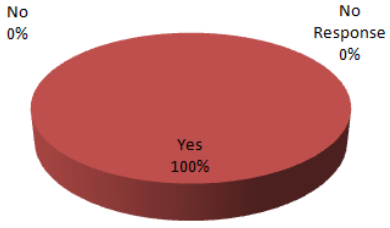
Question 2b: Have the technical barriers been identified and addressed?



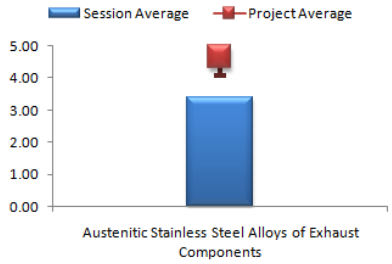
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Bonding of Materials Using Reactive Nanofoils (Xin Sun, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this work is enabling further vehicle weight reduction by investigating new reliable and cost-effective joining methods. The other response stated that it aims at reducing weight. It is a challenging idea. Application will be most likely outside the engine in the rest of the power train and chassis.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person stated that it is difficult to assess, but there is a partner that could be helpful in deployment. They added that more evidence must be given on the OEM's interest. The other person listed the following as barriers: higher heat energy input, lack of reliable and cost-effective joining methods. They commented on the following approaches: acquire nanofoils of various layer thickness and lay-up, quantify amount of heat generation, braze solder steel and different materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the amount of weight savings is relatively modest. The other noted that the group had tested 4 mm SAE 1008 to SAE 1008 solder joint, 2mm AA5182 to AA5182 braze joint and completed a bond strength comparison with adhesion bond and developed a cost model for nanofoils.

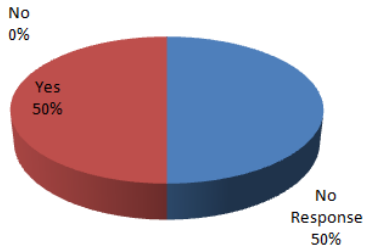
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first response stated that the project is exploratory, and it has a lot of potential to be used in various applications. The other reviewer stated that it is a concept feasibility study only for now. The group has maintained close interactions with OEM, Tier 1 suppliers, and nanofoil suppliers, and some companies have showed interest.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

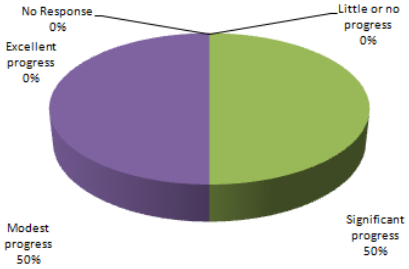
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Bonding of Materials Using Reactive Nanofoils

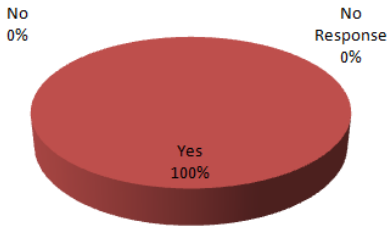
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



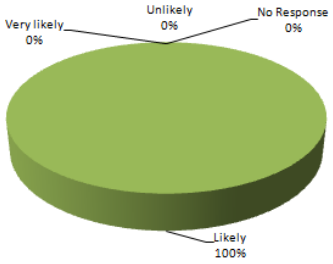
Question 3: Characterize the technical accomplishments and progress toward goals.



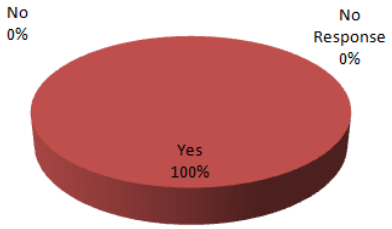
Question 2a: Are the goals of the project technically achievable?



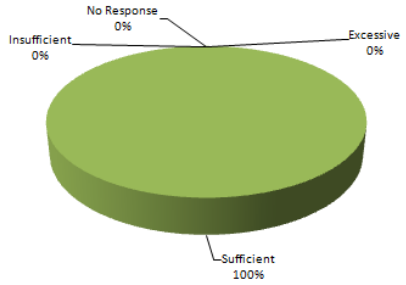
Question 4: How likely is the project team to move technologies into the marketplace?



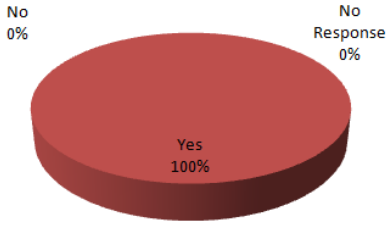
Question 2b: Have the technical barriers been identified and addressed?



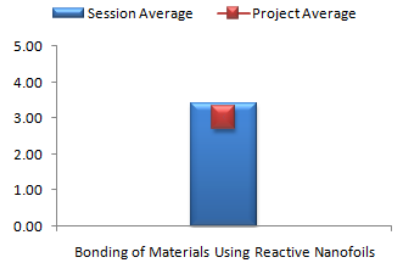
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Carbon Foam Thermal Management (Nidia Gallego, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were mixed overall. One person commented that this program supports the effort by looking at a graphite foam thermal siphon to cool the power electronics. Another wrote that the project is supportive for hybrid vehicles; as such, it will lead to a reduction of fuel consumption. It is not made clear whether or not the size and weight reduction are adequate for demands in new generation hybrids. One other reviewer wrote that it is not at all clear how performance obtained or realistically projected will substantially reduce weight in a vehicle, or reduce power requirement for a given amount of necessary cooling in an engine or vehicle. The analysis of the size of the potential impact seems not to have been made. Specifically, even though the material is lighter than copper or aluminum, the same heat transfer schemes cannot be used, and a completely new cooling system does not seem to have been carefully thought out with total system weight compared to conventional systems. A lighter heat transfer material in a heavier total heat transfer system would not be a win.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person wrote that the strategy of interesting a supplier seems to be working, and deployment seems to be potentially achievable, but the potential impact on DOE goals does not seem to be high. Another response stated that in the consortium there is involvement of a foam manufacturer and a heat exchange manufacturer. What is missing is an OEM setting the demands for the heat exchanger. One other reviewer stated that the best uses of graphite foam for cooling have been addressed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the improvement of 20% in cooling rates over a conventional thermal siphon can be seen as a modest amount of progress. The other responded indicated that the project's objectives were originally defined as an optimized heat exchanger design that best utilizes graphite foam to significantly reduce the size and weight of the thermal management system. The question is whether the project meets those requirements with a thermal siphon over other cooling technologies.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Comments were generally cautious or pessimistic to this question. One reviewer wrote that the team could bring the technology to the market, but it is not very likely since there is no insight into the needed reduction in size and weight. Another felt that, while vendor interest seems to be high, technical obstacles still seem to be high as well, in particular with regard to robust mechanical properties and fluid interactions. In an application that would significantly contribute to VT goals, success seems to be difficult to achieve. One other person wrote that for the traction application the size, weight and cost of the system may be too high. This person added that the thermo siphon with graphite foam may have applications within the industrial market.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

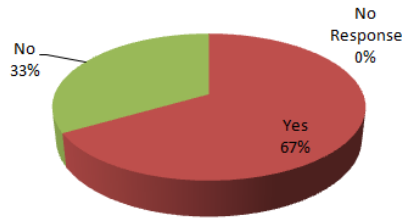
One person noted that it was indicated that the project will complete this year, so the total budget will be sufficient. The other response stated that it is likely that breakthrough understanding will be required, and this is probably not a function of funding.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

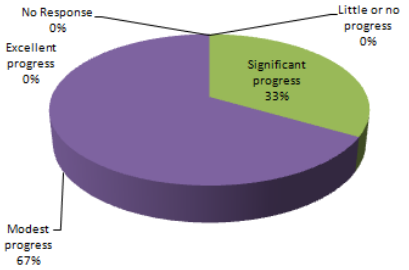
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Carbon Foam Thermal Management

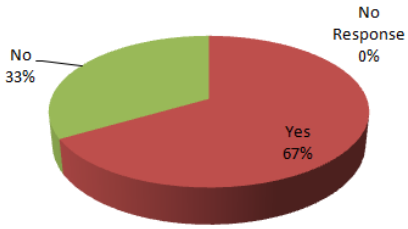
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



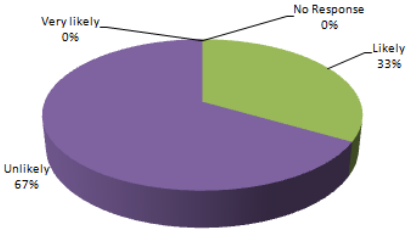
Question 3: Characterize the technical accomplishments and progress toward goals.



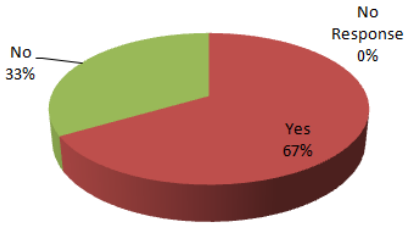
Question 2a: Are the goals of the project technically achievable?



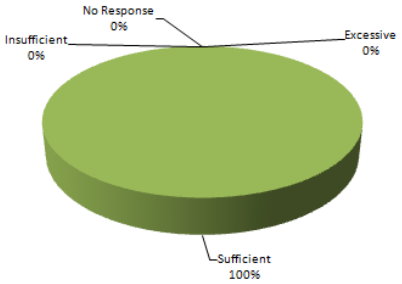
Question 4: How likely is the project team to move technologies into the marketplace?



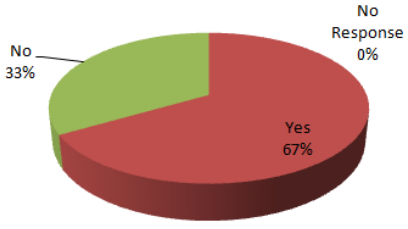
Question 2b: Have the technical barriers been identified and addressed?



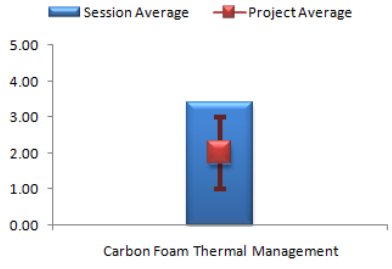
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Catalyst Characterization (Thomas Watkins, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that more efficient SCR allows a higher NOx engine without leading to lower fuel consumption. The other respondent stated that this project addresses a very important problem linked directly to fuel consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the project is lacking the contribution of a catalyst supplier, while the other person stated that this is good work to do, with a workmanlike (though not spectacularly imaginative) approach. In this area, the reviewer adds, almost any careful and extensive evaluation will produce useful findings.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One response indicated that better optimized after-treatment systems will reduce fuel consumption. The project will lead to new characterization methods for SCR catalysts. The other reviewer commented that this work seems to be moving slowly, but moving. Application of existing techniques to a more rapid analysis of a wide range of sample thermal histories would seem to be very productive.

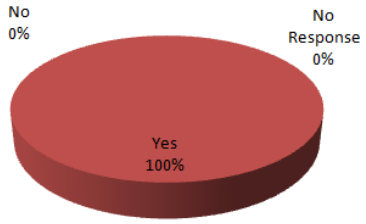
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that any informative results will very rapidly find application in production systems, while the other person felt that missing the contribution of a catalyst supplier bares in itself the risk that the market introduction is not sure.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

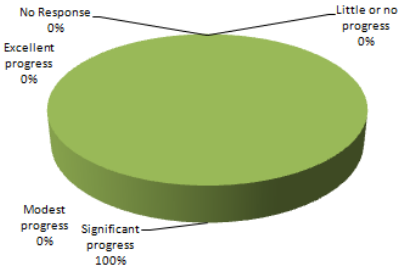
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Catalyst Characterization

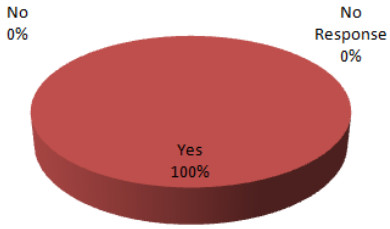
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



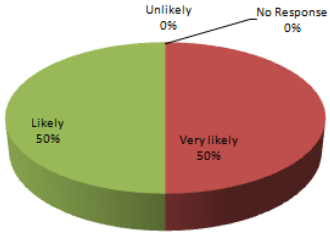
Question 3: Characterize the technical accomplishments and progress toward goals.



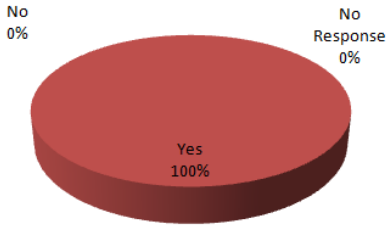
Question 2a: Are the goals of the project technically achievable?



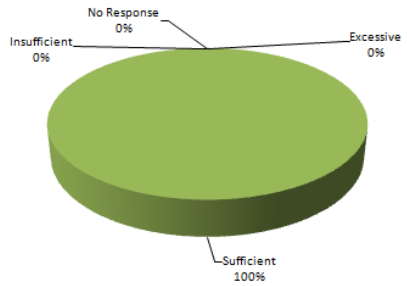
Question 4: How likely is the project team to move technologies into the marketplace?



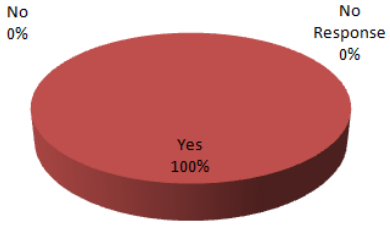
Question 2b: Have the technical barriers been identified and addressed?



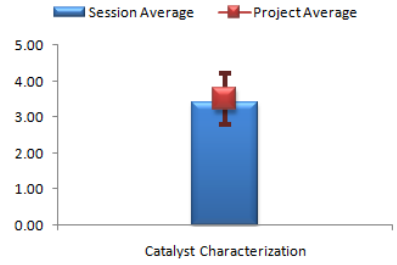
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Catalysts via First Principles (C.K. Narula, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer commented that a more fuel efficient engine must also fulfill the emission requirements. So the project is not directly aimed at reducing fuel consumption. Also, alternative fuels will need a better understanding of the catalyst mechanisms. The other respondent indicated that, if this can be done in a meaningful way, it will provide useful insights. The reviewer added that fundamental understanding advances will immediately find application in production systems.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent stated that the research is aimed at building up base knowledge on the way to catalyst work. Based on this understanding, improved catalysts can be produced. The reviewer added that the interaction with catalyst suppliers is not very clear.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that new understanding is emerging. This has been an area of much episodic investigation, and a more structured fundamental approach is immediately providing new perspective. This is useful. The other respondent stated that not having a proper understanding or having to work with a less efficient catalyst leads to increased fuel efficiency, since the air quality has to be respected.

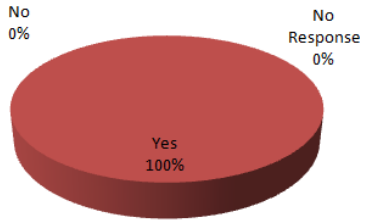
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One respondent referenced the cooperation with John Deere and Ford, while the other person felt that, at this early stage, it is not clear how much guidance will be provided to engineering production systems in the near term. If the work continues at this pace, it is very likely to influence production systems.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

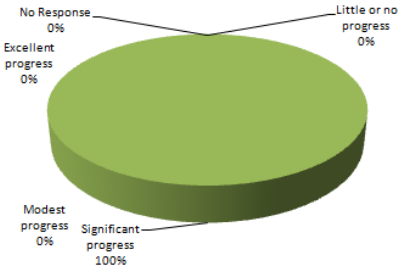
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Catalysts via First Principles

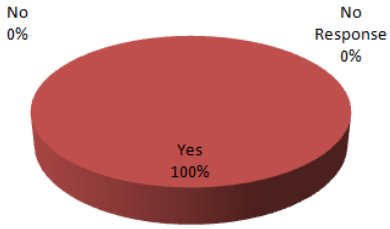
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



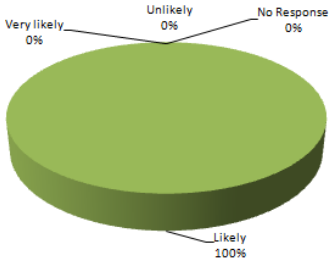
Question 3: Characterize the technical accomplishments and progress toward goals.



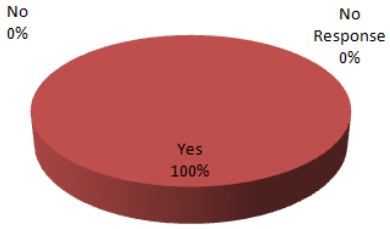
Question 2a: Are the goals of the project technically achievable?



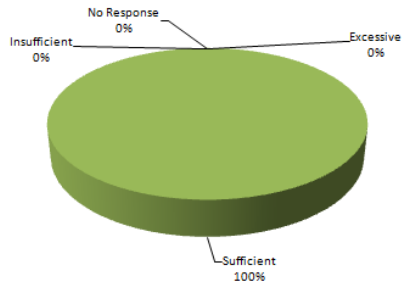
Question 4: How likely is the project team to move technologies into the marketplace?



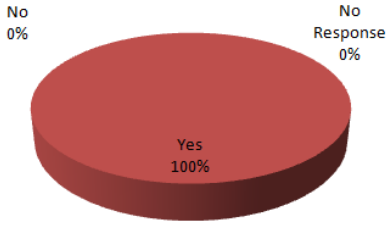
Question 2b: Have the technical barriers been identified and addressed?



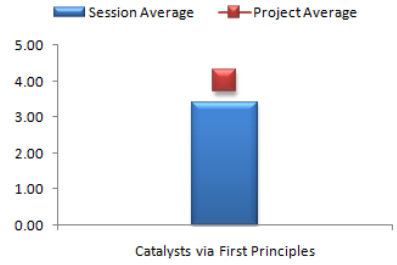
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Characterization of Catalyst Microstructures and Deactivation Mechanism (Larry Allard, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the development of more efficient catalysts will allow all types of vehicles to be more efficient, with another person adding that the group is working to develop a novel new capability for in-situ studies on emission. One other respondent said that the answer is yes, but it is very indirect. Better understanding of catalysts will/can lead to more efficient catalyst conversion, opening the operating window for fuel reduction.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent commented that the consortium has a good mix of academia and industry, and the contribution of BASF will be beneficial for deployment. Another person wrote that this project is developing new instrumentation that will allow new catalyst development. However, the barriers to develop this instrumentation have not been identified, so it is not possible to assess their capability to overcome them. The PI is working with many entities to deploy this technology to others. One other reviewer cited the following as a barrier: understand the interactions between individual atoms and studying high temperature interaction. This person noted the following approach: acquire the best microscopy and develop techniques for advanced catalyst characterization.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person felt that sufficient visual evidence has been presented to demonstrate considerable progress. Another reviewer cited the extensive collaboration with many universities and entities, as well as the group's great publications and great capability in understanding catalyst interaction on an atomic scale. One other person indicated that, although sufficient evidence is given that the work is leading-edge, its connection to the DOE goals is indirect. It is aimed at implementation on the longer term. The work could lead to a breakthrough, but this is difficult to rank in the given format.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that this question was not applicable, since this project is not developing a technology for application to engines or vehicles. Another commented that this is an enabling technology that has been widely used, and cited the great cooperation among UOP, PNNL, ORNL, UT-Austin, and ACEM. The final respondent noted that there is cooperation with a catalyst supplier. They will use the know-how. It would be an improvement if an OEM or engine manufacturer was involved. This would increase the possibility that the technology would lead to improved fuel efficiency.

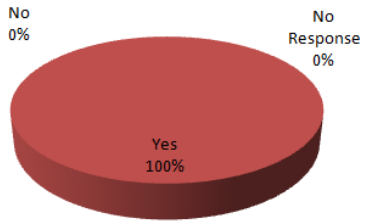
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that there is nothing to indicate that additional resources are needed by VT. Co-funding is being provided by DOE BES.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

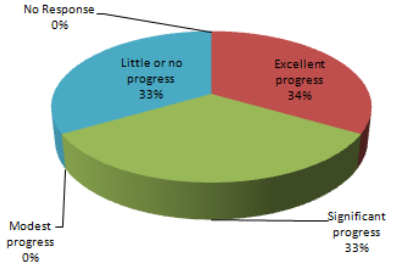
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Characterization of Catalyst Microstructures and Deactivation Mechanism

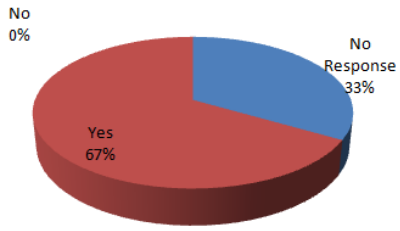
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



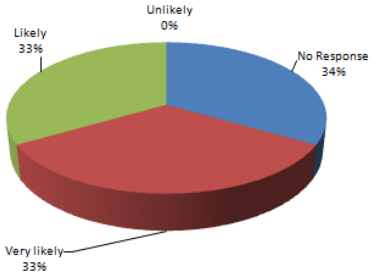
Question 3: Characterize the technical accomplishments and progress toward goals.



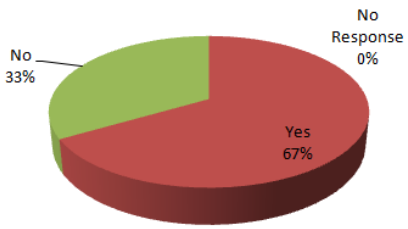
Question 2a: Are the goals of the project technically achievable?



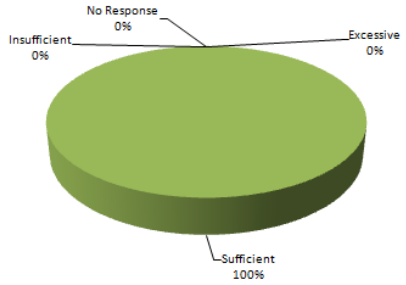
Question 4: How likely is the project team to move technologies into the marketplace?



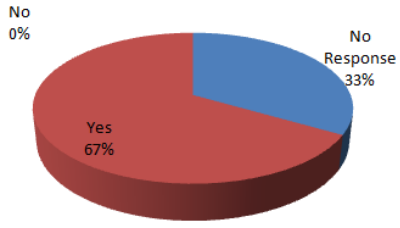
Question 2b: Have the technical barriers been identified and addressed?



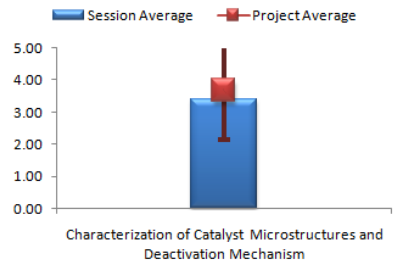
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Durability of Diesel Engine Particulate Filters (Thomas Watkins, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were very positive here, with one person stating that the project is aiming at reducing fuel consumption used for regenerating the DPF. In this field, large progress is achievable. The other respondent stated that this is necessary development, with the pace of technological understanding well behind the pace of commercial application. This work badly needs to be done and done rapidly. The quality of the work being done is excellent.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Both reviewers were positive in this section, with one stating that there is a good balance in the project contributors was shown. There is strong involvement of a tier 1 supplier working in close cooperation with an OEM. Also, laboratories are involved. The other person stated that this is a well thought out program, and that the necessary tools are in place. Any success will immediately be applied in production.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that the regeneration fuel consumption is greatly reduced, which can be considered as a significant fuel consumption. The other reviewer commented that the project has shown good progress given the difficulty of the problems.

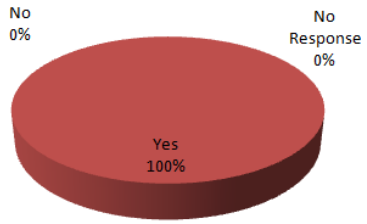
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the cooperation of Cummins with Dodge will lead to market introduction as soon as the technology is available, and the other response stated that there will be useful findings resulting from this project, and they will immediately be taken into account in the improvement of production filters.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the quality of the work being done and the thought processes around the results are excellent.

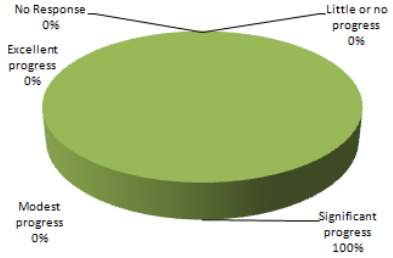
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Durability of Diesel Engine Particulate Filters

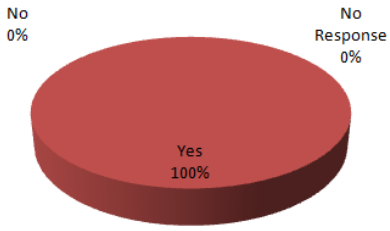
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



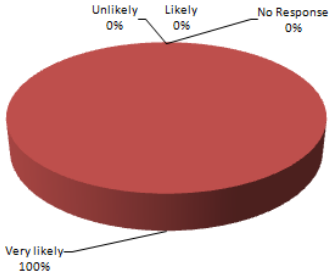
Question 3: Characterize the technical accomplishments and progress toward goals.



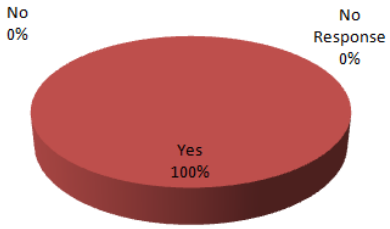
Question 2a: Are the goals of the project technically achievable?



Question 4: How likely is the project team to move technologies into the marketplace?



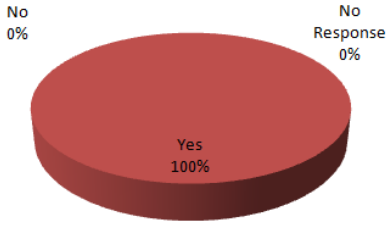
Question 2b: Have the technical barriers been identified and addressed?



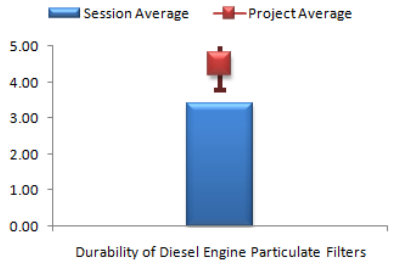
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Environmental Effects on Power Electronics (A. Wereszczak, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated yes, because it is supportive of high power electronics. This is needed for future generations of hybrids. Similarly, another reviewer commented that the focus on power electronics size and mass reduction is critical to the success of future HEV and PHEV deployment and thereby displacement of oil imports. One other response stated that wider adoption of hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV) products will save millions of barrels of oil due to a higher fleet MPG average. However, before this can occur the cost of these products must be much closer to that of traditional vehicles. One way to assist industry in achieving that goal is to develop technologies that can reduce the cost of the cooling systems in existing HEV and PHEV products. This goal can be achieved by either developing power electronics that can operate at higher temperatures and therefore reduce the cooling requirements, or by reducing the thermal resistance between the power electronics and the coolant so that the standard ICE coolant can be used for the power electronics as well. This work has the potential to achieve the second goal and therefore could make a significant contribution to a much lower cost PHEV / HEV product line and therefore, significantly higher average MPG and the associated saving in oil.

One reviewer stated that this was well-thought-out and is likely critical path work. Another felt that the proposed work has good synergy with other NTRC projects (direct substrate cooling). The results of the environmental tests on PEMs will be very helpful to PEM manufactures and users to determine their qualification criteria with new materials for the higher temperature application. Another added that the high temperature operation is a trend for HEV application, and it is important to understand the reliability under more stringent environments.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Comments were generally positive here, with one person indicating that the development of ceramic substrates that can increase the reliability of these modules and decrease the thermal resistance between the power devices and the heat sink is a good approach and will be a likely outcome of this work. Another stated that the approaches are laid out carefully, while one person commented on the solid strategy and focus on enhancing power electronics capability, performance and lifetime. These are all of an utmost importance to vehicle OEM's. One person stated the strategy to work with a substrate manufacturer is good idea. It is probably necessary to also include a PEM manufacturer.

One reviewer commented that this technology is in competition with other solution investigated in other presented project like carbon foam cooling and refrigerant cooling. As a whole, the materials for electric and hybrid drive systems projects all deal with different parts needed for solving the issues with high temperature in electronics. It is not very likely that all proposed solutions will find their way in the industry, but it is likely that one will come through.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One person commented that these are still the early days of the program, but the approach seems likely to make good progress, while another reviewer stated that the progress is on track. One response indicated that good progress has been made to date in understanding the state of the art in these products as well as in the initial steps towards the development of new materials that may enable the objective. Another reviewer commented, similarly, that progress is good and focus on conventional coolants (automotive WEG - water ethylene glycol) is very appropriate for high temperature power electronics and supports programs aimed at 200°C junction temperatures. One reviewer felt that several significant accomplishments were listed and the project approach seems quite reasonable. One other person felt hybrids in themselves will partly be able to overcome the barriers mentioned, and this will only be a small contribution to the further introduction of Hybrids.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Reviewers were generally positive in this section, with one person stating that it is very likely that improved materials will result from this work and enable lower thermal resistance between the power die and the coolant. Since this could dramatically improve the performance of these products, adoption by industry is very likely. Another person commented that he or she sees this project having a very likely chance of panning out.

One reviewer stated that the technology that will be transferred is the test results that will give OEM manufacturers the necessary information to evaluate some new packaging concepts. Similarly, one person wrote that the test results can be of benefit to the component suppliers.

To contrast, one final reviewer stated that the use of engine coolant is a high risk because of the cleanliness of this fluid over time. So testing with clean fluids will not give a clear view on real operating conditions.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

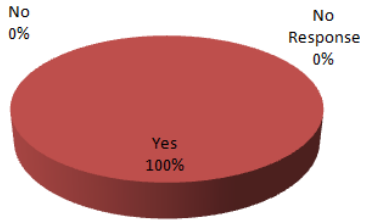
Responses were somewhat mixed in this section. One person stated that the resources appear adequate to achieve the project goals, and another stated that they are sufficient. One other reviewer commented that the goal is too broad to be achieved.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

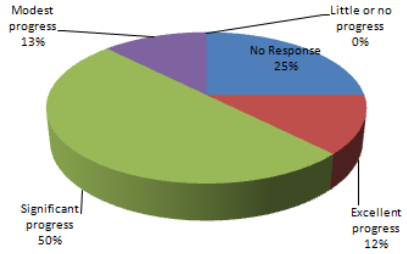
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Environmental Effects on Power Electronics

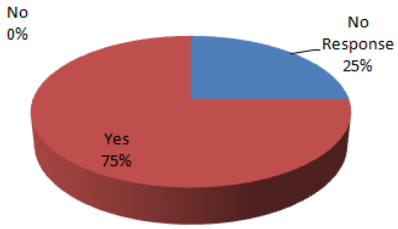
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



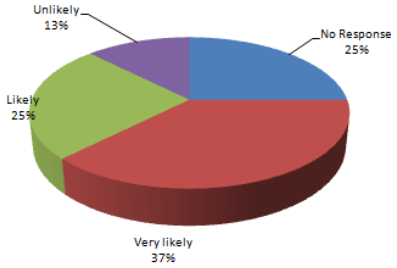
Question 3: Characterize the technical accomplishments and progress toward goals.



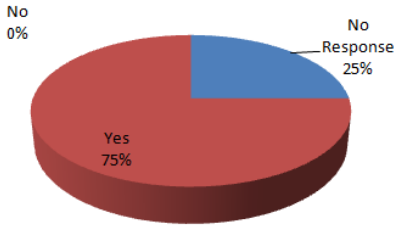
Question 2a: Are the goals of the project technically achievable?



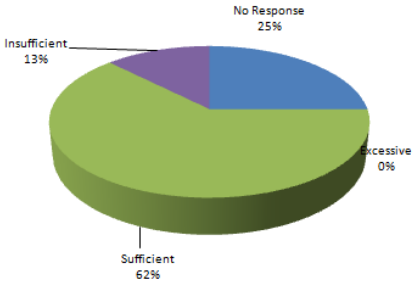
Question 4: How likely is the project team to move technologies into the marketplace?



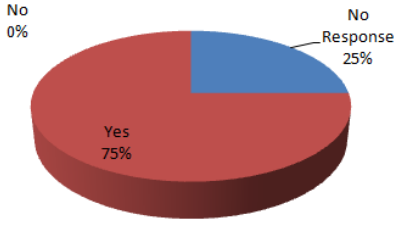
Question 2b: Have the technical barriers been identified and addressed?



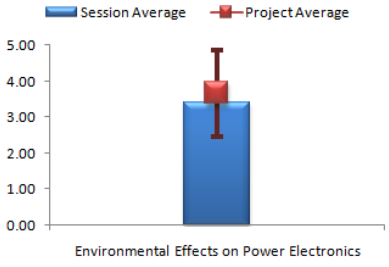
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Evaluation of Combustion Characteristics and Materials via ACERT Engine (Caterpillar) (Ron Graves, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer stated that this project will improve diesel engine performance, efficiency, and emissions. The goal is to achieve 55% efficiency for a diesel engine. The other respondent also commented that the aim is to have materials available that will allow 55% fuel efficiency, adding that this is a multidisciplinary project.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person indicated that the project is still in its early phases, adding that the partnership covers the supply chain. Another commented that the barriers are parasitic, friction, and heat transfer losses, while the approach includes an industrial-National Lab partnership.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first response stated that the aims of the project are fully aligned with DOE's goal, but added that the project is in its early phase and the main aim right now is to define the path forward. The other reviewer commented that they have assembled a research team and are working together to procure hardware from CAT.

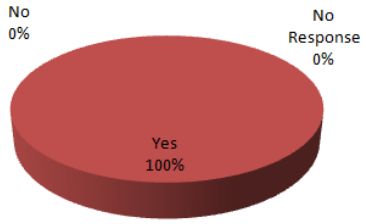
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer noted that CRADA will be executed with CAT, adding that CAT provided the engine for ORNL to test. Following up on this, another reviewer stated that the involvement of an OEM will ensure that the results find their way to the market.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the budget was discussed, and the outcome of this discussion was that it was sufficient.

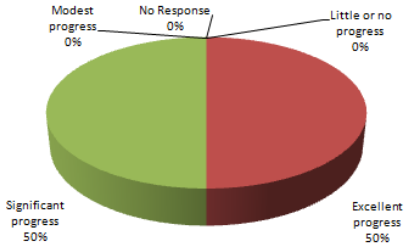
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Evaluation of Combustion characteristics and Materials via ACERT Engine (Caterpillar)

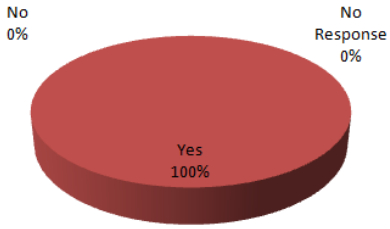
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



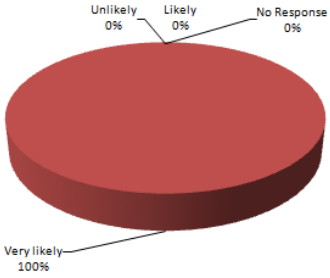
Question 3: Characterize the technical accomplishments and progress toward goals.



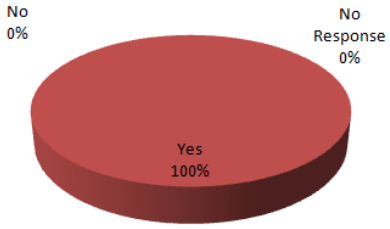
Question 2a: Are the goals of the project technically achievable?



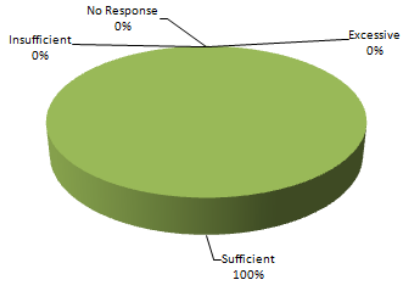
Question 4: How likely is the project team to move technologies into the marketplace?



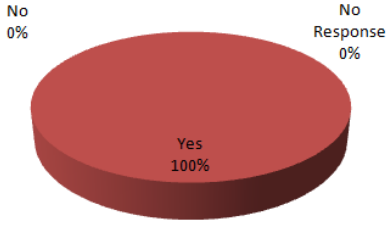
Question 2b: Have the technical barriers been identified and addressed?



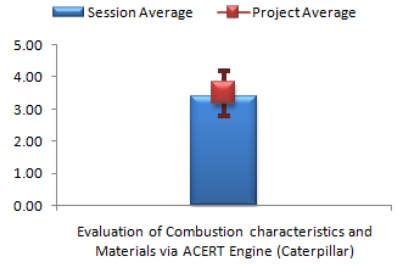
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Fabrication of Small Diesel Fuel Injector Orifices (George Fenske, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer noted that smaller diameter orifices will improve combustion leading to reduced fuel consumption. It should be noted that the reduction of produced particulates allows the engine engineer to reduce the fuel consumption further through wider engine operating conditions. Another person followed up by saying that experience outside of the presented work indicates that smaller holes in the injector nozzle will reduce smoke (soot) and possibly reduce NOx emissions, however extrapolating that to a significant petroleum displacement does not seem likely. One reviewer commented that this is a well-known pathway to improve combustion. This is an innovative approach, but not moving rapidly at all.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that, although 2 a, b, and c are answered with "yes," fuel injection manufacturers are involved but not mentioned by name due to NDA. Another response commented that the body of the presentation mentions technical barriers with regards to emissions reduction without a fuel economy reduction; the data would indicate that this is likely to be achieved with this technology with the added benefit that it could result in a reduced overall system (power train system) cost. Identified, but not discussed in sufficient detail, were technical barriers; the adherence of the plated material and the consistency of the shape of the final hole or the consistency of the surface finish within the hole. These would seem to this reviewer to be significant technical barriers whose resolution must be demonstrated in a reliable manner for this project to be considered a success.

One other reviewer said yes to all of the above questions, but with large reservations. Adherence and durability of the coatings is likely to be a huge issue. Cavitation is a constant problem in high pressure injectors, and spalling due to modulus mismatch under cavitation conditions would be expected to be a huge problem. Microgeometry at the edge of the opening is also critical and may be difficult to manipulate.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that this project could lead to a short term improvement in fuel economy by improved fuel injection. The other person responding commented that the demonstration of the capability to produce small spray holes has been shown and identification of technical barriers has been accomplished. The presentation implied that some or all of these issues have been addressed but did not provide details of how or demonstration of success. If these technical barriers have been addressed the progress is certain being made in a timely manner.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Responses were generally positive in this section. One reviewer stated that, assuming that the three technical barriers can be overcome in a way that can be implemented in high volume production, the results of this project are likely to be utilized very soon after they are available. Another commented

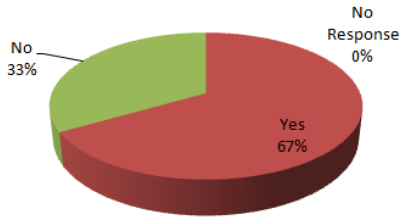
that one of the key items not making it very likely is the change from laboratory to mass production. Also, cost can be an issue. Following this, one person stated that this community is relatively open to innovations, and the proposed process is not likely to be expensive in the grand scheme of injector technology.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Both reviewers agreed that resources looked sufficient, with one person stating that, looking at the progress and the work package, the resources look sufficient. The other reviewer stated that he or she did not see any indications in the material that the project has either excessive or insufficient resources.

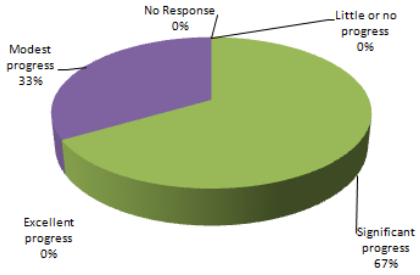
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Fabrication of Small Diesel Fuel Injector Orifices

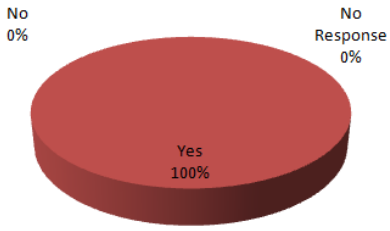
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



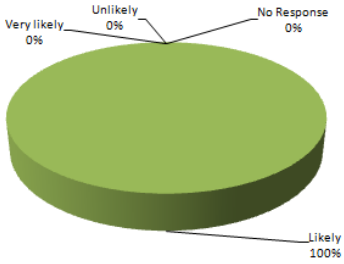
Question 3: Characterize the technical accomplishments and progress toward goals.



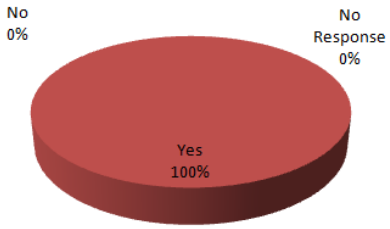
Question 2a: Are the goals of the project technically achievable?



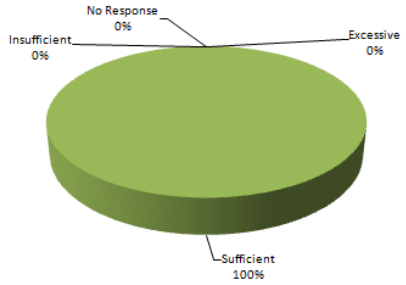
Question 4: How likely is the project team to move technologies into the marketplace?



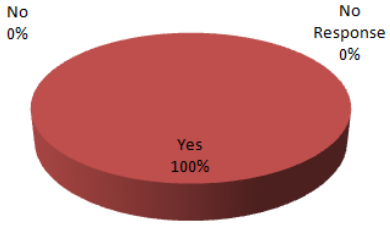
Question 2b: Have the technical barriers been identified and addressed?



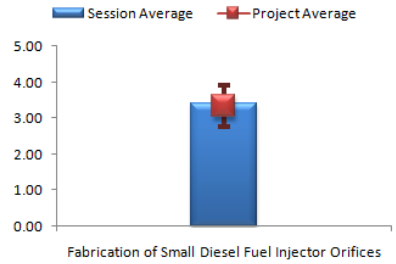
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Fatigue Enhancements by Shock Peening (Cummins) (Dean Paxton, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer simply stated the goals are supported only very indirectly. The other respondent commented that improved fatigue properties are determining the maximum loads in critical components like fuel injection systems. This reviewer added that increasing the operational envelope will lead to reduced fuel consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that there is cooperation with engine manufacturers, and this will ensure that the results will lead to use. Also, suppliers of equipment are involved. The other respondent disagreed, stating that it is uncertain that these techniques, even if successful, would be deployed. What is missing, this reviewer adds, is the advantage that would occur from the success of this project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One response began by commenting that there is a trend to increase fuel injection pressures for further fuel efficiency/emission reduction. The technology developed in this project will allow the industry to achieve this. This reviewer adds that the extra benefit is the fact that the introduction of high performance but difficult-to-machine materials is avoided.

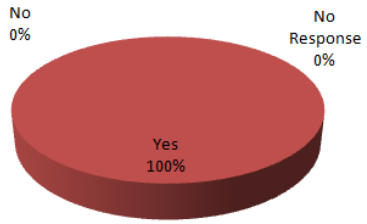
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first person commented that a strong interest from industry had been shown, while the other reviewer stated that their response was only accurate if a significant advantage can be shown relative to current technologies.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent indicated that, in general, no financial data are presented to the reviewers in the propulsion materials group.

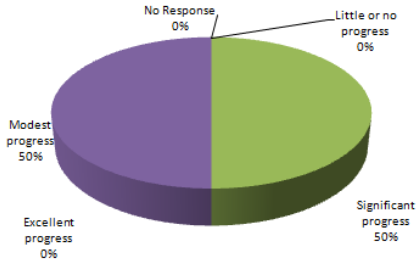
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Fatigue Enhancements by Shock Peening (Cummins)

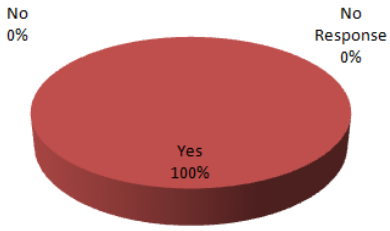
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



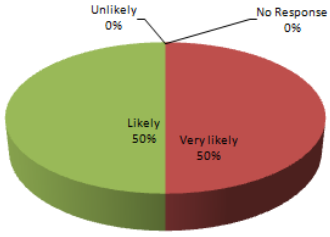
Question 3: Characterize the technical accomplishments and progress toward goals.



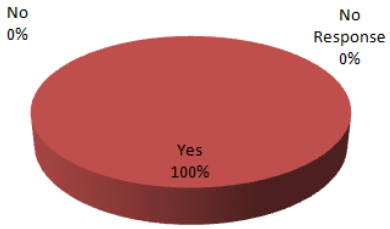
Question 2a: Are the goals of the project technically achievable?



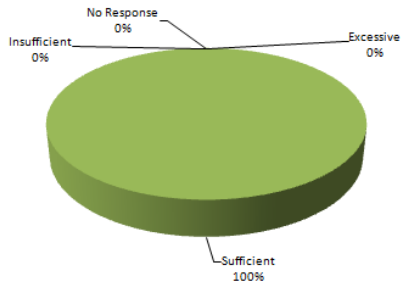
Question 4: How likely is the project team to move technologies into the marketplace?



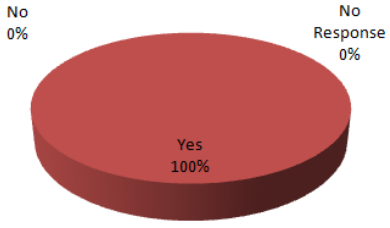
Question 2b: Have the technical barriers been identified and addressed?



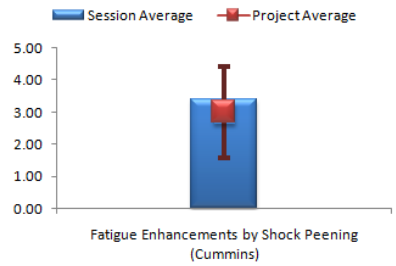
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Friction and Wear Reduction in Diesel Engine Valve Trains (Peter Blau, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were mixed. The first reviewer commented that the aim is to develop a next-generation valve material for fuel-efficient and low-emission engines. One other person commented that better valves will support development of higher efficiency engines, while another stated that the project aims at maintaining fuel efficiency over the lifetime of a vehicle. So it is indirectly supporting the overall DOE objective.

Another reviewer stated yes, but barely. This project is more focused on the long-term impact of late engine life compression loss due to worn valves versus friction reduction in engines. Therefore, its impact on fuel efficiency is very minimal over the total life of the engine. Though scientifically interesting, this project seems more focused on addressing a valve leaking issue versus the primary goal of DOE regarding reducing petroleum use.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that there is some coordination with Caterpillar, but the value is unknown. Another noted that the project is to design and build a high temperature repetitive impact apparatus to test wear and do oxide damage tests. This work includes model development in 2008.

One person commented that using test apparatuses for characterization of the valve wear is not the same as the in-engine conditions. To contrast, another reviewer stated that the PI has developed or has very good experimental tools to assess various valve materials and their high temperature behavior under engine-like conditions, which will be critical to overcome high temperature issues associated with the various valve material constituents.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Responses were generally mixed in this section. One reviewer stated that this project has shown good progress given the relatively short duration and limited funding. Another felt that great progress had been made in building apparatuses for conducting high temperature wear impact tests.

To contrast, one person noted that the goal of the project is to reduce wear of valve/valve seats. This would only reduce the use of fuel in a small part of the use of the engine. One reviewer stated that this project is only partially funded ($200K), which may contribute to its slow progress. It is understood that high temperature durability experiments to develop valve wear models are time-intensive, but the model development seems to still be lacking. This will be targeted in future plans.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person noted that there is a follow-up CRADA with Caterpillar planned. This shows the interest of the industry. Another reviewer stated that this subject area is continually evolving as engine OEMs attempt to deliver durable engines to the marketplace. This project has very good potential to impact

the design of next or next-next generation of engine valves. One individual stated that industry should be able to use this information: whether they do use it is based on costs, benefits, and need. For example, these developments may not be needed on current technology engines.

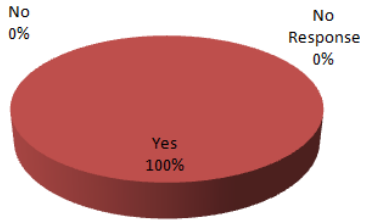
One final reviewer suggested that the investigators should coordinate work with CAT, and added that the HTRI will become available for industries.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that funding appears to have been reasonable for this project. Any extension and the associated costs should be weighed carefully. The other respondent felt that this project has outstanding experimental facilities/test apparatuses towards addressing the core valve leaking issue. The high temperature test rig in particular is an excellent and necessary resource for understanding and subsequently developing valve wear models.

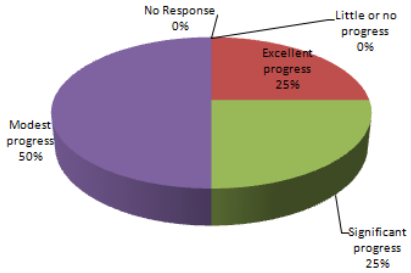
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Friction and Wear Reduction in Diesel Engine Valve Trains

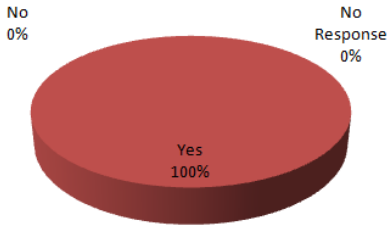
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



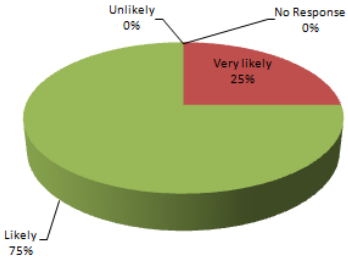
Question 3: Characterize the technical accomplishments and progress toward goals.



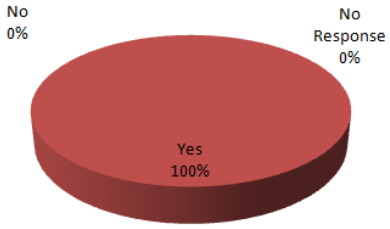
Question 2a: Are the goals of the project technically achievable?



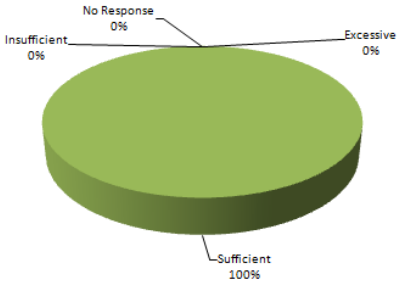
Question 4: How likely is the project team to move technologies into the marketplace?



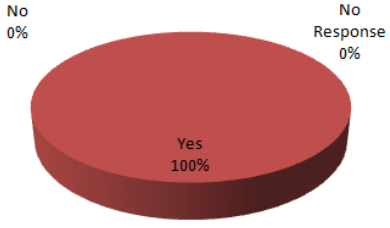
Question 2b: Have the technical barriers been identified and addressed?



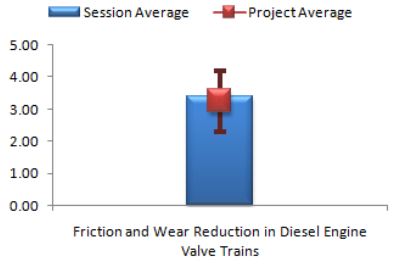
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Temperature Materials Laboratory (Edgar Lara-Curzio, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that development of stronger and lighter materials is essential to more fuel efficient vehicles. However, not all projects conducted result in transportation energy reductions. Another reviewer wrote that the program supports DOE-EERE-VT in meeting their goals by providing researchers from industry, universities, and government agencies access to a skilled staff and equipment for materials characterization. Similarly, one person stated that the HTML will be an enabler for innovation. Giving small enterprises access to state-of-the-art laboratory equipment will create innovations.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person felt that, since this project provides a service, goals and barriers are not applicable here. Another commented that the HTML is organized into six user centers to serve different needs. One reviewer stated that a strong interaction with a great number of companies is foreseen.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer commented that, although it is difficult to see HTML as project, the presence of this facility will be key to achieving DOE's goals. Another person added that users have made technical accomplishments and indicate their support by continuing to use the facility. One person stated that great results have been archived in all the user centers.

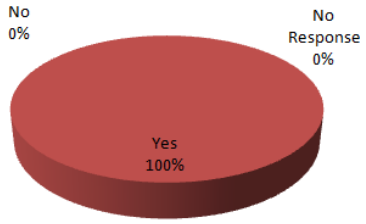
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer noted that the HTML provides facilities for many organizations to advance their technologies into the market, while the other respondent stated, similarly, that many industries and universities utilized the user centers to conduct research that are practical and useful to them.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that it was not possible to assess completely without knowing the costs of maintaining the facility and how many projects (and their complexity) are being accommodated throughout the year.

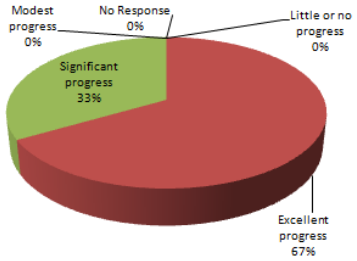
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Temperature Materials Laboratory

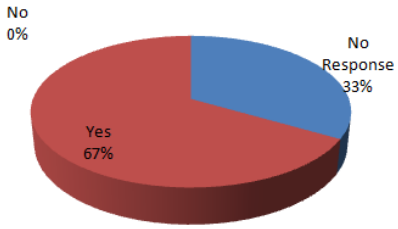
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



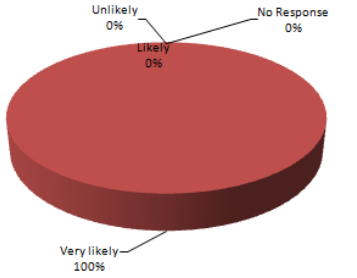
Question 3: Characterize the technical accomplishments and progress toward goals.



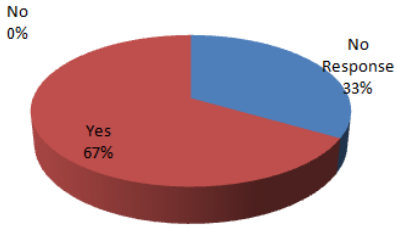
Question 2a: Are the goals of the project technically achievable?



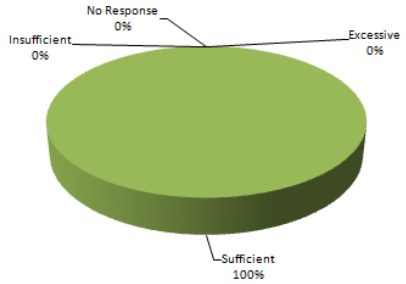
Question 4: How likely is the project team to move technologies into the marketplace?



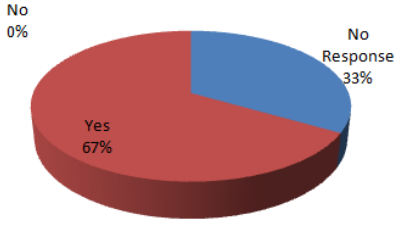
Question 2b: Have the technical barriers been identified and addressed?



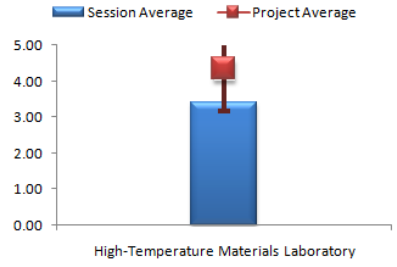
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Hydrogen Compatible Materials (Jim Holbery, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated that this project is needed to enable introduction of direct injection of hydrogen. This is a technology having the potential for reduced gasoline consumption in the future. Another commented that the activity should enable practical/commercial applications of hydrogen injection systems in internal combustion engines, thereby making hydrogen a more viable alternative to petroleum based fuels.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Comments in this section were mixed, with one person stating that the consortium covers the whole supply chain. Another indicated that close linkages to key organizations capable of utilizing the results in commercial applications have been established or identified for establishment. To contrast, another began by stating that the material systems problems in this system are truly significant. Previous huge programmatic efforts in this general area have only met with marginal success, so a series of major breakthroughs seems somewhat optimistic. Commercial success would depend on achieving performance competitive with hydrocarbon-fueled (lubricated) systems. This is a tough target.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer felt that the results of the project so far look good. It leads to a better understanding of the effects of hydrogen on various materials used in the fuel injection equipment. However, the project will not lead to application in the coming years. One other person stated that, from the presentation, it was not clear that a substantial amount of results have been wholly verified. It appeared to this reviewer that much has been accomplished analytically, but verification of the results is in the near-term plans. The reviewer felt that by only seeing the written material and the presentation he or she may have developed the wrong impression on this point.

Another response commented that even slow progress is remarkable. The program is well structured and creative, but the task is a tough one. If the program succeeds, it will be a big accomplishment.

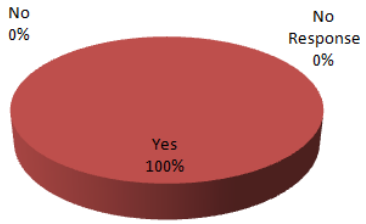
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Responses were generally positive here, but a reviewer was hesitant to speculate due to the surrounding unknowns. One person stated that the project team is balanced with the OEM involved, making it likely that positive results will be introduced. Of course this project solves only part of the total number of questions to be solved before this technology can be made available to the automotive industry. Another believes the work will be a key enabler for hydrogen internal combustion engine commercialization, but moving this into the market place is heavily dependent upon many other factors beyond the scope of this project. Those out-of-scope barriers shifted this reviewer's opinion from very likely to likely. One other person commented that, again, the problem is very significant.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the project appeared to have adequate resources, but again he or she may have gleaned more from seeing the presentation than from only reading the written material. Another respondent stated that they are not sure that any funding level would be sufficient at the moment for this task.

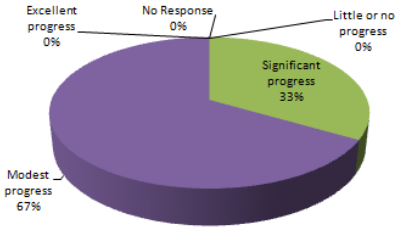
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Hydrogen Compatible Materials

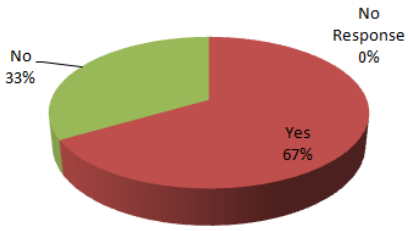
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



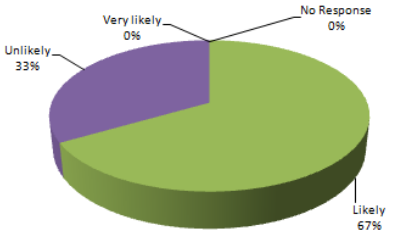
Question 3: Characterize the technical accomplishments and progress toward goals.



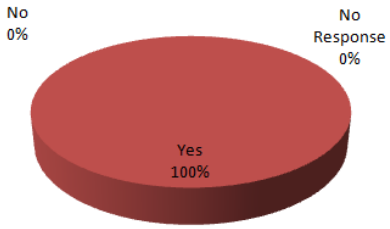
Question 2a: Are the goals of the project technically achievable?



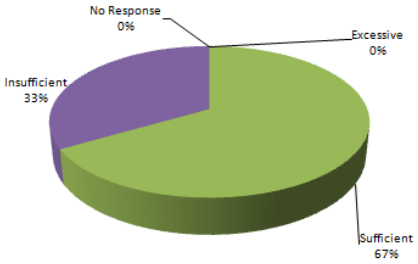
Question 4: How likely is the project team to move technologies into the marketplace?



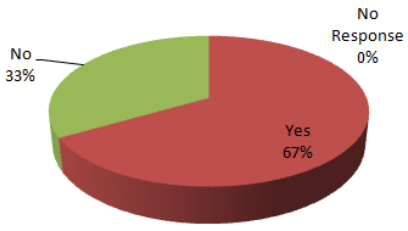
Question 2b: Have the technical barriers been identified and addressed?



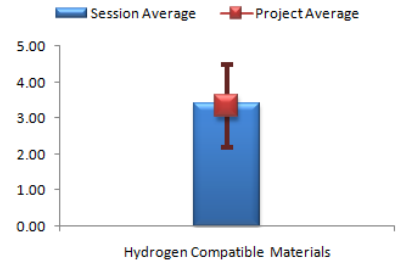
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



IEA Annex on Materials for Transportation (Stephen Hsu, of National Energy Technology Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent stated that the project will improve energy efficiency and reduce fuel consumption, thus achieving petroleum conservation and displacement.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent commented on the work with international organizations to achieve common goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent commented on the leveraging technical efforts to reduce oil consumption.

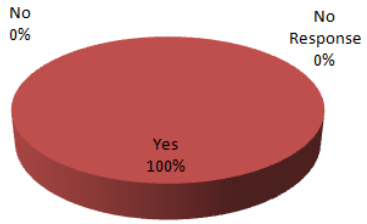
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent stated that there is great collaboration across the globe.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

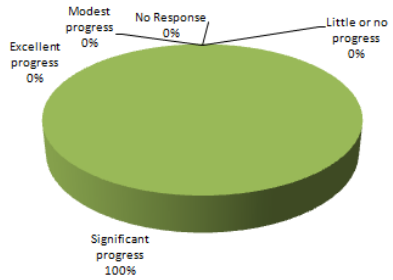
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: IEA Annex on Materials For Transportation

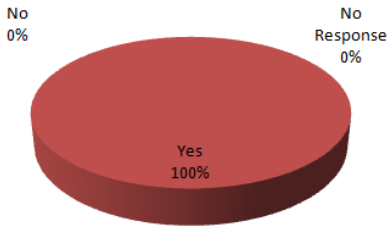
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



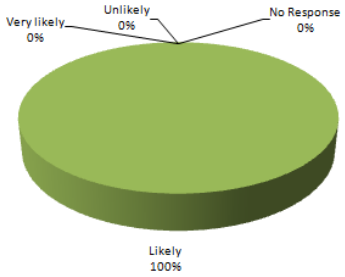
Question 3: Characterize the technical accomplishments and progress toward goals.



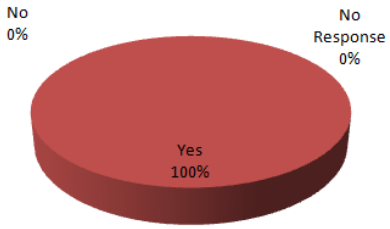
Question 2a: Are the goals of the project technically achievable?



Question 4: How likely is the project team to move technologies into the marketplace?



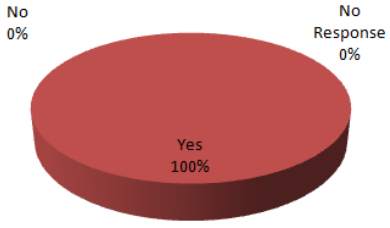
Question 2b: Have the technical barriers been identified and addressed?



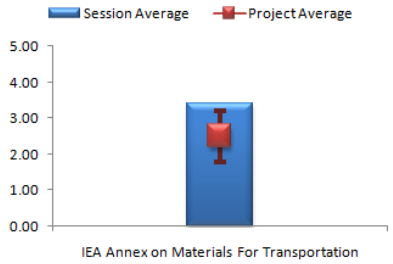
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Integrated Surface Engineering for Improving Energy Efficiency (Aaron Yocum, of National Energy Technology Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person commented that the project will improve energy efficiency and reduce fuel consumption, thus achieving petroleum conservation and displacement. The other noted that the project aims at reducing friction losses and, through the integrated approach, 5% fuel efficiency improvement is aimed for.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer noted that the consortium has representatives from the whole supply chain, adding that this will be helpful in introduction of the technology. The other response cited the following barriers: lack of theory and understanding of how surface textures control/reduce friction, demonstrated success for conformal contacts, cost effectiveness of texturing, and fabrication cost and ease of texturing on actual engine parts. The reviewer cited the following approaches: conducting control experiments and developing a model.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer commented that friction reduction with the studied technology is beneficial for fuel efficiency, while the other commented that the group has worked on three regimes of friction reduction and studied different surface texturing effects on friction reduction at different speeds.

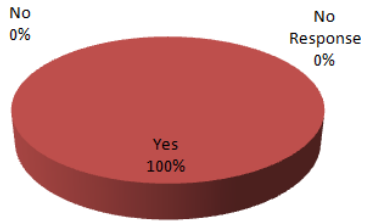
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person indicated that the group is working with CAT, Timken, United Technologies, Crane Packing, and other smaller engine manufacturers. The other reviewer stated that similar surface modifications are already in the market, and the progress in the project is relatively slow or too slow. The reviewer added that VW is already to its second generation of the type of surface modification mentioned.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent commented that the group is developing thin film coatings on textured samples, including developing compatible surface chemical coatings and discussing these results with industrial partners.

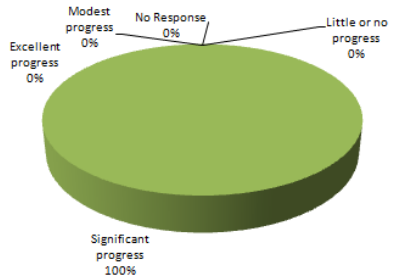
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Integrated Surface Engineering for Improving Energy Efficiency

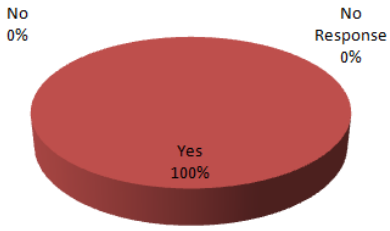
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



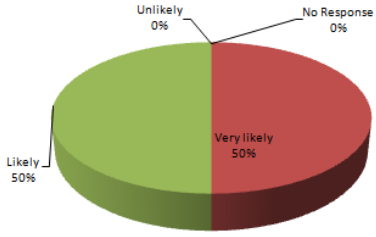
Question 3: Characterize the technical accomplishments and progress toward goals.



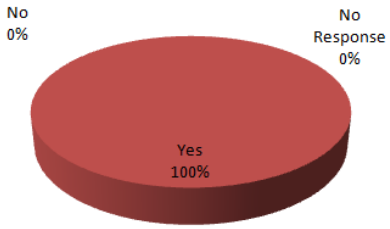
Question 2a: Are the goals of the project technically achievable?



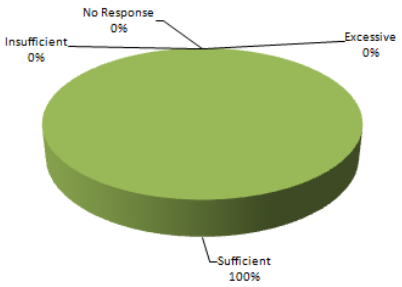
Question 4: How likely is the project team to move technologies into the marketplace?



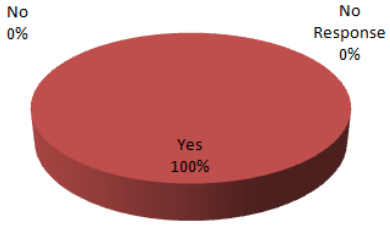
Question 2b: Have the technical barriers been identified and addressed?



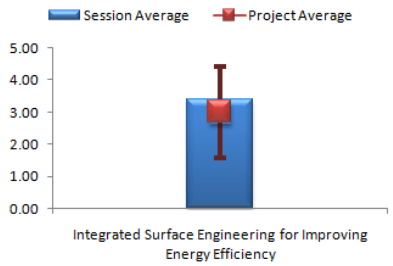
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Joining of Advanced Materials by Plasticity (Jules Routbort, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that this is basic research initially, but becomes an enabling technology. There are multiple possible applications including valves, sensors, fuel cells, optical, and biomaterials, etc. Another person stated that it opens up the potential for introducing a whole set of new locally improved materials. The application is not on the short term. One reviewer, similarly, commented that this was good basic R&D, but the application to high-efficiency engines in tenuous. The need for using this in NOx sensors is unproven. One final reviewer commented that this work has been focused on coal-fired plants versus piston engines, and thus has really not been focused on reducing vehicle-level fuel consumption. The future work will include development of a NOx sensor, which would be applicable to engines.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the researchers had demonstrated grain boundary sliding to be the mechanism by X-ray testing, while another person stated that, in the case of an oxygen sensor, the technology was demonstrated. This reviewer adds that direct deployment of the technology in cars, however, is not yet realized. The first potential application mentioned was a NOx sensor. Another individual added that there was no discernable deployment strategy for engine applications. One final respondent stated that this was not applicable. The PI admitted this project hasn't been focused on ground vehicle applications, and thus the related technical barriers were not addressed to date.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Results to this prompt were mixed. One reviewer stated that there were excellent results for the time and money spent. Another commented that the group had produced pore-free strong joints using plastic deformation in a variety of advanced materials. The application of an oxygen sensor had been demonstrated. Many publications and patents issued and applied.

In contrast, one reviewer felt that this was difficult to assess since the first application was not for transport industry. Following up on this, the final reviewer stated that, again, this project has zero relevance toward DOE vehicle economy improvement, and thus has made zero progress toward overcoming related barriers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Results in this section were mixed, with one reviewer commenting on the accolades of the group: one patent issued (or two applied), 22 publications, awarded R&D 100, and currently have two post docs and one Ph.D. student. This reviewer added that they are doing great work.

In contrast, others felt this project was not applicable to the transportation industry. One stated that it was probably not relevant for engine applications. Another noted that it was demonstrated, but unfortunately not in the transport industry. One final respondent noted the oxygen sensor, and

followed up by stating that this project is not relevant toward DOE goals and will not transition to a vehicle or engine OEM.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

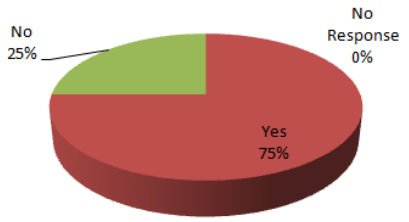
One reviewer stated that this is hindsight since the project is essentially done, and another person stated that this question was not applicable. One other person commented on the good cooperation between ANL and OSU.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

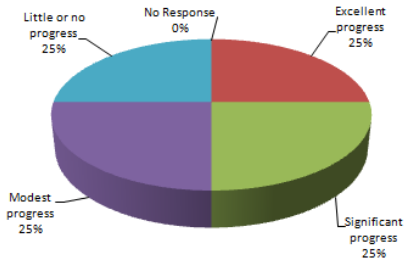
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Joining of Advanced Materials by Plasticity

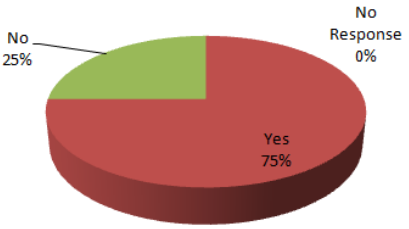
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



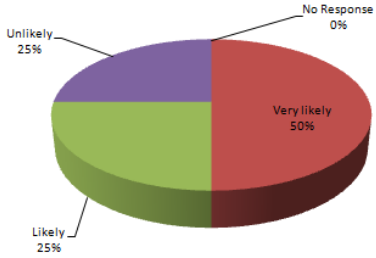
Question 3: Characterize the technical accomplishments and progress toward goals.



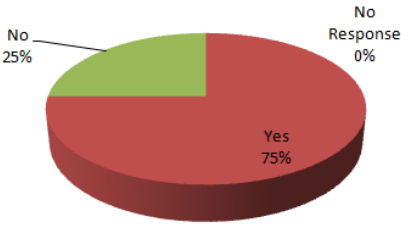
Question 2a: Are the goals of the project technically achievable?



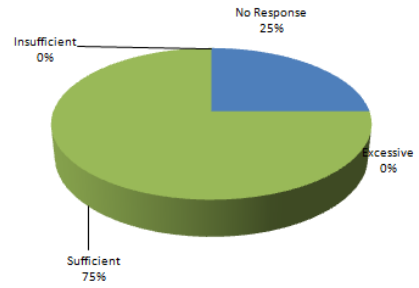
Question 4: How likely is the project team to move technologies into the marketplace?



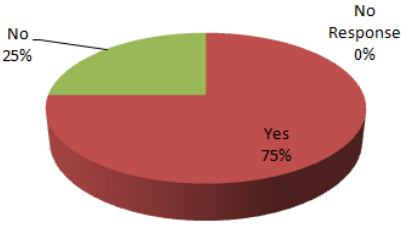
Question 2b: Have the technical barriers been identified and addressed?



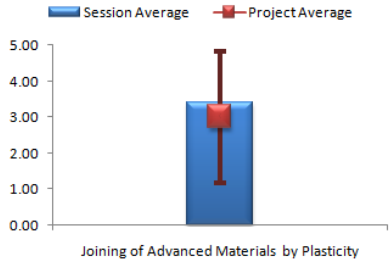
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Life Prediction for Diesel Engine Components (Nate Phillips, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the project supported lightweight valve material to achieve higher fuel efficiency, while the other noted that a 5% increase in fuel efficiency is claimed.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first commenter stated that there were good analysis results. The other respondent noted that the consortium has research institutes and an OEM involved. It would be a good addition if there was also a valve manufacturer involved. The outcome of the engine test showed that some technical barriers still exist.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent noted that the engine test was performed on a natural gas engine and no fuel savings were measured.

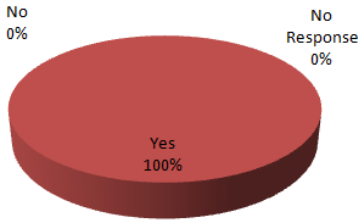
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer simply noted the CRADA with CAT. The other respondent commented that the project did not show a positive effect on fuel economy based on the use of ceramics, adding that this is because of a premature engine failure.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

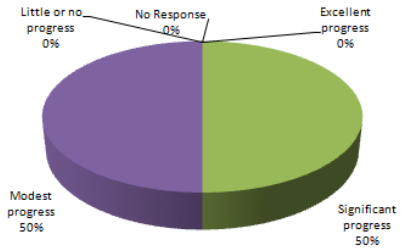
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Life Prediction for Diesel Engine Components

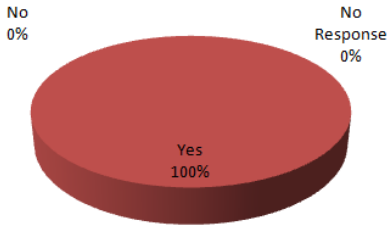
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



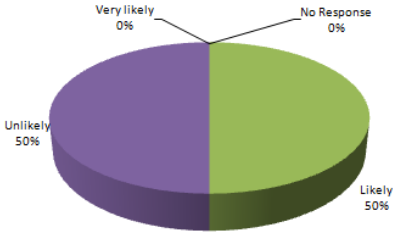
Question 3: Characterize the technical accomplishments and progress toward goals.



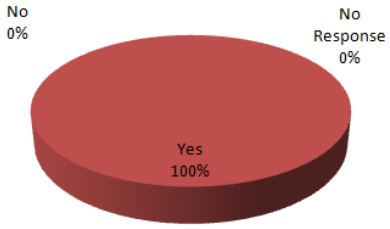
Question 2a: Are the goals of the project technically achievable?



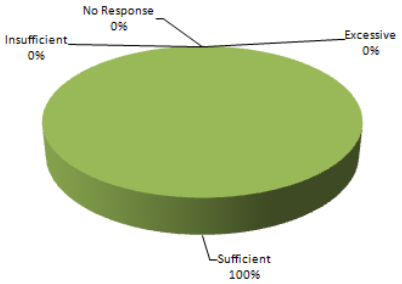
Question 4: How likely is the project team to move technologies into the marketplace?



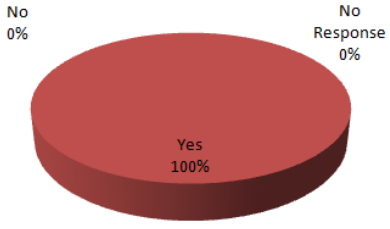
Question 2b: Have the technical barriers been identified and addressed?



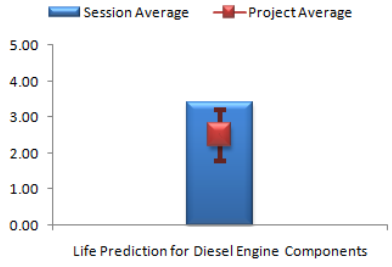
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Lightweight Valve Train Materials (Titanium) (Nate Phillips, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated positively that the program has been going on for eight years already, and resulted in valves 30% lighter than steel, a 200% increase in service lifetime, and a 5% increase in fuel efficiency. One other reviewer also indicated that a 5% increase in fuel efficiency is claimed.

To contrast, one reviewer commented that this project had an objective of assessing the thermal efficiency improvement in a heavy-duty engine, but never was able to quantify the claimed 5% gain. This is very disappointing and it appears most time was spent exploring the durability of alternative material, lightweight valves. Also, the PI could not quantify claimed over-speed or high speed operation and its impact on fuel economy.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer noted that the consortium includes research institutes and an OEM. It should be a good addition to have a valve manufacturer involved as well. The outcome of the engine test showed that some technical barriers still exist. To contrast, another stated that one key objective was a 5% reduction in fuel consumption for a heavy-duty engine. This appears to have been an unrealistic goal according to the presentation which highlighted the PI's inability to experimentally quantify any gain. This 5% goal was very aggressive and implied that lightweight materials would eliminate almost all valve train friction loss.

One final reviewer noted that the primary barriers are high cost, unproven methodology, durability and reliability. The group is taking a three-prong approach via material properties, component stress analysis, and component prototype testing.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that the engine test was on a natural gas engine and no fuel savings were measured. Another person commented that the project has made almost no progress in addressing DOE fuel economy goals. The reviewer adds that the good news is that the PI did show that lightweight materials can exhibit some level of durability in a relevant engine environment, though such materials are far from ready for production purposes.

One final person noted that the group had completed a life prediction model, valve fabrication, and determined the effect of machining procedures on the strength of ceramics. They also did NDE laser scattering inspection of the parts, residual stress measurements on Si_3N_4 test samples, rig tests on valves, and engine tests. Despite the failure in the long-term engine testing, good technical information was obtained.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer commented on CRADA with CAT, noting that CAT is testing the new valve material for their applications. This person added that possible future uses include HD engines that currently

use Ni-Superalloys, Marin and EPG engines. Another person stated that the project did not show a positive effect on fuel economy based on the use of ceramics. This is because of a premature engine failure. One final reviewer indicated that the proposed technology did not show much promise toward a production situation.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

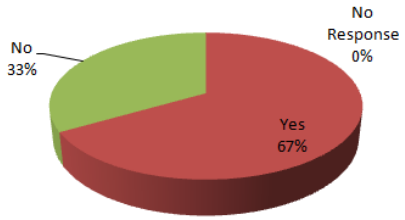
The lone respondent commented that this project included enough test resources to assess its objectives, i.e. engine and bench testing of lightweight valves. It would have been nice if the PI could have given more thought in addressing fuel economy targets during the engine test protocol, but this does not appear to be a resource issue.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

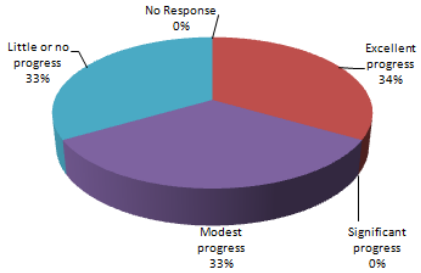
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Lightweight Valve Train Materials (Titanium)

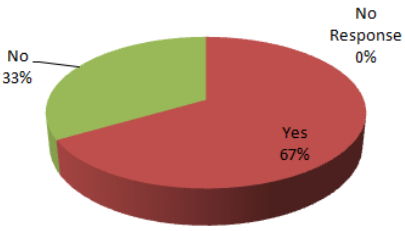
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



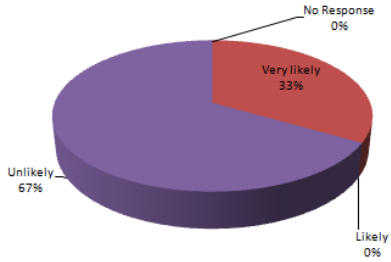
Question 3: Characterize the technical accomplishments and progress toward goals.



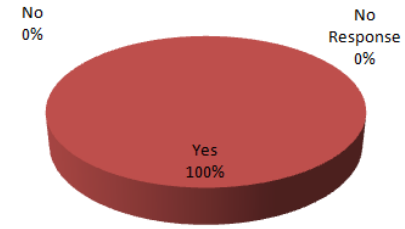
Question 2a: Are the goals of the project technically achievable?



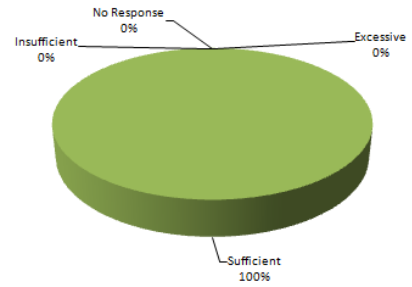
Question 4: How likely is the project team to move technologies into the marketplace?



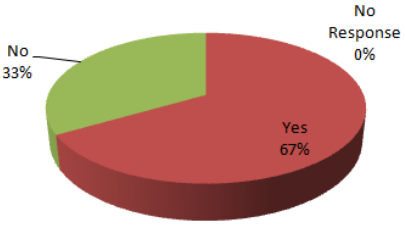
Question 2b: Have the technical barriers been identified and addressed?



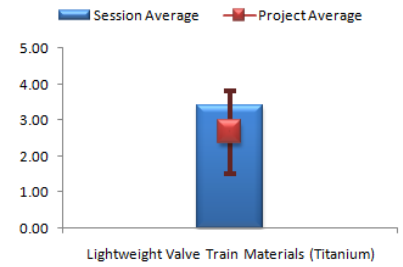
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Materials for Advanced Engine Valve Train (Phil Maziasz, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Three reviewers stated that there is a need for higher temperature components, including valves and seats for high-efficiency engines. This will help achieve higher fuel efficiency and lower emissions. To contrast, one other respondent stated that this is not clear, and that it appears this project is more focused on assessing valve wear and durability under current and future high temperature combustion conditions. The impact on fuel efficiency is unclear. This project seems related to at least two other valve material projects that have focused on potentially current (?) or future valve issues at Caterpillar.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer noted that the project uses an integrated approach (design and material). This will increase the chance of success. Also, the project has a close cooperation with valve and valve seat manufacturers. Adding to this, another reviewer commented on the good, current CRADA with Caterpillar and the interaction with seat and valve suppliers. Another person indicated that the PI is working with the CAT team in defining the valve seat wear issue, and that ORNL is adding more in-depth microanalysis and materials behavior/mechanism analysis. Also, CAT has developed the Buettner Rig Wear Test for conducting component wear tests. One final reviewer stated that the PI and partners have a very good understanding of high temperature material behavior for engine valves in a real-world engine environment. This is a fairly high risk project, but one that is necessary for addressing future higher pressure and temperature combustion systems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that this is a brand new project and therefore little progress has been made to date, while another also stated that it is a new project, so not much progress was made in the project. This reviewer added, however, that the scope of the project is well defined. Another wrote that there has been good progress given the time that the project has been operating. One final reviewer stated that, in future engines, valves must be able to withstand more severe conditions. As such it is a needed enabling technology.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer noted that there is a close cooperation with the end user, while another stated that this project appears to have intimate involvement from a major engine OEM, which should allow for a likely transition assuming this project is successful. Another reviewer commented that the new CRADA with CAT began in September 2007 and will continue for 2.5 years. This reviewer added that CAT has formed a team of component suppliers who will provide parts to and receive data from this CRADA.

One final reviewer stated that the application of new alloys is readily doable. The question is whether they will be economically viable.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

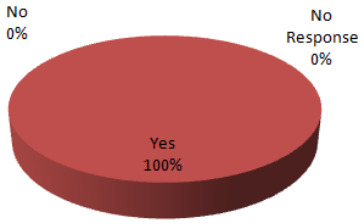
The first reviewer stated that, without knowing more about the project, these resources seem reasonable but may be a limiting factor to what is done later on. One reviewer added that the project is still in its early phase, so no remarks were made. The final respondent stated that, again, this is a new project, and it appears that the PI has enough resources to address the proposed work scope.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

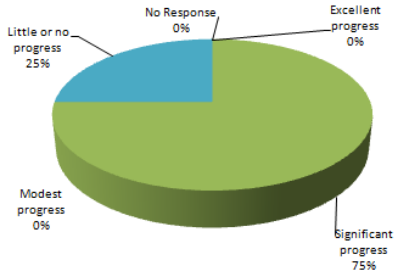
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Materials for Advanced Engine Valve Train

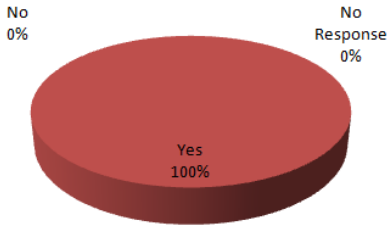
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



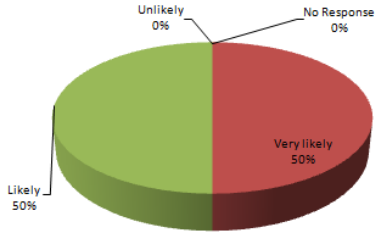
Question 3: Characterize the technical accomplishments and progress toward goals.



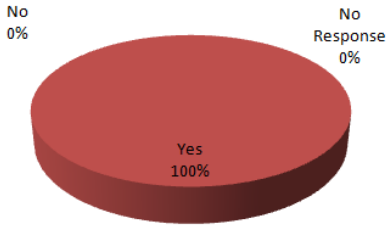
Question 2a: Are the goals of the project technically achievable?



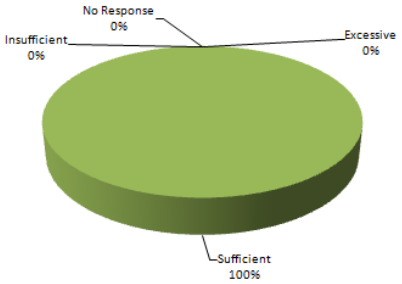
Question 4: How likely is the project team to move technologies into the marketplace?



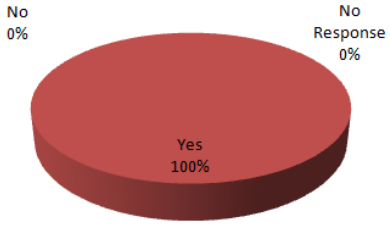
Question 2b: Have the technical barriers been identified and addressed?



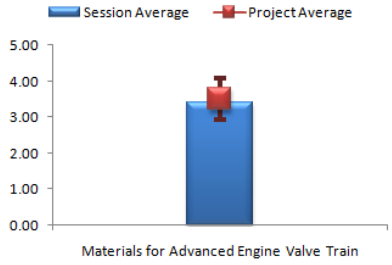
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Materials for HCCI Engines (G. Muralidharan, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person indicated that HCCI will be one of the most likely directions for improved fuel efficiency, and improvement of valves is important. Another person felt that the program was well thought out, and on a clear critical path. This is likely high-leverage work.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the project had a solid approach, working closely with eventual suppliers, based on solid science and past related success. Another stated that the cooperation with valve manufacturers will lead to proper feedback on the direction to develop the materials. This reviewer's only concern is that the budget is not adequate to do sufficient measurements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent stated that having valves able to withstand the higher temperatures and stresses at a reasonable cost is key for the introduction of new engines operating in the HCCI mode.

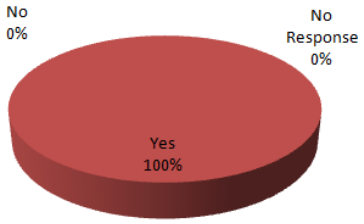
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent commented that higher temperatures will come but the cost of the eventual proposed solutions will be important. This will require a close cooperation with key players.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that a full characterization of valve material will require many tests. It is not very likely that sufficient confidence can be built up in the given budget.

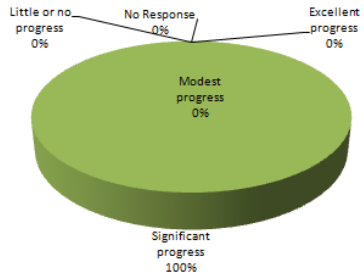
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Materials for HCCI Engines

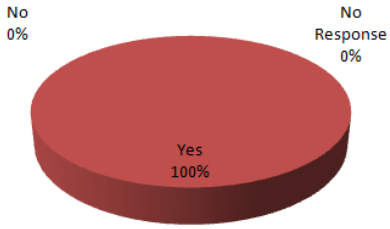
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



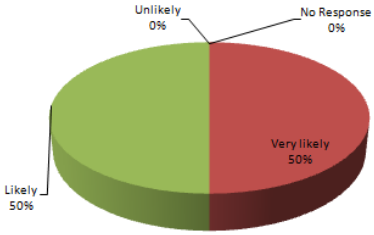
Question 3: Characterize the technical accomplishments and progress toward goals.



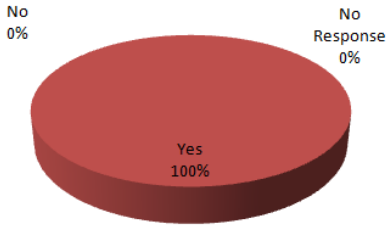
Question 2a: Are the goals of the project technically achievable?



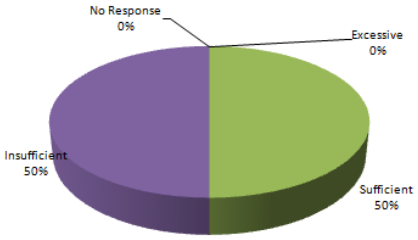
Question 4: How likely is the project team to move technologies into the marketplace?



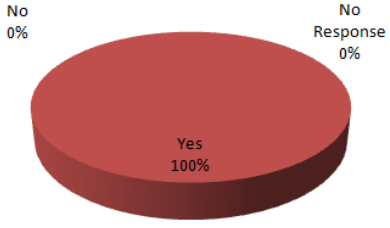
Question 2b: Have the technical barriers been identified and addressed?



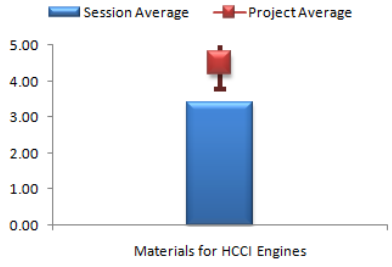
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Materials for HECC/HCCI Engine Components (Caterpillar) (Glenn Grant, of Pacific Northwest National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were mixed. One reviewer commented that this technology is an enabler for HCCI, and this will result in lower fuel consumption. Another stated that it is unclear that this technology would have any specific application to HCCI or HECC engines. It seems that, if successful, this technology would benefit all engines, not just high efficiency engines. Another reviewer commented on the project's focus on FSP to enhance the thermal and mechanical efficiency of engine materials. The project is also trying to increase the durability of engine components.

One final reviewer stated yes, and a little no. This project is focused on improving the mechanical properties of certain engine components (piston and head application) and has a secondary focus on augmenting fuel efficiency in engines through the allowance of higher firing pressures in tomorrow's engines. With this said, it is an important R&D area for engine OEMs toward addressing engine life durability targets.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that this is a very good project toward developing next-generation pistons, heads, and other engine components for high firing pressure engines The PI and its engine OEM partner appear to have a very good engineering 'feel' for what is possible from a materials selection viewpoint. Another commented that the project is in a very early phase, so it is not clear that technical barriers are overcome yet. It is an interesting approach to create local improved material properties. The consortium has a strong input from an OEM, so positive results will find their way.

Another person stated that deployment strategy is currently limited to CRADA with Caterpillar. One final reviewer commented on the selective surface enhancement for engine components. FSP has been applied for aluminum and bronze, but not much on steel and cast iron. Process development is needed, and tool design will be addressed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One response stated that this was a good start for this project, which has been going on only a very short time. Another reviewer added that this project is relatively new and should make significant progress during the next fiscal year.

One person noted that CRADA was just signed in Nov. 2007. The project scope was defined, and there has been some progress made in designing and fabricating preheating tools. One final reviewer commented that HCCI will be a large step forward in fuel efficiency. This material will provide enabling technologies.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the project team demonstrates great insight into the processes, and has the equipment to do the job. Another person cited the CRADA with CAT. One reviewer felt that there is

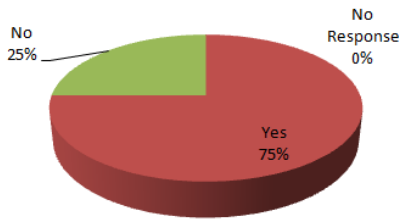
still some question on how suitable the technology is for mass production. A final reviewer commented that this project has a very strong engine OEM influence, which will give the project the best possible probability for future engine application, especially since the engine OEM has dedicated engine test resources for evaluating any new components under real-world conditions. It will be necessary for engine OEMs to continue increasing firing pressures to meet both future fuel economy goals and also emission standards, and thus this project could be one enabler.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Responses were generally positive here. One person stated that the resources appear to be reasonable for the scope. Another noted the 50% cost-share with CAT. One reviewer commented that milestones were mentioned and that the project is within the planning. One final reviewer indicated that excellent bench test and engine test rig resources are dedicated to this project.

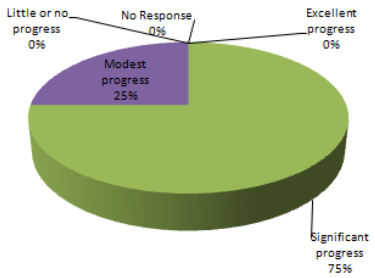
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Materials for HECC/HCCI Engine Components (Caterpillar)

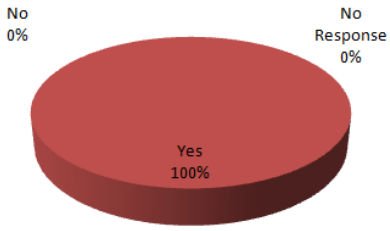
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



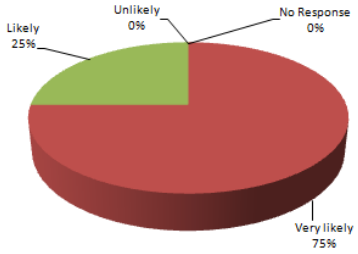
Question 3: Characterize the technical accomplishments and progress toward goals.



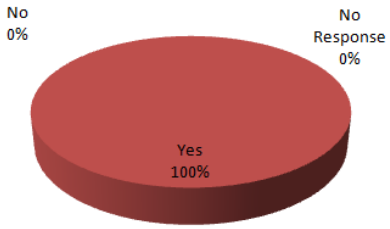
Question 2a: Are the goals of the project technically achievable?



Question 4: How likely is the project team to move technologies into the marketplace?



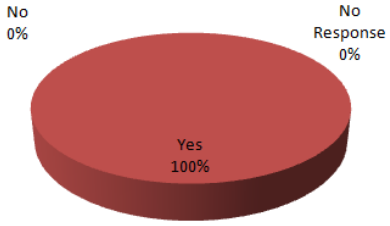
Question 2b: Have the technical barriers been identified and addressed?



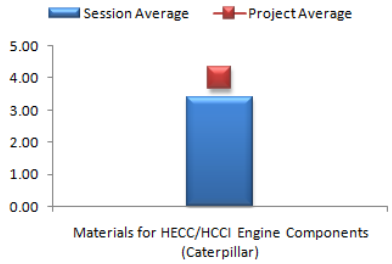
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Materials for High-Pressure Fuel Injection Systems (Peter Blau, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that pressure demands on the materials for the fuel injection system have significantly increased. This project will increase fuel efficiency. One other person added that fuel injector improvements are needed for lower fuel consumption. One final respondent stated that this project indirectly addresses DOE fuel economy goals through the exploration of materials that allow for higher pressure fuel injection and also a more precise metering of fuel during various injection schemes. Nevertheless, it is unclear how specifically such fuel injection strategies will improve fuel economy.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent commented that the team working on this project has shown that they are able to deploy technologies successfully. Another reviewer stated that the implied goal of materials for higher pressure injector nozzles is possible, though the quantitative goals are not clear, i.e. injection pressure, amount of injected fuel, etc. One final reviewer felt that the main challenges are cavitation and erosion, microdefects, and life prediction. This person added that the approach will be to take residual stress measurements of nozzle tips, CFD of mixture flow, develop and apply test methods to measure the effect of pressurizations, and to take bore-hole roughness measurements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that this is a new project, and therefore little progress has been made to date. Similarly, one other person stated that it is a new project, so not much progress was made. This reviewer added that the focus will be on developing specialized methods to characterize the injector nozzle hole. One respondent stated that one of the limitations for future fuel efficiency improvement lies in the ability for future fuel injection components to withstand these conditions. The outcome of this project can be important.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer noted the CRADA with CAT, adding that they will be involved with CAT in the project. Similarly, one person noted that the project is a CRADA, such that a close collaboration with an OEM is ensured, opening the way towards the market. One final respondent commented that this project has a strong engine OEM partnership that will be critical in transitioning this R&D toward a production situation.

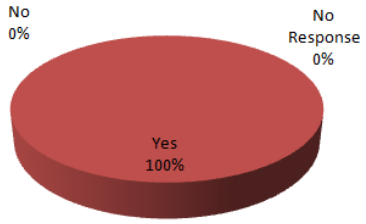
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented that no start was made yet and that the project is not yet fully defined. The other reviewer added that this is a new project, and it appears the PI has the necessary monetary and experimental/analytical tools to address the proposed work scope.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

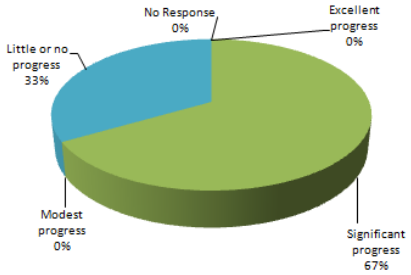
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Materials for High-Pressure Fuel Injection Systems

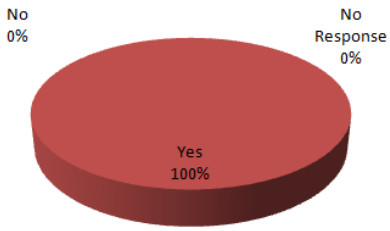
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



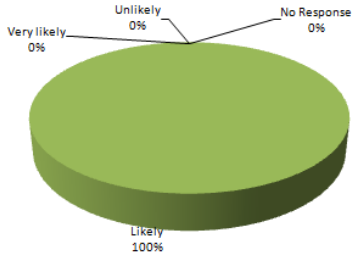
Question 3: Characterize the technical accomplishments and progress toward goals.



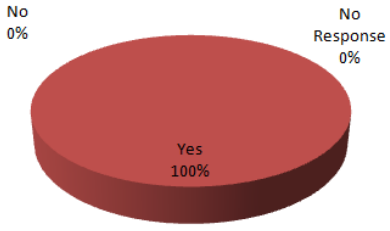
Question 2a: Are the goals of the project technically achievable?



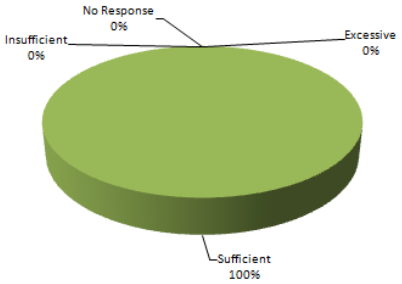
Question 4: How likely is the project team to move technologies into the marketplace?



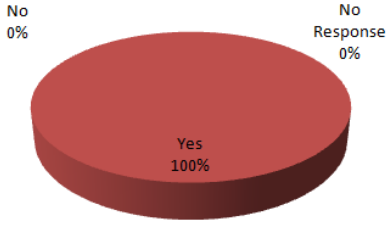
Question 2b: Have the technical barriers been identified and addressed?



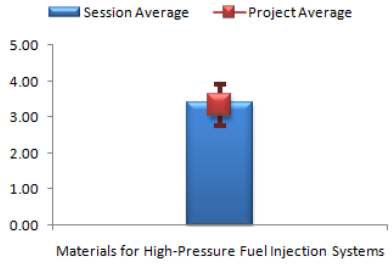
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Mechanical Reliability of Piezo-Stack Actuators (A. Wereszczak, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that the technology is enabling a further optimization of fuel injection strategies, leading to reduced fuel consumption. Another person stated that the project supports these goals indirectly, through more precise and faster injectors. One person remarked that the project investigates potential replacement of solenoid actuators with the PMLA for better fuel control, for better fuel efficiency, and for heavy-duty diesel engine applications. One final reviewer, similarly, states that this project indirectly supports DOE's fuel efficiency goals through the potential improvement of today's high pressure common rail injectors toward better controlling and thus meeting the fuel delivery schedule. This reviewer adds that it is apparent throughout the last ten years that continual, more precise control of the injection event is necessary to enable the various combustion modes present in today's and tomorrow's advanced diesels and also to move toward better control of aftertreatment devices.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses to this prompt were mixed, with one reviewer stating that this project seems more focused on assessing materials for use in advanced fuel injectors than developing new materials, and thus its success will be dependent on today's materials. It is too early to assess if today's materials will provide a solution. Another reviewer wrote that it is dependent on injector manufacturers to implement these findings. Similarly, one other person began by stating that one thing of importance is the reduction of flaw sizes in the ceramic materials. The reduction of this is left to the supplier. It would be an improvement when this activity at the supplier is supported more actively.

One reviewer noted that the investigators intend to work with Cummins in developing the technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Results were generally positive here, with one person stating that the project shows reasonable progress for the time spent to date and the funding for this work. Another commented that some progress has been made. One reviewer stated that this project is aimed at reducing fuel consumption by an improved fuel injection strategy. This is most likely to be successfully. It also has a high level of realizing this improved fuel efficiency.

To contrast, one person felt this project overall is truly exploratory in nature, which tends to have a discovery rate that is partially a function of luck. It appears to date that very little can be reported on potential material types, though this is coming soon, maybe in the next review. It would have been nice to see more of a discussion on potential materials.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that, to date, no progress has been made in this area, but the CRADA with Cummins is a good start. Another similarly stated that ORNL intended to work with Cummins in

getting the technology further developed. One other reviewer noted that interest from industry was already shown, and this technology is already used in cars.

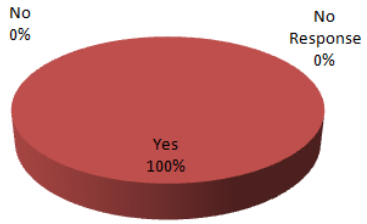
One final reviewer stated that transfer will come down to durability and cost. This person added that the information presented today leads him or her to believe there is a reasonable opportunity that one engine OEM could transition this technology into their future high-pressure common rail injector product.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the amount of funding appears to be about right given the objectives. New findings of difficulty to achieve the barriers could change this. The other respondent indicated that, based on the presentation, it appears that the PI has adequate computational resources to complete the tasks in hand.

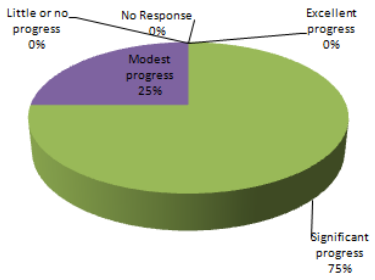
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Mechanical Reliability of Piezo-Stack Actuators

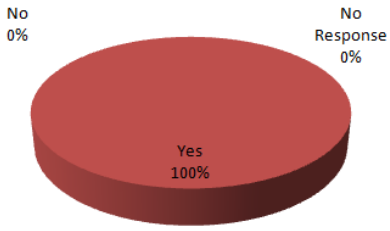
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



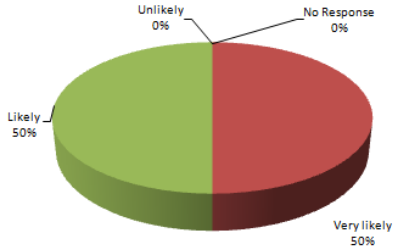
Question 3: Characterize the technical accomplishments and progress toward goals.



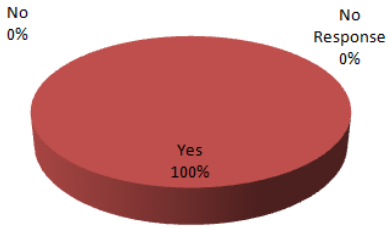
Question 2a: Are the goals of the project technically achievable?



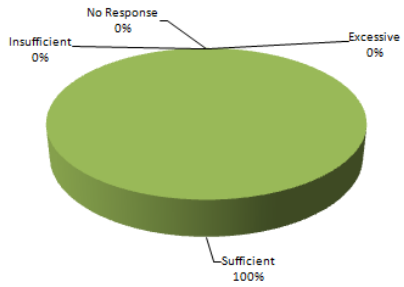
Question 4: How likely is the project team to move technologies into the marketplace?



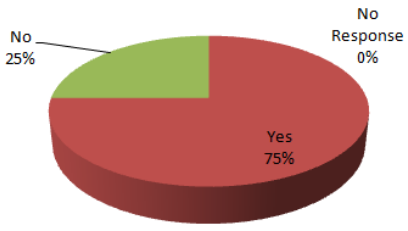
Question 2b: Have the technical barriers been identified and addressed?



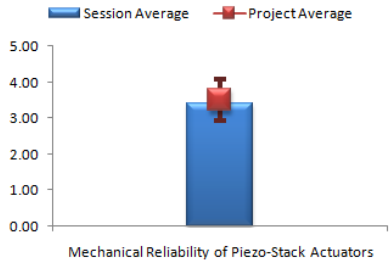
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Non-Destructive Evaluation of Diesel Components (Nate Phillips, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer noted that this is part of the lightweight valve train material project, and the goal is to reduce weight to improve fuel efficiency and lower emissions. The other reviewer commented that a 5% increase in fuel efficiency is claimed.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the group worked with ANL in using NDE in evaluating tested components. The other individual stated that the consortium has research institutes and an OEM. It should be a good addition when there is also a valve manufacturer was involved. The outcome of the engine test showed that some technical barriers remain.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that there was good progress being made, while the other commented that the engine test was done on a natural gas engine and no fuel saving was measured.

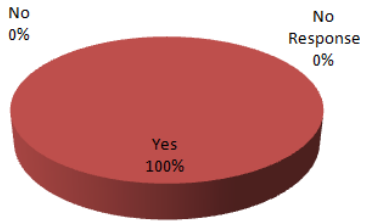
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented on CRADA with CAT, noting that CAT is intending to use it in production. The other respondent stated that the project did not show a positive effect on fuel economy based on the use of ceramics. This is because of a premature engine failure.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

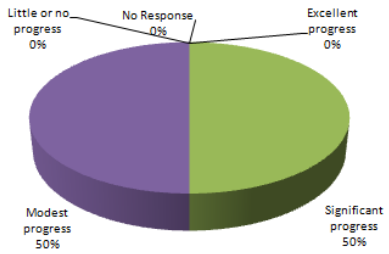
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Non-Destructive Evaluation of Diesel Components

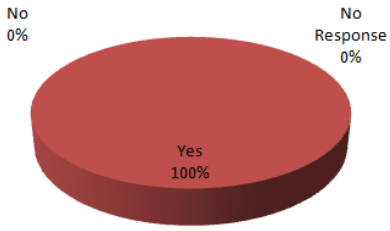
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



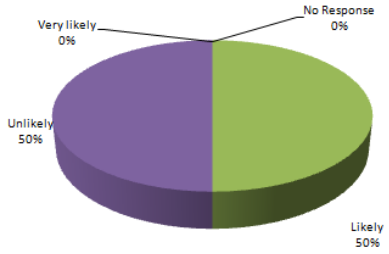
Question 3: Characterize the technical accomplishments and progress toward goals.



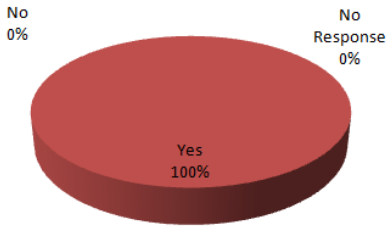
Question 2a: Are the goals of the project technically achievable?



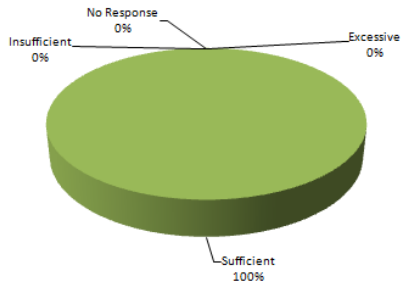
Question 4: How likely is the project team to move technologies into the marketplace?



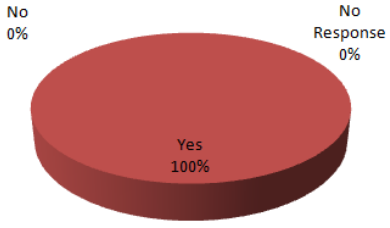
Question 2b: Have the technical barriers been identified and addressed?



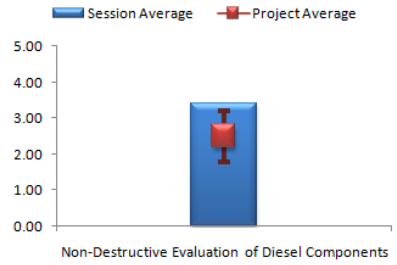
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NOx Sensor Development (Robert Glass, of Lawrence Livermore National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person commented that further introduction of diesel engines in light-duty applications would lead to a significant reduction in oil consumption. Since NOx sensors are costly, this leads to a reduced attractiveness of diesel powered vehicles. Another stated that this is a well-known problem, which still needs to be solved. Several people are working in this area, as has been the case for several years. This is very important work and is on a critical path for widespread dieselization.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer remarked that the consortium covers the supply chain, so there is a good feedback on the results and a clear understanding of the requirements is guaranteed. One other person commented that sensitivity to fuel quality and impurities is likely to be an issue, as has been the case for several other related efforts.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent stated that the influence of the current price level of NOx sensors on the further proliferation of diesel-powered cars is likely to be limited. So the execution of this project will only have a mild effect.

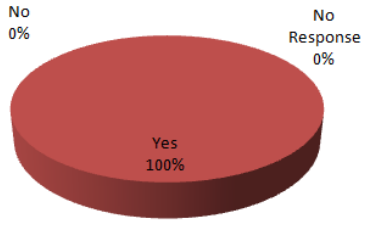
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person noted that an OEM is involved in case of lower cost, such that this will likely lead to introduction. The other respondent stated that someone will eventually round up the results of much prior work, along with a slightly new approach, and make a workable system. This may be the winner. The connection to Ford is likely to provide a door to the market if viable technology is identified. However, this work has been in play for several years, and has missed several product generation changes. One wonders how and when Ford will come to life.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

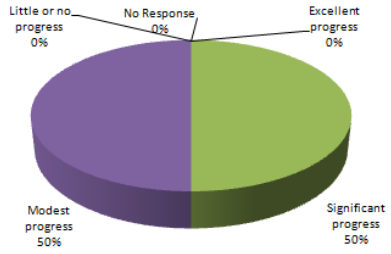
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NOx Sensor Development

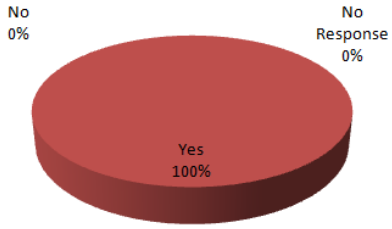
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



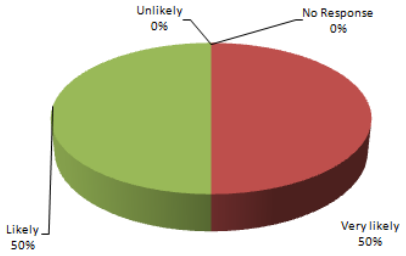
Question 3: Characterize the technical accomplishments and progress toward goals.



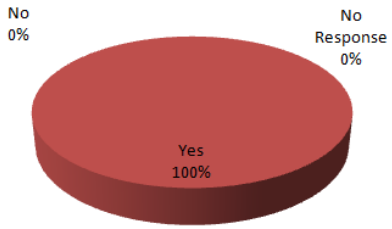
Question 2a: Are the goals of the project technically achievable?



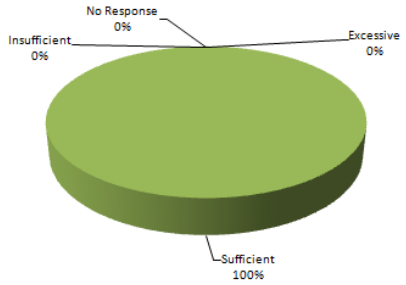
Question 4: How likely is the project team to move technologies into the marketplace?



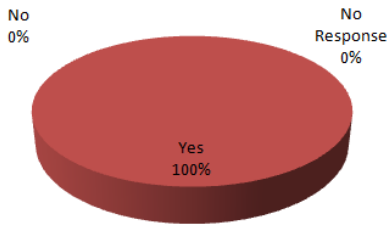
Question 2b: Have the technical barriers been identified and addressed?



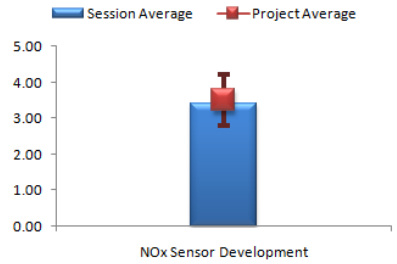
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Power Electronics Materials Compatibility (B.L. Armstrong, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Multiple reviewers commented on the importance of this project for hybrid technology. One person stated that it aims at solving the high temperature issues in power electronics for hybrids, thus enabling a wider introduction of hybrids, while another reviewer wrote that the focus on automotive air conditioning working medium (R134a and similar) supports a move to hybrid and plug-in vehicles that will result in substantial reduction of petroleum imports. In a more detailed response, one reviewer stated that wider adoption of hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV) products will save millions of barrels of oil; however, before this can occur the cost of these products must be much closer to that of traditional vehicles. One way to assist industry in achieving that goal is to develop technologies that can reduce the cost of the cooling systems in existing HEV and PHEV products. Today, a common strategy is the use of two separate cooling loops in these products: one for the ICE and one for the power electronics. This extra cooling loop is expensive and is part of the higher cost of these products. The technology underdevelopment in this work could enable the use of the existing AC cooling loop to cool the power electronics and reduce the cost of these products. That would then lead to wider adoption of these products and an enormous amount of savings in oil due to a higher fleet MPG average.

One response stated that, although R134a is not a common coolant for cooling power electronics, it is readily available on vehicle systems and should be considered as a coolant for electronics. Another person felt that the impact on power consumption is likely to be high, but is not talked about at all. This reviewer wondered if PI's even understand the need to think through the potential impact on petroleum displacement in specific terms. The technology enabled is highly leveraged and needs to be pursued. One other respondent stated that this project will determine the reliability of direct contact refrigerant coolant of the power electronic components. This coolant technology could enable the reduction in size, weight and cost of the power electronics. This could be an enabling technology for the power electronics.

One reviewer admits some uncertainty regarding this question, adding that if the author is proposing to cool electronics with a refrigerant, then additional vehicle power will be needed to cool the refrigerant, which would seem to have a negative effect on saving power. As long as the gains achieved by cooling the electronics outweigh the losses associated with additional cooling, then the reviewer states a tentative yes. One final review noted that the objective of this project doesn't match the title of the project.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person commented that long-term compatibility and the impact of contamination within the AC system itself and the effect on the power electronics is the key issue that must be resolved. This work is on track to address that issue and appears to have a solid plan of action that will resolve it. Another stated that all resources needed in the project are available. The project is aimed at a determining the effect of coolants on the materials used in high power electric components. One person noted that the

test plan outlines material compatibility concerns and corrosion expectations of R134a on power electronic packaging materials. One reviewer suggest that, besides looking at the comparability of the power components, other metals, metal combinations and solders, the control electronic components, and PC boards should also be covered.

Some reviewers were not certain about the deployment strategy, with one person stating that a deployment strategy was not seen in the presentation, and another stating that the technical approach is not clear. One reviewer felt strongly that more thought could be put into potential payoffs of success in the work. There is clear payoff for enabling other technologies. At the same time, how those technologies are enabled can have a wide variety of impacts into fuel consumption, independent of the target technology enabled. This really ought to receive some thought.

Lastly, one reviewer stated he or she liked this concept, at least in terms of using R134a as a direct coolant. The module is effectively sealed from the environment (which has significant gains by itself), it is contained in a material of high dielectric strength, it can be cooled with existing vehicle cooling systems, and the PI is investigating the material interactions with the refrigerant and the packaging materials. The list of compatibility issues seems sufficient, but the author does not disclose how he'll actually measure or determine good/bad. Will it be visual only? Will mechanical studies be performed, or will electrical output be measured? The PI should be clearer about what he'll define as success or lack thereof. The reviewer likes the idea of accelerated testing, but considering that the author will have no baseline to compare to (multiple years in service, for example), it will be difficult to correlate anything from his accelerated efforts. It's a worthy endeavor, but the reviewer is not sure what will be gained. Lastly, the author also does not disclose the exact materials that he will evaluating, so one cannot assess if his study will capture all of the existing high power packaging materials used in industry today.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Comments in this section tended to be either positive or acknowledge that this project is relatively new. One person stated that good progress appears to have been made to date. Another indicated that being able to cool the high power electronics in a future generation can be seen as a small enabling step for the future progress in hybrids. One reviewer simply referred to the group's test methodology that had been identified to accelerate materials corrosion from exposure to automotive coolant system working fluids.

Multiple reviewers noted that this is a new project, or that there is no evidence yet. One reviewer wrote that it was very early to judge; the project is just getting started, but this seems like a reasonable path forward. Another simply wrote that no achievements were presented. One final reviewer stated that he or she was not sure if the PI has had sufficient time to make significant progress towards his goal, but the plan seems laid out well enough and significant thought has gone into the effort. Progress has been made.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Most of the reviewers were generally positive regarding this question. One person wrote that, since the coolant would ideally be in contact with the die and wire bonds in order to achieve maximum cooling efficiency, the data generated by accelerated compatibility test under development in this work will be very valuable to industry. In this reviewer's opinion, this is a key barrier to the adoption of this technology, and by providing data that resolves the issue, transfer of technology to industry is very

likely. Another person added that the reduction of power electronics center physical size and mass are top priorities in OEM hybrid vehicle deployment. The project addresses those needs. Similarly, one person stated that automotive manufacturers will be very interested to review the results to determine the viability of using the refrigerant as a coolant for power electronic modules. Another reviewer commented that this has the potential to meet the cooling needs of all the components in the power electronic system. The project needs to be done to determine if the risk can be overcome.

One person stated that it was difficult to determine since the project is not aimed at a product but an understanding of the behavior of materials. Similarly, another reviewer stated that it was not clear what to achieve.

One final reviewer stated that they are not qualified to answer this question, mostly because the question is bigger than the reviewer, or the efforts at ORNL. Moving the technologies toward the marketplace is a direct function of acceptance of the technology by the marketplace. As long as the PI is working or collaborating with industry experts on electronic cooling systems, then the program stands a chance of being successful. Otherwise, there will be some challenges, especially time to market. If a systems supplier picks up this technology when it's complete (2010?) and spends further time/effort developing a cooling system around it, it may not see the market until 2015 or later. The PI needs to begin sharing preliminary data with systems suppliers to gauge interest in the program to see if it will have acceptance in the marketplace.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Three different reviewers stated that the resources were sufficient, with one stated that the resources appear adequate to achieve the project goals, while another said that the project will be accomplished with the given resources.

Another person commented that they see no issues in the PI achieving his milestones. This person adds that “developing a methodology” and “initiating testing” aren’t exactly aggressive achievements, and those elements could already be accomplished at the time of this writing. “Continued testing during the next FY” is also generic enough to be easily met. As mentioned, the reviewer likes this approach. If at all possible, the reviewer never advocates pushing electronics above the 150-175°C threshold, specifically for automotive applications. Using a cooling system is a fundamentally better idea and using R134a also has benefits. The only concerns are the system-level issues associated with this module concept. The reviewer understands that the scope of the work is not the system, but at some point this idea will need to be transferred to an OEM. The reviewer has concerns about pressurizing and sealing the module, especially with electrical connections coming to the outside world, and the costs associated with such a connector system. The reviewer has issues about servicing the module and the efforts involved to safely extract the electronics should something go wrong with them. The reviewer also has issues about the additional power draw required to cool the electronics and how the HVAC system engineers would feel about another draw on their compressor. The reviewer is sure all these issues can be resolved, but they are just a few concerns. Otherwise, this reviewer likes this novel approach.

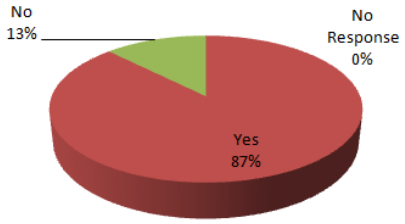
One person commented that the project will take longer than a year to complete unless compatibility issues are found, and another said it was not clear what the tasks are.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

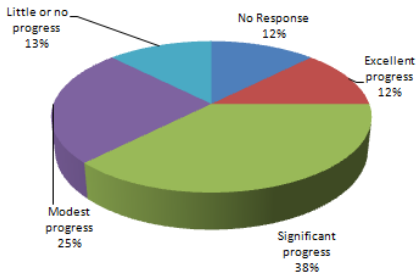
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Power Electronics Materials Compatibility

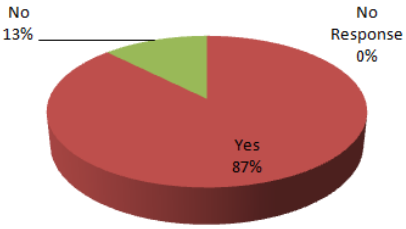
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



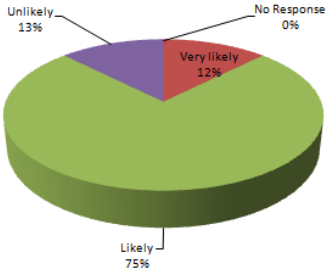
Question 3: Characterize the technical accomplishments and progress toward goals.



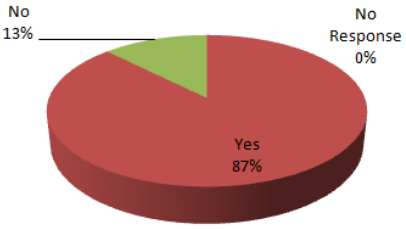
Question 2a: Are the goals of the project technically achievable?



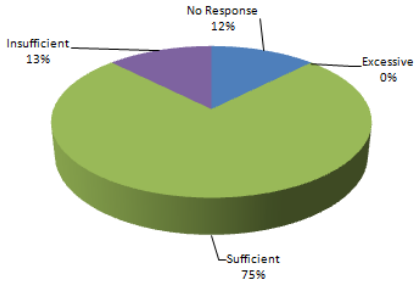
Question 4: How likely is the project team to move technologies into the marketplace?



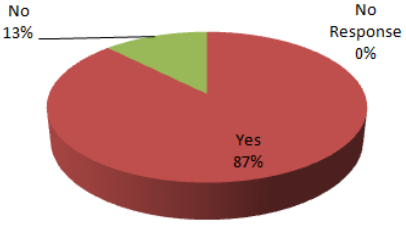
Question 2b: Have the technical barriers been identified and addressed?



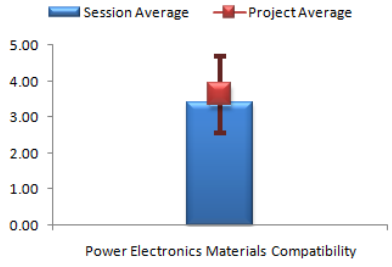
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Residual Stress (Jules Routbort, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One response indicated, yes, but added that this project and 13721 should be considered together as there is no additional petroleum savings for this project over 13721. Another reviewer stated that this is a supportive project for improved application of thin super hard coatings, and the support is indirect. One final reviewer began by stating that reducing friction and wear in the drive train resulted in 3-4% fuel efficiency. Performance strongly depends on residual stress profile. Currently, no method exists. This project develops and refines high-energy X-ray techniques to measure residual stresses.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person stated that the deployment activities were covered in 13721, and no additional activities were identified in this project, while another reviewer also commented that the project is linked to project 13721, adding that in this project there is close cooperation within the supply chain. One other reviewer commented that the approach is to use high energy x-rays for profiling residual stress in thin coatings and develop indentation-based techniques to measure hardness, fracture toughness, and adhesion energy.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the progress is commensurate with the duration to date and the budget. Another person stated that it is difficult to see the link between the ability to measure the internal stresses and a reduction in the use of fuel. The technology helps to understand the behavior of hard coatings. One final respondent commented that the group has measured thin coatings of nanocrystalline MoN and MoNCu, created strain measurement techniques (cross-sectional microdiffraction; measured depth-resolved strain/structure in MoN films and MoNCu film), and measured adhesion energy using indentation.

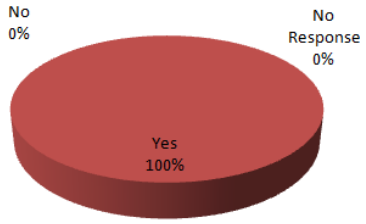
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person stated that successful low-friction coatings have many applications in engines, and some are no doubt economically viable today. To contrast slightly, another reviewer stated that there was no technology transfer mentioned in the presentation, and that this is an enabling technology. One other person commented that measurement technology is difficult to transfer due to the very expensive equipment used.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the budget appears reasonable given the activities identified to be completed.

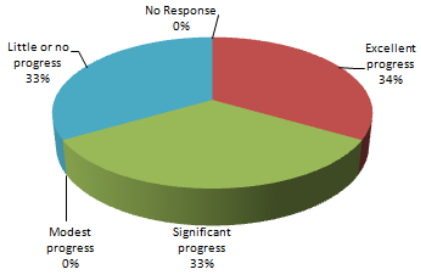
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Residual Stress

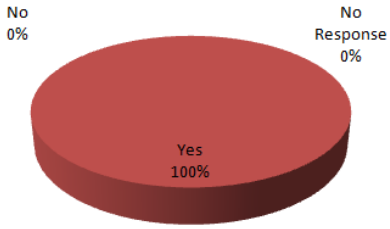
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



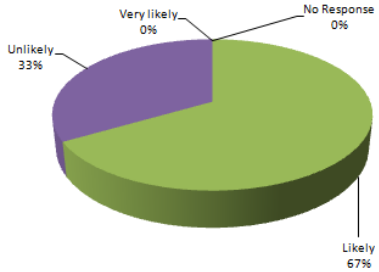
Question 3: Characterize the technical accomplishments and progress toward goals.



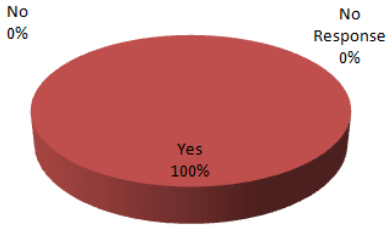
Question 2a: Are the goals of the project technically achievable?



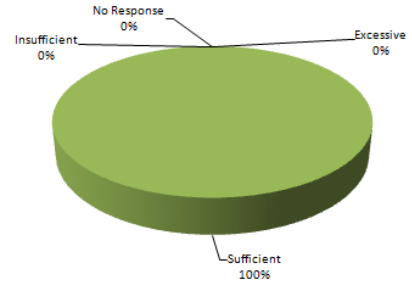
Question 4: How likely is the project team to move technologies into the marketplace?



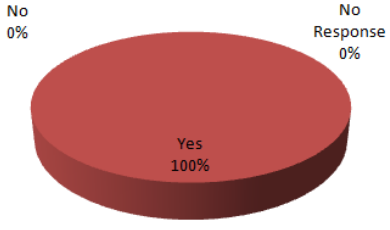
Question 2b: Have the technical barriers been identified and addressed?



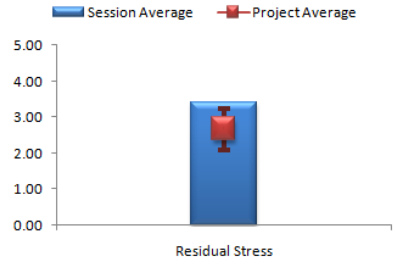
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Solder Joints of Power Electronics (G. Muralidharan, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 8 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses in this section tended to depend upon how familiar reviewers were with the importance of high-temperature soldering techniques. One individual wrote that future generations of hybrids will lead to higher temperatures in the power electronics. The conventionally-used solder materials can not deal with this temperature. For this reason, alternative solder material is needed. Another stated that, in order to enable a wider adoption of hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV), the cost of these products must be much closer to that of traditional vehicles. One way to assist industry in achieving that goal is to develop technologies such as SiC based power electronics that can replace the current Si based systems. Since the SiC modules could operate at much higher temperatures, significant cost, weight and size could be saved and facilitate the goal of lower overall product cost. However, a key problem is that the existing packaging technology used in power modules is not capable of working at these high temperatures. Therefore, this work is critical to achieving this goal. The reviewer added that wider adoption of HEV and PHEV products will save millions of barrels of oil. One reviewer simply stated that hybrids lead to lower fuel consumption.

Similarly, one reviewer stated that higher temperature electronics such as SiC and GaN require mounting systems and bonding materials that can withstand 200°C temperatures. This project has this requirement in its sights and the expertise needed to execute. Another person added that the present solder joints used in die bonding the power silicon die are only good to 125°C. In order to get the power electronics to operate with 105°C coolant, a 175° die bond material will be required. This project is very critical in getting reliable power electronics. One response simply stated that high temperature power electronics for vehicle applications is the technical trend. Solder joint reliability is one of the key factors to achieving this goal.

In contrast, some of the briefer responses were less convinced by the importance of the work. One respondent stated that new packaging concepts eliminate the need for solder or wirebonds; however, a better understanding of the solder composition can improve today's power module performance. Another reviewer felt that there was no direct relation that has been analyzed to connect improvements in this area to petroleum displacement. This person suspects that this is not a critical path to enabling other technology, and that this work would get done as routine process development at a vendor. One final reviewer stated that it may contribute indirectly, but this person doesn't think this question should apply to a materials evaluation. He or she does not think it is the fault of the paper, but this person was not sure how to correlate a study on solder joint reliability to saving barrels of petroleum. However, since higher efficiency engines require reliability at higher temps, the reviewer felt that this was okay.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Comments to this prompt were generally mixed. One person stated that the approach adopted by the researchers is solid and appears on track to achieve the project's goals. The key problem in the industry is that there are more than 100 solders, brazes, and adhesives that could theoretically be used as die attaching materials for this application. The adhesives can be ruled out due to inadequate thermal and electrical conductivity. However, many of the solders are good candidates for this role,

and the proposed methodology will identify which materials make sense as well as provide the required reliability data. One other person wrote that the barriers and technology gaps are identified. This reviewer was pleased to see that the investigators have cited the issue with eutectic AuSn voiding. Concerns with solder layer voiding and trends towards the progressive worsening of voids with temperature cycling are a major issue. The project strategy correctly identifies solder integrity as one of the prime focal points, though the person didn't see a deployment strategy in the presentation.

Other responses offered suggestions or were less positive. One person stated that this project needs to look at some of the newer die bond technologies such as sinter die bond materials. Another wrote that the project is missing the information from an OEM to define the requirements in relation to 15 years of operation. One reviewer wrote that this does not seem to be appropriate work for DOE. This looks like very mundane process development work that should be done by vendors headed for production with specific systems. One other response stated that the approach set in this project is more on testing and evaluating of different solders. It may be that none of the existing solders would work.

Lastly, one reviewer offered a lengthy commentary on the trajectory of this project. The response states that, since the reviewer was not involved at the inception of this project, it is unclear if the PI performed any literature studies or if the PI explored any previous work in the industry or academia. Hopefully the PI is aware of work at the University of Maryland (CALCE) with Patrick McClusky or the University of Auburn with Wayne Johnson. The reviewer cannot confirm all activities at Maryland or Auburn, but there have been significant efforts towards high temperature applications. Furthermore, this person hopes that the PI would attend or participate in the IMAPS HiTEC conference in Albuquerque in May (http://www.imaps.org/hitec/). Regarding the work, the reviewer expects that a facility such as ORNL would perform a more thorough high temperature solder investigation than just the industrial standard of building a module and then thermal cycling it. The reviewer would like to see thermomechanical modeling, including creep and fatigue, at elevated temperatures, and then correlate them to failure analysis findings. Finding material parameters to effectively model different solder compositions would have a far greater impact than just cross-sections of solder joints. Also, the PI points to testing 'alternate solders', but fails to disclose what solders he would be testing, and the reviewer is also curious if the PI intends to create new solder compositions or only use commercially available ones. Also, the PI points to wirebond investigations but does not disclose plans to look at them, at least not in FY08. A high temperature study on wirebonds could occupy years of time by itself. The bottom line is that the scope of the study undertaken by the PI is FAR GREATER than what he may be anticipating. There are multiple, more highly-focused projects that could be created instead of this effort. The idea to investigate solders for high temperature applications IS REQUIRED in this industry, but the reviewer would suggest re-evaluation and possible collaboration with other industrial/academic teams who may be trying to solve the same problem. This reviewer does not think that the PI will effectively or completely solve this dilemma in the time required with the strategy presented.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

More than half of the responses comments on the fact that this is a new project with minimal accomplishments. One person stated that either this is a new project or it is in its early stages to show any progress. Another noted that the PI has identified his approach to overcoming the technical barriers, but given that project has only recently kicked off (4th Quarter, 2007), one could not expect

significant work to be accomplished by now. Similarly, one reviewer stated that this is a new project just started in 4th Quarter of FY07, adding that the result so far is not sufficient to make a comment.

One reviewer wrote that this does not seem to be targeted to significant barriers toward DOE goals, while another felt that the progress is modest because a better solution would be to avoid the high temperatures through advanced cooling.

Another reviewer indicated that the project statement is skimpy in technical details and the reviewer did not participate in the on-site merit review meeting, so he or she may have missed some of the supporting discussions on technical accomplishments. However, the reviewer does know the principal investigators and is confident they will make the progress outlined in this proposal. Lastly, one person commented that the initial findings using 80/20 Au/Sn and shear testing represent a good start, and vacuum soldering will reduce the void fractions observed to date. The investigators may wish to consider other materials since 80/20 is a very hard solder and is rather expensive, although the quantity required in a given HEV or PHEV would be very small and, therefore, the total module cost would not be significantly affected. Other materials can also be used and if time allows it would be useful to include those materials as well.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses to this question were somewhat mixed, but generally positive overall. One person wrote that, as stated above, this die attach is a key problem and resolving it effectively is expensive and time consuming. This work will provide the necessary data to enable industry to select the correct die attach materials for this application. Another felt that, once an alternative solder material is available, it is easy to use it in the industry, with one person adding that knowledge gained in this project can be transferred to a components manufacturer. Another reviewer stated that the project results can help improve reliability of some of the existing products in the market by allowing manufacturers to use better solder composition. One other response indicated that high-temperature electronics has been an industry want for 20 years now in automotive, and (the reviewer knows for fact) for downhole and other geophysical activities. Progress has been slow but steady and this project does advance the state of the art.

To contrast somewhat, one reviewer stated that, if they expand their look at other high-temperature die bond materials, the project is likely to move forward into the market place. One final reviewer stated that the work being proposed by the PI should have value to the marketplace, but in order to gain greater acceptance, the PI should be partnering or collaborating with market players (either power IC companies - On Semi, Fairchild, Infineon, etc., or with module manufacturers). Because the PI is only performing high temperature studies on existing systems, the PI's work should be validated by those where a direct impact will be made. If the marketplace does not accept these solutions or efforts because of cost, usage, availability, etc., then this study is of little or no value. Furthermore, if this study creates no solutions, then the PI will have confirmed what is already known about the difficulties of high temperature electronic packaging. This study should be a collective effort of die suppliers who can discuss bond pad metallizations, wirebond wire suppliers who can help select the correct wire composition based on power and temperature requirements, and substrate suppliers. Just 'throwing this work' into the marketplace may result in a less than enthusiastic response.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Two reviewers stated that the resources appear adequate to achieve the project goals, or that the resource statement is sufficient. Another person noted that the reliability test is very expensive and time consuming.

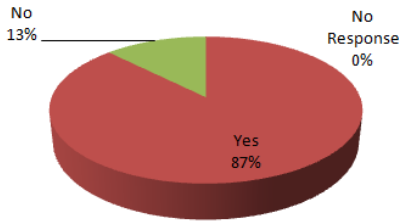
One person stated that the evaluation period for the materials will take longer than a year. Funding should be on going into 2009 and increase in funding should be looked at.

One final reviewer didn't know the milestones for the project, or they are not clearly identified, but the components identified to be completed are logical for the effort. The reviewer would like to know how many thermal cycles will be completed by the 9/08 milestone target, especially given that OEM's are now requiring up to 3000 cycles, and he or she would also like to understand more about the thermal cycle profiles that the PI is targeting, including temperature ranges (-50°C or –65°C, up to 150°C or 200°C), times at temperatures, and if the thermal testing will be thermal shocks (air-to-air chambers) or thermal cycles (single chamber). If the PI wants to make this study relevant, it would be ideal to see correlation to practices and procedures followed in the automotive electronics industry. The reviewer only identified one milestone in the Plans for FY08 section and, given that the PI appears to be evaluating only one solder, then it seems reasonable that the resources are sufficient to meet the timeline. The reviewer has already made comments about where this project lacks focus, but also wishes to emphasize that this work is extremely important and relevant to the high temperature packaging industry, so by no means is the reviewer asking the work to stop. The reviewer's belief is that this work should be done and it should be done correctly. Multiple teams of people should be involved in this effort or the PI will not complete everything on time. The reviewer sees a lot of work to accomplish, and believes that the work will be much more significant than what this work plan proposes.

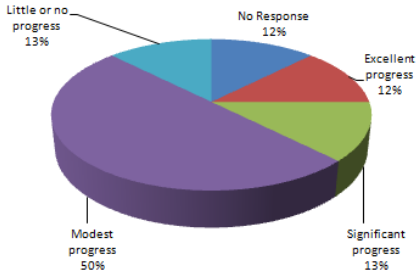
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Solder Joints of Power Electronics

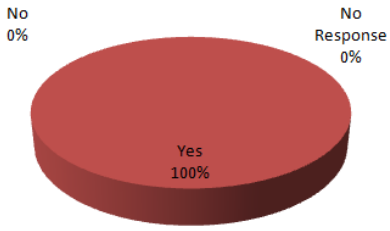
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



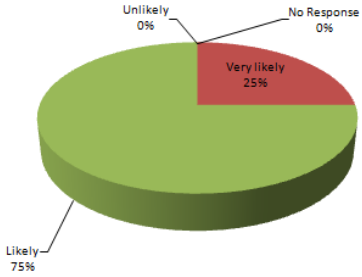
Question 3: Characterize the technical accomplishments and progress toward goals.



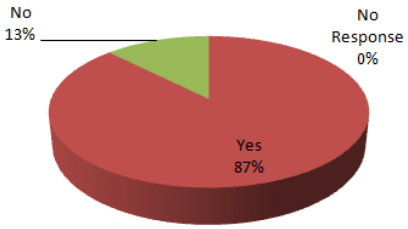
Question 2a: Are the goals of the project technically achievable?



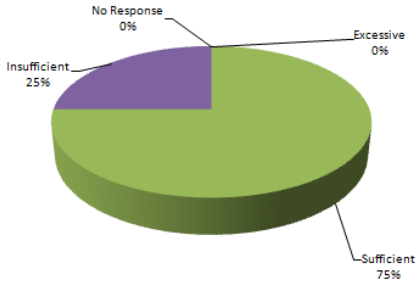
Question 4: How likely is the project team to move technologies into the marketplace?



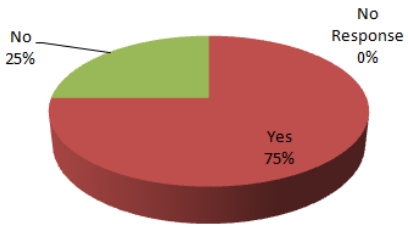
Question 2b: Have the technical barriers been identified and addressed?



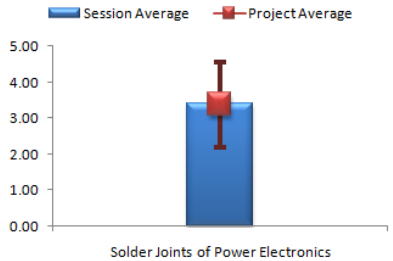
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Super Hard Coating Systems (Ali Erdemir, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that friction reduction has broad application in all types of engines, while another commented that 10-15% of fuel energy is consumed by friction in the engine. They added that reduction of S and P in oil places more demand on the material for friction and wear control, and pointed to developing a low-friction coating to reduce friction. The final reviewer noted that the project targets the reduction of parasitic losses. They added that these losses are responsible for 10 - 15% of the energy consumption, and, as such, this project is in line with DOE's objectives.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that they are working with component suppliers and it is presumed that if successful, economic coatings are developed, they will be implemented. Another added that one of the problems with hard coatings is the poor wetting characteristics with lubricants. This project aims at solving this issue. There is cooperation with a supplier. The whole supply chain is involved in this project.

One final reviewer commented that the barriers were: a predictive model for lubricious coating design, reproducibility/scalability/manufacturability, and performance. The team's approach is a bottom-up approach: use a crystal-chemical model as a predictive tool, demonstrate production/deposition, characterize structure and properties, verify tribological, and then perform engine tests.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer indicated that the progress achieved is reasonable given the duration of the project to date and the funding provided. Another commented that they have demonstrated production and completed coating design, development, and characterization. The group has also studied friction and wear tests, performed in EGR-contaminated/acidified oil, and done resistance-to-scuffing tests and XPS studies. One final reviewer stated that the improvement in parasitic losses only applies to a limited amount of components, and thus the overall effect will be limited. A full implementation of this technology would enable the use of low-viscosity lubricants in HD, giving it a higher potential in this market.

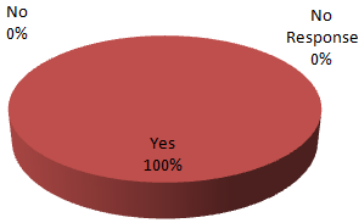
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person stated that low-friction coatings have many potential applications, including several where economics are not critical. Also, it is desirable to reduce the amount of wear additives in lubricating oils to protect emission control devices, creating demand for more low-friction coatings. Another commented that their selection was based on the group's contact with coating companies. These companies are successfully in introducing these technologies. The introduction will occur first in some nice market. Similarly, one person noted that they are working with a major industrial coating manufacturer to scale up: Burgess-Norton, Eaton, Mahle, Westport, CAT, Honda, and Hyundai. They will have the option to license an agreement with a company.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the project is receiving co-funding and no activity has been identified that cannot be completed within the current budget.

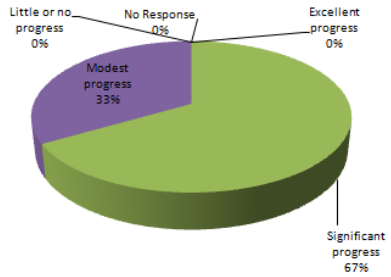
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Super Hard Coating Systems

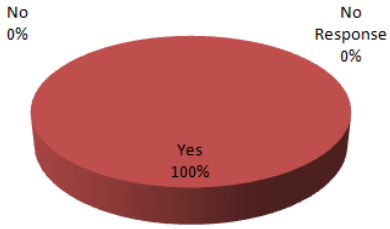
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



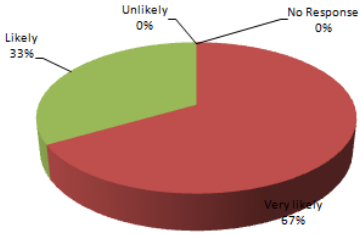
Question 3: Characterize the technical accomplishments and progress toward goals.



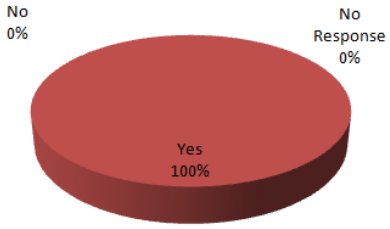
Question 2a: Are the goals of the project technically achievable?



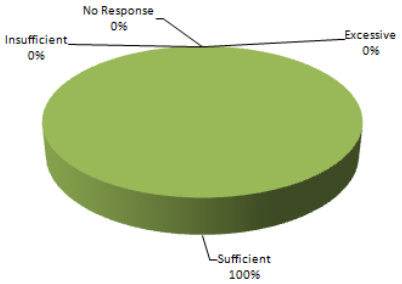
Question 4: How likely is the project team to move technologies into the marketplace?



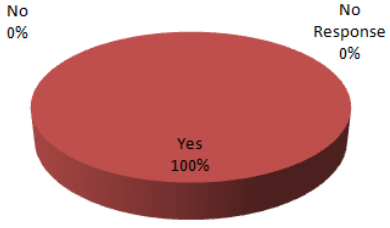
Question 2b: Have the technical barriers been identified and addressed?



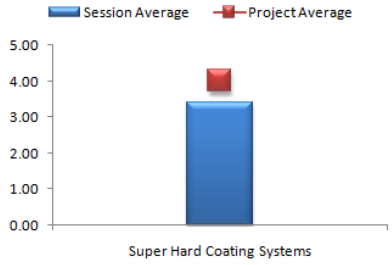
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermoelectrics Materials by Design, Computational Theory and Structure (David Singh, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer remarked that improved thermoelectric materials are essential to making them economically viable, while another noted that the investigators are trying to find promising thermoelectric materials for waste heat recovery in vehicles.

One response noted that the project addresses the use of waste heat and could lead to a potential 10% improvement of thermal efficiency. Similarly, another reviewer stated that the objectives of a 10% increase in fuel economy on a designated vehicle platform are well understood. This is a theoretical guidance program and is essential to complement the experimental work. Adding to this, one person stated that the program is both timely and important, and there is very little theoretical work on TE materials research as compared to the experimental effort.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that this project is exploring new thermoelectric materials, and while higher efficiency materials might be found, whether they are practical depends on their cost and reliability. Another noted that the main barrier is to find higher ZT materials at an appropriate operating temperature that are cost-effective, manufacturable, and durable. The group's approach is to use first principles calculations to obtain electronic structure and vibrational properties. One other reviewer stated that the project is limited to academia, and involvement of industrial partners would be beneficial for the deployment even though the project is long term.

One person indicated that the project goal of 10% increase in fuel efficiency is not likely, but significant progress can be made. The barriers have been identified. A lot of work on the development of the theory of the various materials has been accomplished, and this work should continue as an essential part of the experimental work to provide guidance. The PI's have a strong team in place to address these barriers. The PI's understand the overall goals of the program very well. One final respondent added that the PI is a very well-respected expert in the field. He is as good as you can get.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Reviews were generally positive in this section. One reviewer stated that the amount of progress is commensurate with the duration to date. Another noted this is a new project, but noted that promising results have been obtained for Mg-Ti-O and Zn-Ti-O ordered materials. Similarly, one person stated that the project is in its starting phase. There is a solid approach for improving the material properties. This is needed to get the technology in the market. One reviewer commented that this is a theoretical guidance program and is essential to complement the experimental work. Another simply stated, very well done.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that thermoelectrics have great potential and will be implemented if they are reliable and available at low cost, while another commented on the cooperation with ORNL researchers, adding that this project is configured to the Vehicle Technology Solid Waste Heat Recovery Program. One other respondent noted that this is a theoretical effort and will aid the experimental results transition into technology.

One reviewer felt that the potential is high, so if the benefits are shown the market will come. The reviewer added that no clear opinion is possible at this moment. One final person remarked that no information is available to respond to this prompt.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

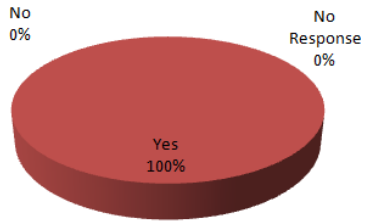
One person stated that the funding for this project is reasonable given its scope and activities, while another agreed, writing that the team has sufficient resources available. One final reviewer stated that there is a very good plan in place. The PI is an expert in the field. This is a very good project. Looking at oxide is appropriate for several very good reasons. This reviewer discourages work towards La_3Te_4 on the basis that Te is becoming increasingly expensive and there is not enough of this TE for large-scale applications.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

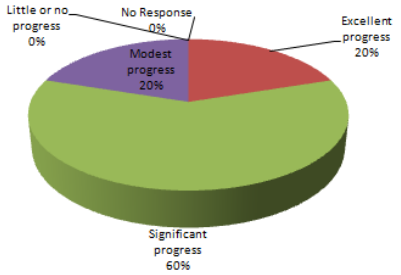
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermoelectrics Materials by Design, Computational Theory and Structure

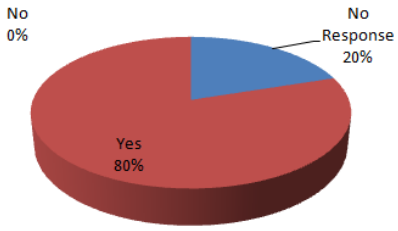
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



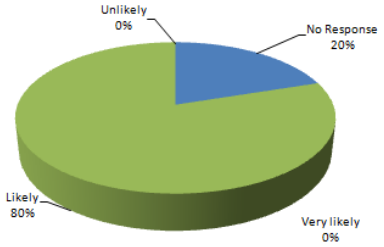
Question 3: Characterize the technical accomplishments and progress toward goals.



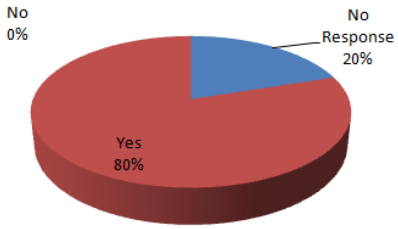
Question 2a: Are the goals of the project technically achievable?



Question 4: How likely is the project team to move technologies into the marketplace?



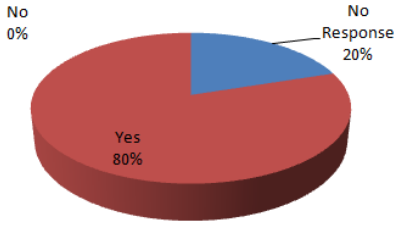
Question 2b: Have the technical barriers been identified and addressed?



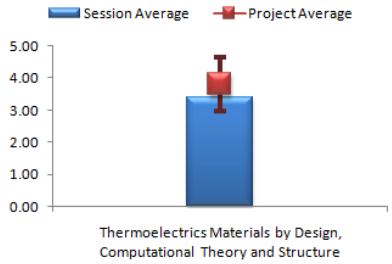
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials (Dieter Gruen, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses to this prompt were generally mixed. One reviewer stated that enhanced thermoelectric materials are essential to practical implementation, while another added that the recovery of waste heat will result in improved efficiency for transportation. Similarly, one person wrote that thermoelectric materials have the potential of improving fuel efficiency, adding that further improvement in material properties will increase the potential even further. Another reviewer commented that the project is aimed at creating breakthrough thermoelectric materials, which would definitely support the objective of petroleum displacement.

Other comments were less optimistic. One reviewer stated that the objectives of a 10% increase in fuel economy on a designated vehicle platform are not well understood. This program centers on thin-film diamond nanostructures. The team offhandedly comments that a ZT of 4 is possible, yet they have no data to base their conclusions on this. They have expertise on nanostructured diamond but no expertise in thermoelectrics. This is much needed. One final reviewer commented that the purpose of the program is to develop high ZT materials with high temperature stability. However, this reviewer is not sure if the PIs are on the right path.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that it is too early to tell whether this approach to developing new TE materials will be successful. Another person added that the project is exploratory. Deployment will start when more evidence for success is gathered. Similarly, another reviewer stated that the best answer would be "maybe". The materials proposed for this study have very high thermal conductivity, which is bad for thermoelectric materials. This reviewer did not see a good rationale for selecting these materials. One person noted that the initial project concept was based on ultra nanocrystalline diamond (UNCD) thin film work funded by Office of Science.

One reviewer commented that one of the approaches of this project is to explore the possibility of nanoscale-induced ZT enhancement in ultra–nanocrystalline dispersed diamond (slide 3/8). So far the project team only shows data on boron doping and annealing. This reviewer is not sure whether their approach is appropriate or not. Specifically, the investigators are supposed to have a high power factor for the nanocarbon ensembles already. One final respondent began by stating that the project's goal of a 10% increase in fuel efficiency is not likely. Significant progress is not likely to be made. The barriers have been well defined. They offhandedly comment that a ZT of 4 is possible, yet they have no data to base their conclusions on. They have expertise on nanostructured diamond, but no expertise in thermoelectrics. This is much needed. Their strategy is boiler-plate. Why not use this strategy on an already good TE material instead of one of the worst? Diamond is non-conducting and has a very high thermal conductivity. This reviewer adds that the PI's have a strong team in place to address nanostructured diamond, but need thermoelectric expertise. Also, they don't really understand the issues. The PI's understand the overall goals of the program very well, but this reviewer doesn't think they understand how they will achieve them. There was a gentleman in the audience that was asking

good questions and the presenter just dismissed them instead of addressing them. Either they don't understand the issues or wanted to gloss over them.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Responses to this prompt were generally mixed. One reviewer stated that the extent of progress is reasonable given the project duration to date, while another commented that this is a new project, the initial results seem promising, and the investigators have a long-range plan for the project. One other person remarked that, due to the innovative nature of this project, this is difficult to assess but potential is shown on thin layers.

Other comments were less favorable. One person noted that some power factors (electrical properties) have been measured, but they are very poor, about a thousand times lower than those of good thermoelectric materials. No thermal conductivity results were given. Another reviewer indicated that they have only presented doping on the electrical conductivity of diamond films, but they don't state how low it is or how they might get it high enough. One other reviewer wrote that one of the goals of the project is to achieve ZT >4. Based on the data they have shown in their review, even the boron doped samples have a power factor much less than many existing materials; one has to have extremely low thermal conductivity values to achieve ZT = 4.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses were mixed for this prompt, and tended towards the negative. One person stated that there are many applications for high efficiency TE materials, so implementation of good materials is likely, but two individuals stated that there was no mention about the technology transfer in the presentation.

One reviewer indicated that the current project team will not transfer the technology to the market. The team will aim at bringing the technology to a level that a more application-oriented project could start. Another person added that there is no industrial partner, and the commercialization of nanomaterials for an application that requires bulk solids is likely to be a long and difficult process. Another commented that this program centers on thin-film diamond nanostructures. They offhandedly comment that a ZT of 4 is possible, yet they have no data to base their conclusions on this. They have expertise on nanostructured diamond, but no expertise in thermoelectrics. This is much needed.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that, at present, the funding appears reasonable given the activities being conducted. Another similarly stated that the team has sufficient resources available, but added that they need TE expertise on their team. One other respondent chose a neutral score because there was no budget given in the presentation.

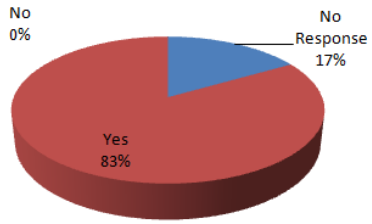
One final reviewer stated that next year's activity is not likely to meet the proposed milestones set forth for the project. This reviewer is not sure how this team plans to have the thermal conductivity, Seebeck, and electrical resistivity measured. The reviewer asks whether they have internal capabilities. The project is supposed to explore the effect of the enhanced power factor of their materials due to the quantum confinement. Their data so far shows the opposite, i.e., the nanocarbon assembles shows very small power factor values. It seems that the plan is to dope the materials and not to investigate the power factor as a function of, for example, size of nanocarbon. This reviewer suggested that it will be helpful if the project can establish some thermal conductivity data.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

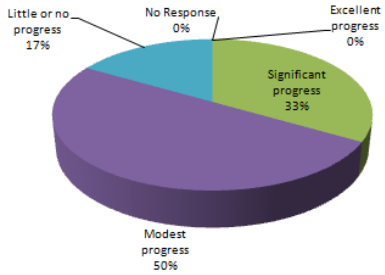
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials

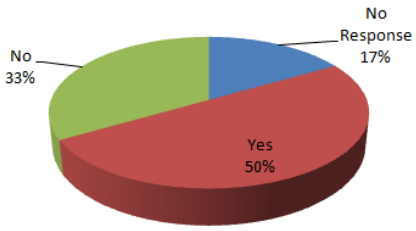
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



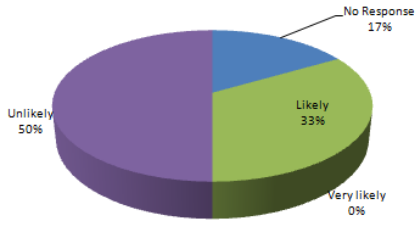
Question 3: Characterize the technical accomplishments and progress toward goals.



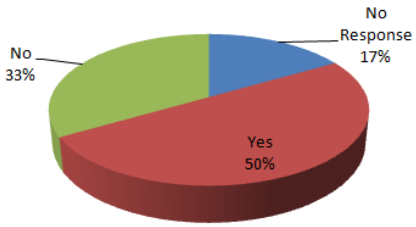
Question 2a: Are the goals of the project technically achievable?



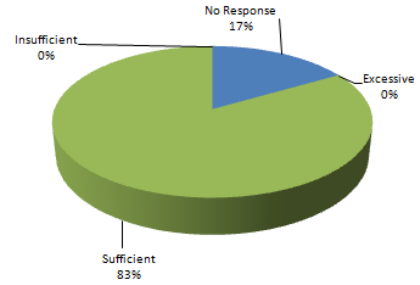
Question 4: How likely is the project team to move technologies into the marketplace?



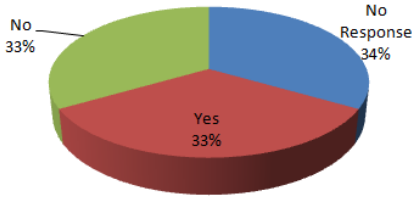
Question 2b: Have the technical barriers been identified and addressed?



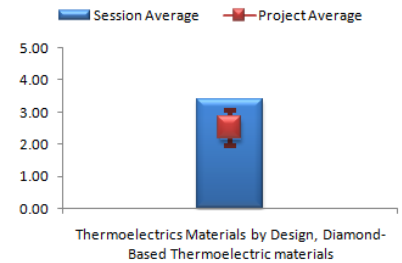
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermoelectrics Materials by Design, Mechanical Reliability (A. Wereszczak, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Reviews to this question were generally positive. One person stated that thermoelectrics have a large potential to reduce petroleum consumption. This project does not improve their efficiency, only their strength, which is essential to implementation. Another person commented that the proposed work is necessary for large-scale deployment of thermoelectric generators in vehicles and/or energy-intensive industry for waste heat recovery. Similarly, one reviewer stated that a material's mechanical reliability is a critical, yet often overlooked, component of thermoelectric technology development. This project would provide very important data for the design and integration of thermoelectric devices using for waste heat recovery as well as for cooling.

Other reviews specifically commented on the proposed efficiency increases. One response stated that the project contributes to an achievement of a 21% thermal efficiency increase in thermoelectric devices by 2012 and 10% engine thermal efficiency increase by harvesting exhaust waste heat. Another noted that this 10 % improved thermal efficiency is claimed, when thermo electrical energy transformation is used. One final reviewer felt that the objectives of a 10% increase in fuel economy on a designated vehicle platform are well understood. This is an experimental program that aides the other programs and is essential to complement the experimental work of the other teams. They provide essential mechanical performance data in order to achieve the devices. Mechanical properties determination is essential to incorporating new materials into devices.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Reviewers were mixed with regards to this prompt. One person commented that the technical approach is very well in alignment with the effort of improving the thermo-mechanical properties of thermoelectric materials. Another indicated that the barriers of the project are that TE materials are brittle and need to manage thermal stresses, while the approach is to develop FEA model to examine stress development and enable design optimization. One other reviewer stated that the goals are relatively modest and should be achieved, but success requires finding new information on fatigue, which can be elusive.

Some individuals offered suggestions. One response stated that the project starts out with an overview of mechanical properties of already existing materials. A closer cooperation with future users could be beneficial. Another person noted that the approach includes materials selection, but the team also needs to consider the device design(s) that they will model. The traditional cooler might not be the best choice. One final respondent felt that the project goal of 10% increase in fuel efficiency in not likely, but significant progress can be made. The barriers have been identified. A lot of work on the development of the mechanical properties of the various materials has been accomplished, especially bismuth telluride materials. This work should continue as an essential part of the other experimental work to provide guidance. The PI's have a strong team in place to address these barriers, and the PI's understand the overall goals of the program very well.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Responses were again mixed for this prompt. One reviewer indicated that the team has made significant progress toward their goals, by creating a module mechanical model and beginning to measure properties of Bi_2Te_3 alloys. It is likely the team will continue to make steady progress. Another individual stated that this is an experimental program that aides the other programs and is essential to complement the experimental work of the other teams. They provide essential mechanical performance data in order to achieve the devices. Mechanical properties determination is essential to incorporating new materials into devices. Similarly, one person commented that this project has established some very important results and data for improving mechanical strength of thermoelectric materials. Another person noted that they had developed an FEA model, developed a test matrix, and purchased TE and fabricated fixtures for the tests.

Other reviews were less positive. One person stated that no quantification of progress was given. Another reviewer indicated that the project focuses on the thermo mechanical properties of the material, but felt that a better performing material would lead to a higher benefit. This is, however, covered in other projects.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer felt that, assuming thermoelectrics are viable economically, this technology should be employed. Another wrote that they provide essential mechanical performance data in order to achieve the devices. Mechanical properties determination is essential to incorporating new materials into devices. One person commented that Marlow Industrial wished to use their thermophysical property for cooling with a TE device.

Another individual stated that publication of this work will be most of what is necessary to transfer to the marketplace. Capable companies will be able to use these mechanical property results to help design reliable generators. It is important that the team choose the most relevant designs for waste heat recovery. One person suggested that the project team should explore collaboration with a high temperature thermoelectric module manufacturer to addresses issues and concerns regarding high temperature thermoelectric generators. One final reviewer stated that, if it becomes possible to retrieve electrical energy from waste heat in a reliable way, this will certainly lead to market attention. At this moment, this reviewer feels that the project is somewhat long term.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviews were generally mixed in this section. One person stated that the team has sufficient resources available, another indicated that chose a neutral score because there was no budget given in the presentation, and one other person stated that, given the results, project funding appears to be high.

One final respondent began by saying that, again, it would be beneficial to see this project team extend their effort to investigate high-temperature materials and modules. This reviewer was not sure whether the project team has set aside resources for acquiring a sufficient quantity of high temperature materials and modules. The project is very well structured and has the appropriate expertise to tackle the technical challenges, which is both important and timely for the TE technology development community. The achievement in the past year is very impressive and the plan for next year is logical and appropriate. This reviewer expects this project to have an important impact on the recent quest for developing automotive waste heat recovery technology. The reviewer understands that acquiring an adequate amount of high temperature TE materials and devices for thermo-mechanical testing

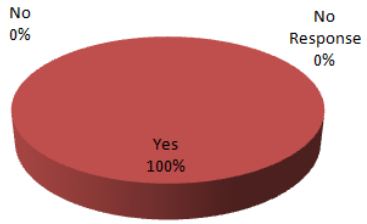
purpose is somewhat challenging, nevertheless, the reviewer encourages the PIs to make an effort to explore thermo-mechanical properties of high temperature modules and materials.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

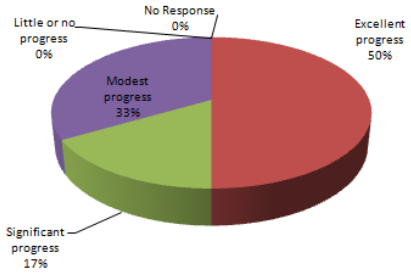
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermoelectrics Materials by Design, Mechanical Reliability

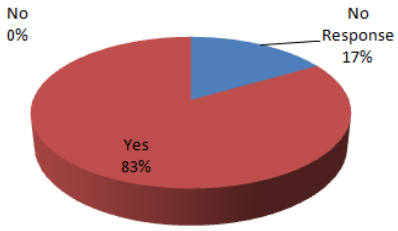
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



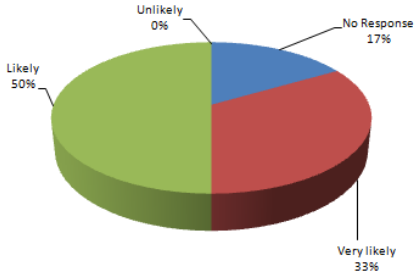
Question 3: Characterize the technical accomplishments and progress toward goals.



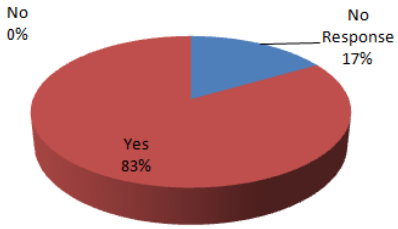
Question 2a: Are the goals of the project technically achievable?



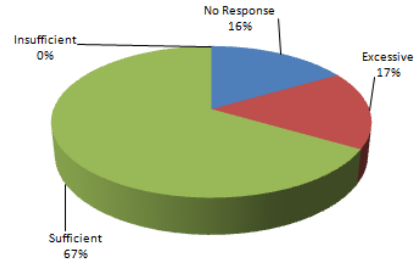
Question 4: How likely is the project team to move technologies into the marketplace?



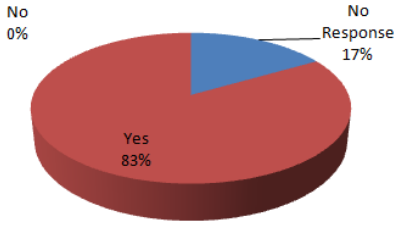
Question 2b: Have the technical barriers been identified and addressed?



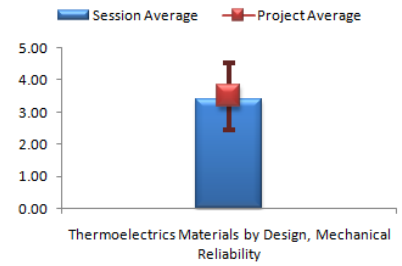
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



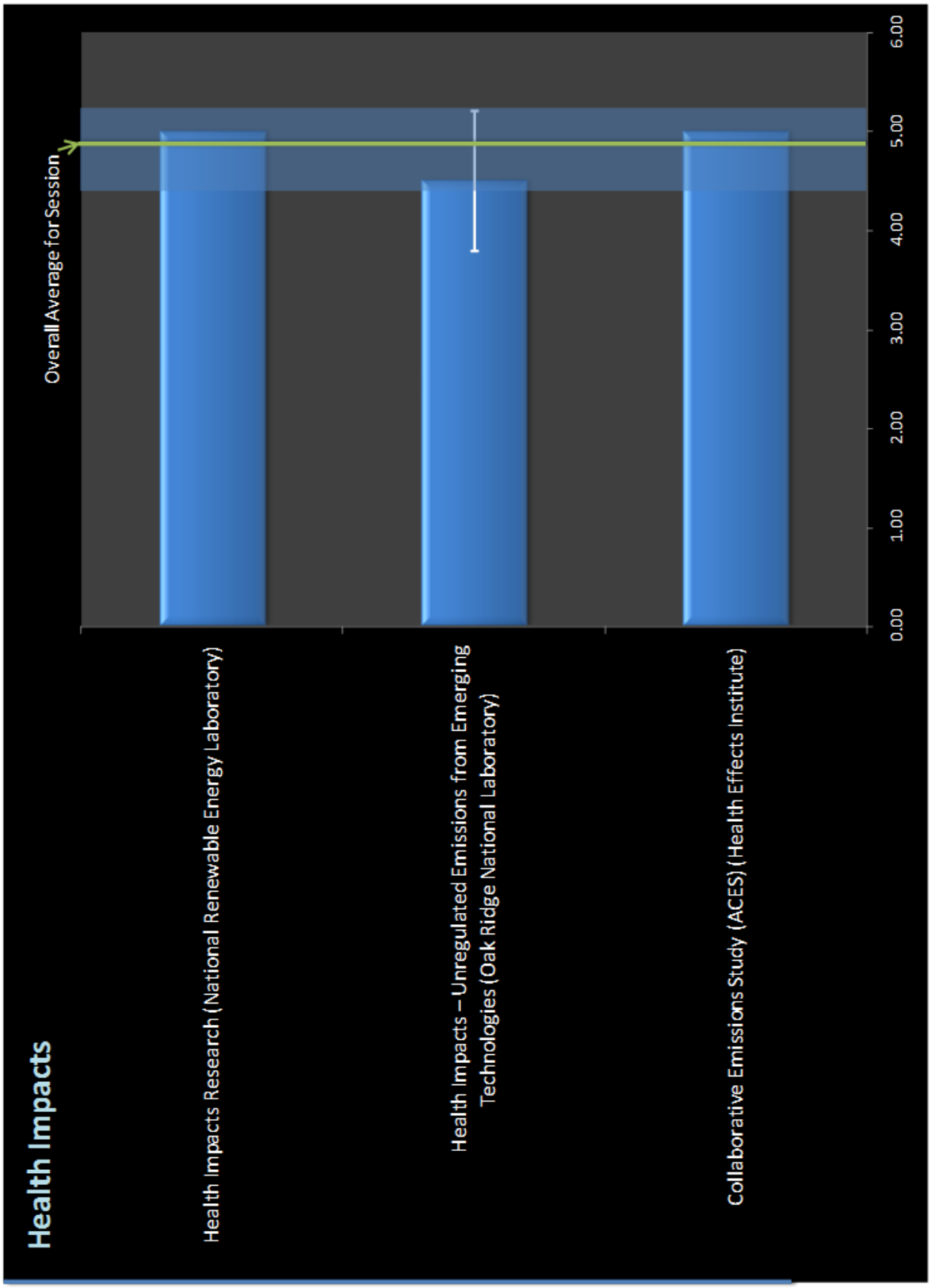
13. Health Impacts

Introduction

The Health Impacts work is being conducted to identify that any potential health hazards associated with the use of new vehicle technologies being developed by VT will not have adverse impacts on human health through exposure to toxic particles, gases, and other compounds generated by these new technologies.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
13-3	Collaborative Emissions Study (ACES) (Dan Greenbaum, Health Effects Institute)	5.00	0.00
13-6	Health Impacts – Unregulated Emissions from Emerging Technologies (John Storey, Oak Ridge National Laboratory)	4.50	0.71
13-9	Health Impacts Research (Doug Lawson, National Renewable Energy Laboratory)	5.00	0.00
	Overall Session Average and Standard Deviation	**4.83**	**0.41**


Health Impacts
Overall Average for Session
Health Impacts Research (National Renewable Energy Laboratory)
Health Impacts – Unregulated Emissions from Emerging Technologies (Oak Ridge National Laboratory)
Collaborative Emissions Study (ACES) (Health Effects Institute)
0.00
1.00
2.00
3.00
4.00
5.00
6.00

Collaborative Emissions Study (ACES) (Dan Greenbaum of Health Effects Institute)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer wrote that this program will provide the scientific basis for arguing that the health risk of new technology diesel exhaust is much lower than traditional diesel exhaust. It will also provide important data to compare this new technology with gasoline and other combustion technologies used to power vehicles.

Another person stated that diesel engines present the potential for improved mileage and thus a possibility for reduced petroleum consumption. He goes on to state that health concerns are a critical factor in the use of diesel engines: EPA has set new restrictions on NOx and exhaust particulate matter emissions; at the same time, scientific research has identified possible exacerbated health hazards associated with ultrafine or nanoparticulate exposures. Diesel exhaust particulate is ultrafine in size. It sometimes contains particulate or semi-volatile genotoxicants or other toxic materials, including some traces of metals. While new technologies are being tested by DOE and manufacturers that can control NOx and PM emissions by weight, it is not fully known how the new engines or new control technologies will affect other characteristics of the engine particulate emissions, e.g., increasing numbers of emitted particles, or producing different size distributions or compositions or surface properties of final PM emissions. Such new properties of PM associated with new engine and/or control technologies, and new modes of operation, e.g., regeneration, should be evaluated as thoroughly and as early as possible given the possible subsequent rapid and massive public deployment of these technologies. This is a statement appropriate in general to all the DOE-VT Health Impacts research projects, including this HEI – ACES study.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that this project is one of a set of health impacts studies that are being performed by DOE-VT to better define and address the possibility of new health concerns that might be associated with new engines and control technologies. It is prudent for DOE to undertake these studies to evaluate and guide engine and control technology R&D from the earliest stage. This is a statement appropriate in general to all the DOE-VT Health Impacts research projects, including this HEI – ACES study.

The other person noted that this project has had lots of input from scientists from academia, regulatory agencies, and government. He adds that the plan is sound, and there has been significant progress in characterizing the emissions from four heavy-duty vehicles. The next phase, testing in a chronic bioassay, is on target to begin early in 2009.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that there were many technical barriers that needed to be overcome. Fortunately, he adds, there are many experts on HEI research committees from academia, as well as from government and industry, who have assisted in overcoming these potential barriers. This expertise will continue to allow the project to move forward as challenges arise during the testing. Similarly, the other person noted that the HEI-ACES study is a major collaborative effort between

well-established research institutes versed in the tasks of engine system selection, physical characterization of emissions, and animal model short- and long-term bioassay of engine emissions. These ACES chronic studies are important to see if there are unanticipated major health effects associated with these new engine/control technologies under some representative operating conditions.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent indicated that many new techniques for measuring engine emissions, as well as biological endpoints in the animal studies, are being developed as part of this project. These will be transferred to other laboratories as the methodologies and results are reported and published in the peer-reviewed literature. In a fuller response, the other reviewer stated that there has existed for decades some contention on the general topic of chronic animal model studies of diesel exhaust. IARC, EPA, and NIOSH reviews of human and animal model data have concluded in general that diesel exhaust exposures possibly or probably pose a carcinogenic risk to man; but interpretation of past animal model studies has been varied, sometimes suggesting response only in non-representative overload conditions of exposure and epi-genetic bases for the induction of tumors in the experiments. Genotoxicant content of diesel exhaust is known to be a function of engine operating condition (load, speed), engine tune, and fuel. These cannot all be examined in chronic exposure studies. The short-term animal model studies planned can to some extent address these. While no in vitro studies are planned, it might be reasonable to collect and provide or archive exhaust materials for such assays, e.g., to isolate steady state or individual cycle component running conditions to identify possible modes of operation or sources of biologically active materials in the exhaust toward interpretation of animal model results or extrapolation to other engine design or operational factors.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

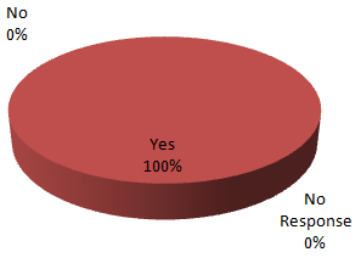
The lone respondent stated that more funding would move the project along more quickly, but the funding is sufficient for now.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

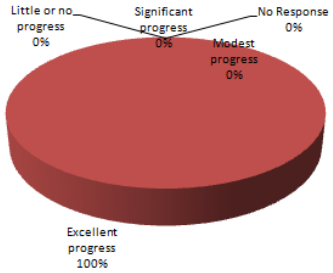
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Collaborative Emissions Study (ACES)

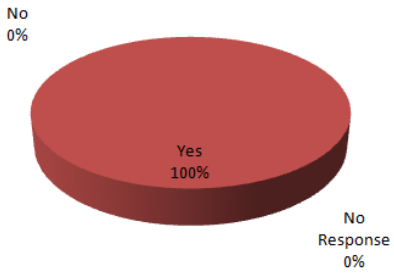
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



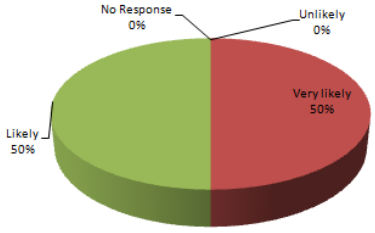
Question 3: Characterize the technical accomplishments and progress toward goals.



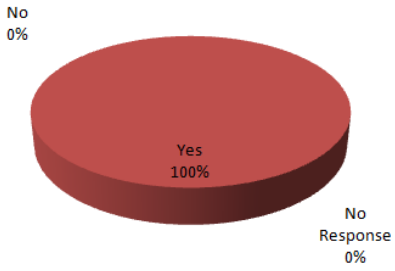
Question 2a: Are the goals of the project technically achievable?



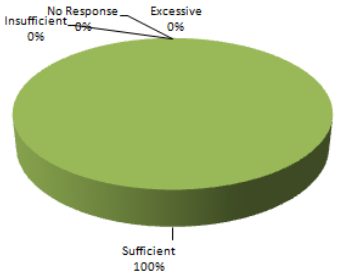
Question 4: How likely is the project team to move technologies into the marketplace?



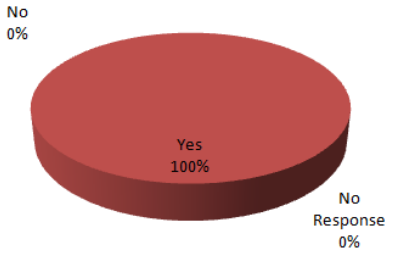
Question 2b: Have the technical barriers been identified and addressed?



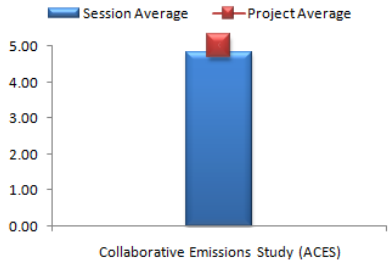
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Health Impacts – Unregulated Emissions from Emerging Technologies (John Storey of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated that this activity certainly has the potential of supporting DOE objectives, but it may not meet the objectives as it is currently being conducted. The reviewer is specifically concerned that testing is being conducted only using an engine dynamometer. He adds that measurement of emissions using this methodology can be quite different from those coming from a chassis dynamometer or from a vehicle tested on-road. He is concerned that the results from the engine dyno will not be compared to those from the other two methodologies. Thus the results being generated may have limited application to real-world emissions when these alternate technologies are being used in actual applications.

Another reviewer commented that diesel engines present the potential for improved mileage and thus a possibility for reduced petroleum consumption. He adds that health concerns are a critical factor in the use of diesel engines: EPA has set new restrictions on NOx and exhaust particulate matter emissions; at the same time, scientific research has identified possible exacerbated health hazards associated with ultrafine or nanoparticulate exposures. Diesel exhaust particulate is ultrafine in size. It sometimes contains particulate or semi-volatile genotoxicants or other toxic materials, including some traces of metals. While new technologies are being tested by DOE and manufacturers that can control NOx and PM emissions by weight, it is not fully known how the new engines or new control technologies will affect other characteristics of the engine particulate emissions, e.g., increasing numbers of emitted particles, or producing different size distributions or compositions or surface properties of final PM emissions. Such new properties of PM associated with new engine and/or control technologies, and new modes of operation, e.g., regeneration, should be evaluated as thoroughly and as early as possible given the possible subsequent rapid and massive public deployment of these technologies. This is a statement appropriate in general to all the DOE-VT Health Impacts research projects, including this Oak Ridge National Lab study.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that one technical barrier of using an engine dynamometer is the problem with extrapolating the results to real world conditions. Another person noted that this project is one of a set of health-impacts studies that are being performed by DOE-VT to better define and address the possibility of new health concerns that might be associated with new engines and control technologies. He adds that it is prudent for DOE to undertake these studies to evaluate and guide engine and control technology R&D from the earliest stages, again noting that this is a statement appropriate in general to all the DOE-VT Health Impacts research projects, including this Oak Ridge National Lab study.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person indicated that the ORNL study is very strong in characterization of MSAT volatile and semi-volatile organics. For PM, the respondent adds, particle size distributions are measured, but it

was not clear what analyses of POM are made. A difficult but possibly important factor in potential health effects might be composition with particle size, e.g., are metals found principally in the smallest ultrafine size range? Are PAH or some known genotoxicants found principally in some specific size ranges?

The other respondent stated that one of the most important new technologies for the future is SCR with diesel. This technology is already being used in Europe and many companies plan to employ this technology in the US starting in 2010. Dr. Storey presented no results on this technology.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer noted that this group does not generally publish their results in the peer-reviewed literature, and thus the new techniques being developed will be very slow to reach the general research community, it at all. Similarly, the other respondent stated that peer-reviewed journals or an SAE Technical Paper might be important complements to DEER presentations for dissemination of these important research results, providing more detail data exposition and discussion, and to a wider audience.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

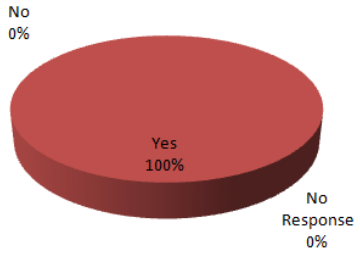
The lone respondent stated that he thinks some of the funds being allocated to this project should be transferred to Dr. Doug Lawson's project, which is much more relevant and has made much more progress over the years.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

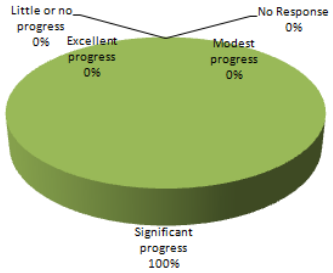
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Health Impacts – Unregulated Emissions from Emerging Technologies

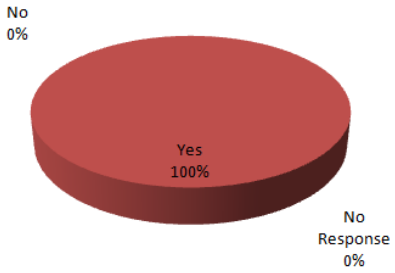
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



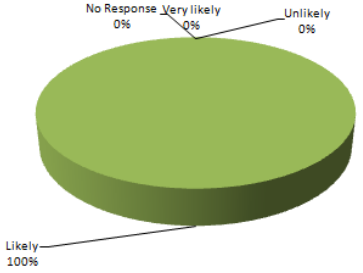
Question 3: Characterize the technical accomplishments and progress toward goals.



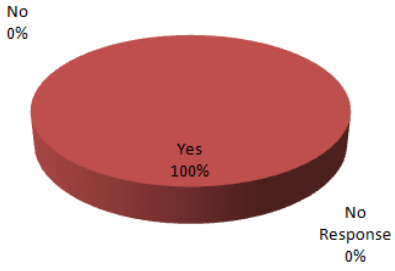
Question 2a: Are the goals of the project technically achievable?



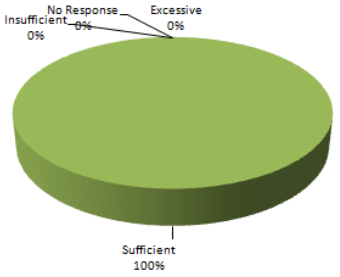
Question 4: How likely is the project team to move technologies into the marketplace?



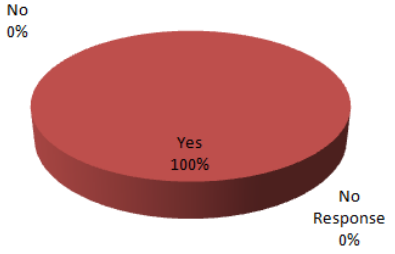
Question 2b: Have the technical barriers been identified and addressed?



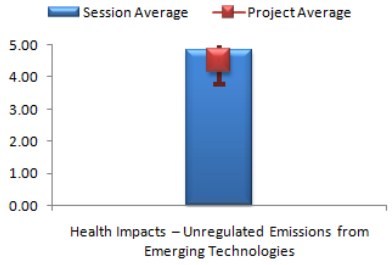
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Health Impacts Research (Doug Lawson of National Renewable Energy Laboratory)

Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

One reviewer commented that this project provides a direct comparison of diesel and gasoline vehicle emissions in the real world. The other person stated that diesel engines present the potential for improved mileage and thus a possibility for reduced petroleum consumption. He adds that health concerns are a critical factor in the use of diesel engines: EPA has set new restrictions on NOx and exhaust particulate matter emissions, at the same time, scientific research has identified possible exacerbated health hazards associated with ultrafine or nanoparticulate exposures. Diesel exhaust particulate is ultrafine in size. It sometimes contains particulate or semi-volatile genotoxicants or other toxic materials, including some traces of metals. While new technologies are being tested by DOE and manufacturers that can control NOx and PM emissions by weight, it is not fully known how the new engines or new control technologies will affect other characteristics of the engine particulate emissions, e.g., increasing numbers of emitted particles, or producing different size distributions or compositions or surface properties of final PM emissions. Such new properties of PM associated with new engine or and control technologies, and new modes of operation, e.g., regeneration, should be evaluated as thoroughly and as early as possible given the possible subsequent rapid and massive public deployment of the technologies. Once again, this is a statement appropriate in general to all the DOE-VT Health Impacts research projects, including this NREL study.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One person stated that this project specifically lists the potential technical barriers and discusses approaches to overcoming those barriers. The other respondent added that this project is one of a set of health impacts studies that are being performed by DOE-VT to better define and address the possibility of new health concerns that might be associated with new engines and control technologies. It is prudent for DOE to undertake these studies to evaluate and guide engine and control technology R&D from the earliest stage. This is a statement appropriate in general to all the DOE-VT Health Impacts research projects, including this NREL study.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer felt that there was excellent progress in all areas. He was especially impressed that this program gets their results into the peer-reviewed literature in a timely manner. The other person stated that studies of the crankcase oil-source of emissions are potentially quite important. He adds that a deuterium tracer is used to apportion total carbon to fuel or oil sources. A priori, it seems likely that the combusted oil will contribute more to the heavier organics and PM in the exhaust, although that distribution and its relative strength compared to the contribution from fuel combustion may be affected by engine tune and operating conditions. However, some level of speciation of the deuterated compounds might indicate an even greater contribution to biologic effects than indicated by mass distribution. Continuing, he states that the weekend ozone effect studies appear profound for understanding mechanisms of environmental air quality. However, they may be a step distant from information useful to direct engine control technology development, in contrast to the lubricant oil component of the study.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent stated that the techniques being developed have a very high likelihood of being transferred because they are actively presented at scientific meetings and published in the peer-reviewed literature. The other reviewer added that these collaborations with other institutes and organizations are noteworthy. He adds that the intention for ongoing peer-review publication of results is important. The peer-reviewed publications production on crankcase oil sources of emissions is impressive (though he suggests providing the citations next year).

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

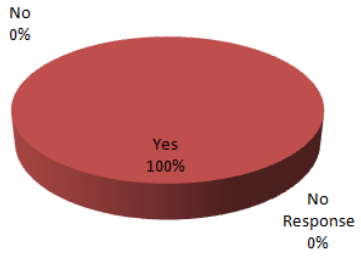
The lone reviewer responding to this question stated that, although this program has made excellent progress with the limited funding they have received, they would make even more progress with additional funding.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

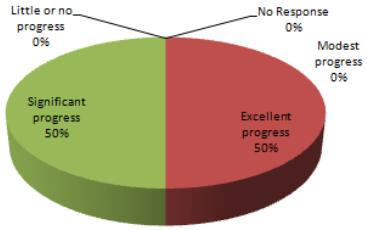
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Health Impacts Research

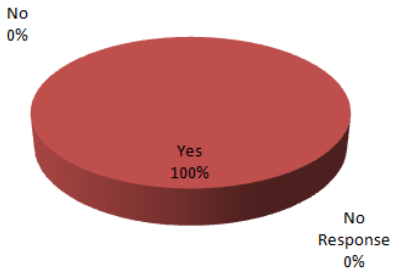
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



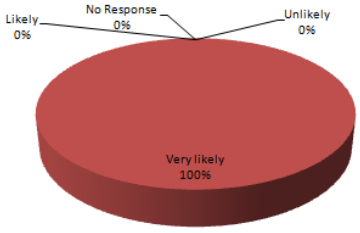
Question 3: Characterize the technical accomplishments and progress toward goals.



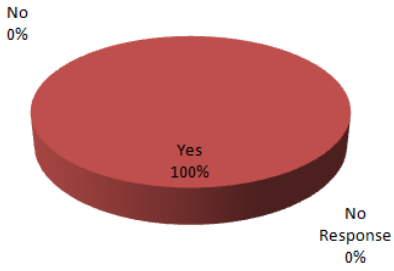
Question 2a: Are the goals of the project technically achievable?



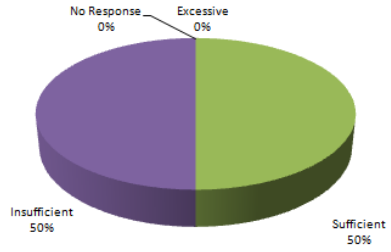
Question 4: How likely is the project team to move technologies into the marketplace?



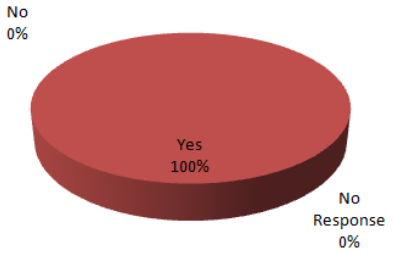
Question 2b: Have the technical barriers been identified and addressed?



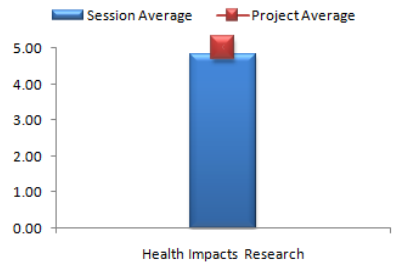
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



14. Vehicle Systems and Simulation

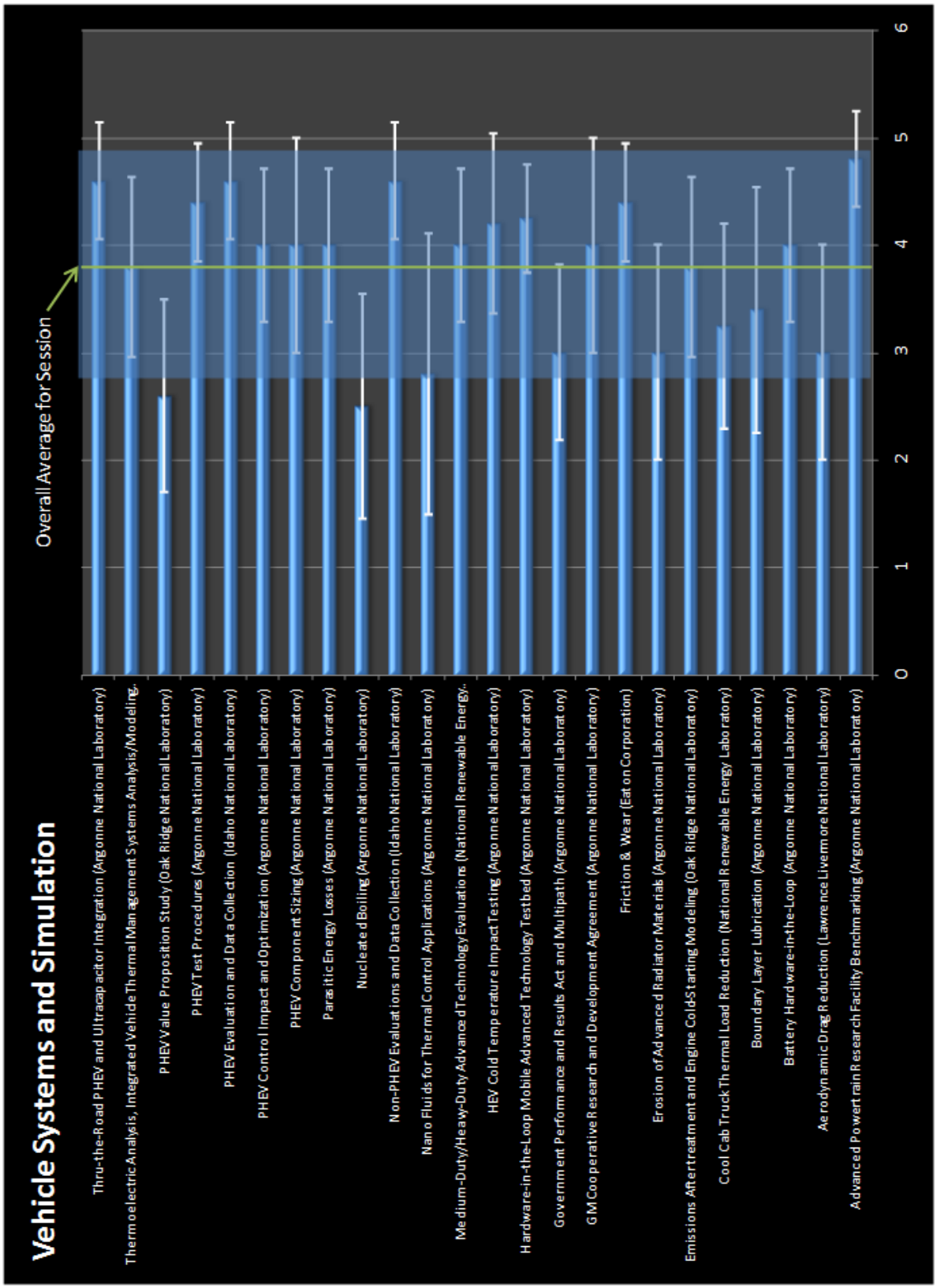
Introduction

Vehicle systems and simulation research provides an overarching vehicle systems perspective to the technology research and development activities of DOE's vehicle research programs, and identifies major opportunities for improving vehicle efficiencies. The effort evaluates and validates the integration of technologies, provides component and vehicle benchmarking, develops and validates heavy hybrid propulsion technologies, and develops technologies to reduce the parasitic losses from heavy vehicle systems. Analytic and empirical tools are used to model and simulate potential vehicle systems, validate component performance in a systems context, benchmark emerging technology, and validate computer models. Extensive collaboration with the technology development activities is required for success. The results of hybrid and vehicle systems activities are used to estimate the national benefits and impacts of DOE-sponsored technology development, and successfully transfer developed technology to industry.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
14-4	Advanced Powertrain Research Facility Benchmarking (Barney Carlson, Argonne National Laboratory)	4.80	0.45
14-7	Aerodynamic Drag Reduction (Kambiz Salari, Lawrence Livermore National Laboratory)	3.00	1.00
14-9	Battery Hardware-in-the-Loop (Neeraj Shidore, Argonne National Laboratory)	4.00	0.71
14-12	Boundary Layer Lubrication (Oyelayo Ajayi, Argonne National Laboratory)	3.40	1.14
14-15	Cool Cab Truck Thermal Load Reduction (Ken Proc, National Renewable Energy Laboratory)	3.25	0.96
14-17	Emissions Aftertreatment and Engine Cold-Starting Modeling (Stuart Daw, Oak Ridge National Laboratory)	3.80	0.84
14-20	Erosion of Advanced Radiator Materials (Dileep Singh, Argonne National Laboratory)	3.00	1.00
14-23	Friction & Wear (Mike Killian, Eaton Corporation)	4.40	0.55
14-25	GM Cooperative Research and Development Agreement (Aymeric Rousseau, Argonne National Laboratory)	4.00	1.00
14-27	Government Performance and Results Act and Multipath (Sylvain Pagerit, Argonne National Laboratory)	3.00	0.82
14-29	Hardware-in-the-Loop Mobile Advanced Technology Testbed (Henning Lohse-Busch, Argonne National Laboratory)	4.25	0.50

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
14-32	HEV Cold Temperature Impact Testing (Barney Carlson, Argonne National Laboratory)	4.20	0.84
14-35	Medium-Duty/Heavy-Duty Advanced Technology Evaluations (Kevin Walcowicz, National Renewable Energy Laboratory)	4.00	0.71
14-38	Nano Fluids for Thermal Control Applications (Wen Yu, Argonne National Laboratory)	2.80	1.30
14-41	Non-PHEV Evaluations and Data Collection (Jim Francfort, Idaho National Laboratory)	4.60	0.55
14-44	Nucleated Boiling (Wen Yu, Argonne National Laboratory)	2.50	1.05
14-47	Parasitic Energy Losses (George Fenske, Argonne National Laboratory)	4.00	0.71
14-50	PHEV Component Sizing (Phil Sharer, Argonne National Laboratory)	4.00	1.00
14-52	PHEV Control Impact and Optimization (Dominik Karbowski, Argonne National Laboratory)	4.00	0.71
14-54	PHEV Evaluation and Data Collection (Jim Francfort, Idaho National Laboratory)	4.60	0.55
14-56	PHEV Test Procedures (Michael Duoba, Argonne National Laboratory)	4.40	0.55
14-59	PHEV Value Proposition Study (Richard Smith, Oak Ridge National Laboratory)	2.60	0.89
14-62	Thermoelectric Analysis, Integrated Vehicle Thermal Management Systems Analysis/Modeling (Tony Markel, National Renewable Energy Laboratory)	3.80	0.84
14-65	Thru-the-Road PHEV and Ultracapacitor Integration (Ted Bohn, Argonne National Laboratory)	4.60	0.55
	Overall Session Average and Standard Deviation	**3.80**	**1.01**


Vehicle Systems and Simulation
Overall Average for Session
0
1
2
3
4
5
6
Thru-the-Road PHEV and Ultracapacitor Integration (Argonne National Laboratory)
Thermoelectric Analysis, Integrated Vehicle Thermal Management Systems Analysis/Modeling..
PHEV Value Proposition Study (Oak Ridge National Laboratory)
PHEV Test Procedures (Argonne National Laboratory)
PHEV Evaluation and Data Collection (Idaho National Laboratory)
PHEV Control Impact and Optimization (Argonne National Laboratory)
PHEV Component Sizing (Argonne National Laboratory)
Parasitic Energy Losses (Argonne National Laboratory)
Nucleated Boiling (Argonne National Laboratory)
Non-PHEV Evaluations and Data Collection (Idaho National Laboratory)
Nano Fluids for Thermal Control Applications (Argonne National Laboratory)
Medium-Duty/Heavy-Duty Advanced Technology Evaluations (National Renewable Energy..
HEV Cold Temperature Impact Testing (Argonne National Laboratory)
Hardware-in-the-Loop Mobile Advanced Technology Testbed (Argonne National Laboratory)
Government Performance and Results Act and Multipath (Argonne National Laboratory)
GM Cooperative Research and Development Agreement (Argonne National Laboratory)
Friction & Wear (Eaton Corporation)
Erosion of Advanced Radiator Materials (Argonne National Laboratory)
Emissions Aftertreatment and Engine Cold-Starting Modeling (Oak Ridge National Laboratory)
Cool Cab Truck Thermal Load Reduction (National Renewable Energy Laboratory)
Boundary Layer Lubrication (Argonne National Laboratory)
Battery Hardware-in-the-Loop (Argonne National Laboratory)
Aerodynamic Drag Reduction (Lawrence Livermore National Laboratory)
Advanced Powertrain Research Facility Benchmarking (Argonne National Laboratory)

Advanced Powertrain Research Facility Benchmarking (Barney Carlson, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that there is an applied, near-term impact, while another stated that the testing of vehicles and components supports the modeling of future technologies. The results are used by private and public organizations to determine future testing and products. One other individual stated that generating benchmarking data is critical in understanding potential improvements in reducing fuel use. The other remarked that DOE objectives weren't discussed in presentation but the linkage is clear. Benchmarking won't save petroleum by itself but by making standardized, validated data available to others, it can be leveraged to save petroleum. This reviewer adds that this program appears to be a key piece of the overall program.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the facilities are running and producing correlated data, while another commented that the data and test procedures are used by many organizations. One reviewer stated that the group continues to overcome data collection challenges in a timely manner, which will allow the data to support product development.

One final reviewer noted that this is a measurement and benchmarking project. Thus, it serves to identify technical barriers, but in itself doesn't take steps to overcome those barriers. That appears to be left to other coordinated projects. The measurement and simulation techniques have improved substantially over the years, and there is a strong collaboration with industry. This is an impressive demonstration of Argonne's ability to help OEMs move in the right direction to optimize their systems. Is DOE working with the eventual market winners? Will Hymotion and Hybrids Plus be able to make an important impact on the market? Is the technical team structure sufficient to ensure that Argonne will be able to transfer their body of knowledge to other OEMs (Toyota, GM, ...)? Should more effort be made to ensure ANL's knowledge is broadly communicated?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that very good quality results were demonstrated, while another added that ANL has provided extensive data on numerous vehicles, which has contributed to technology advancements. One individual stated that this public analysis of operations of plug-in hybrids will clearly influence the future direction of development and deployment of these systems. This project appears to have collected lots of data in a short time and to be an efficient use of funds. Is torque slip of the tires an important source of losses, particularly during aggressive driving and at winter conditions?

One final reviewer stated that there need to be easy ways for OEMs to obtain the test data, adding that this hasn't been effectively demonstrated yet.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent commented that information from ANL benchmarking is already being used within the OEMs to address strategies and technical challenges. Similar to this first comment, one person wrote that data provided from testing has been utilized by the industry to improve product performance. Another remarked that standards developed will be adopted by industry, and there is good interaction with OEMs.

One reviewer stated that the work with OEMs appears likely to move this directly into the market, adding that it is less clear that consumers will pull the technology into market. Perhaps later stages of the technology should demonstrate overall benefits to end users, including cost and environmental impacts.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One person indicated that, as batteries take a larger role in reducing fuel consumption, the effects of ambient temperatures become a more significant impact. Upgrades in the facility will be needed to understand the effects of ambient temperature. Another reviewed agreed about the need for lab upgrades and additional capacity. They perhaps need more on-track data to calibrate the lab dynamometer. It is interesting to get a wider range of conditions and vehicles. This reviewer would fund this area more aggressively because a poor understanding of usage could be a major killer of this technology if market barriers aren't understood and overcome quickly.

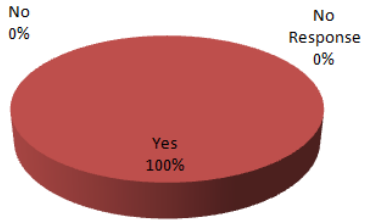
One reviewer stated that ANL seems to have vehicle availability, and the timing is appropriate for the level of staffing.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

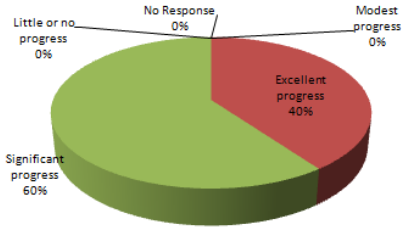
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Powertrain Research Facility Benchmarking

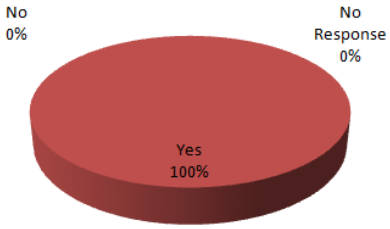
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



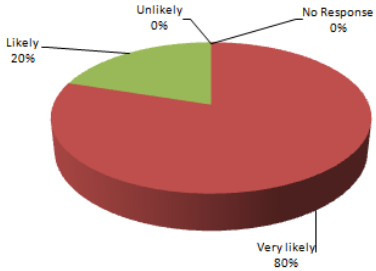
Question 3: Characterize the technical accomplishments and progress toward goals.



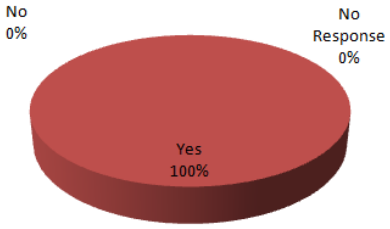
Question 2a: Are the goals of the project technically achievable?



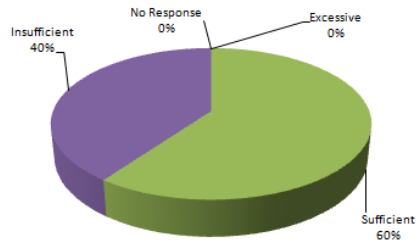
Question 4: How likely is the project team to move technologies into the marketplace?



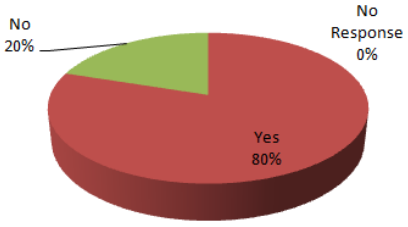
Question 2b: Have the technical barriers been identified and addressed?



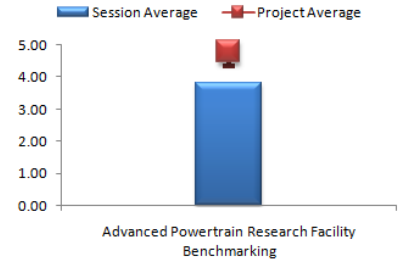
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Aerodynamic Drag Reduction (Kambiz Salari, of Lawrence Livermore National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The lone respondent stated that this project provides guidance and testing for aerodynamic analysis to reduce fuel consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
There were no responses to this prompt.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
There were no responses to this prompt.

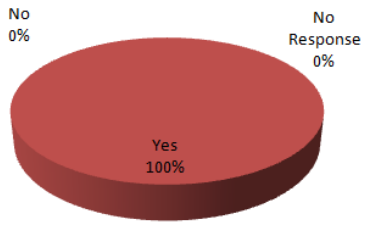
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
There were no responses to this prompt.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

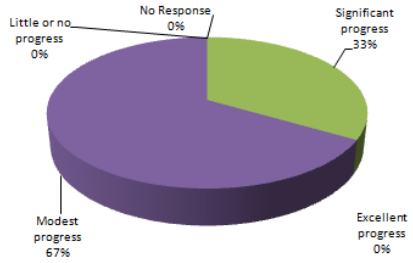
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Aerodynamic Drag Reduction

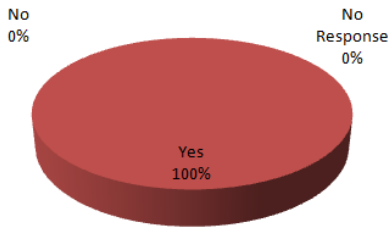
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



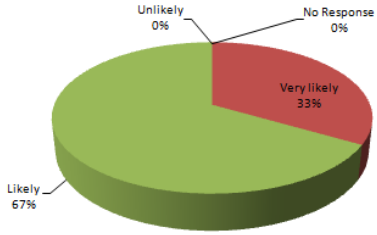
Question 3: Characterize the technical accomplishments and progress toward goals.



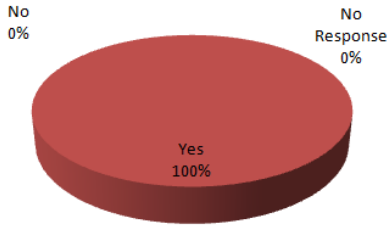
Question 2a: Are the goals of the project technically achievable?



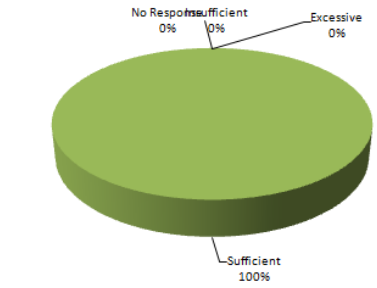
Question 4: How likely is the project team to move technologies into the marketplace?



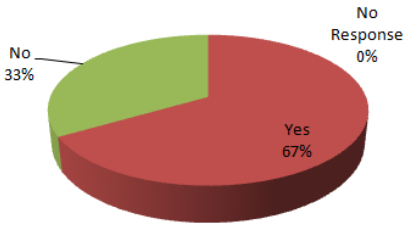
Question 2b: Have the technical barriers been identified and addressed?



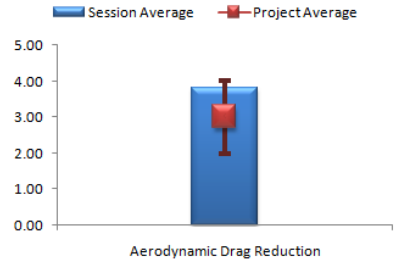
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Battery Hardware-in-the-Loop (Neeraj Shidore, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that this project supports the development of energy storage systems, and another person added that battery technology is very important for HEVs and PHEVs and for petroleum displacement. One other reviewer said that DOE components generated from other technology team funding are to be benchmarked and tested through a HIL process at the labs, and this is one of those tools. One final respondent said that this aspect was not discussed in the presentation. However, the optimization of battery use cycles will allow the optimization of petroleum reduction in hybrid and electric vehicles.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response noted that battery technology is the central barrier for PHEVs. Another reviewer commented that ANL has shown that the system is functioning, and is awaiting DOE projects to test components from the FreedomCAR portfolio. One final reviewer indicated that this project is still at an early stage. The test facility built appears to be an improved route to optimizing batteries and vehicles. It isn't clear yet that this is a better route than existing test methods, but this method appears to have good potential. Will there be an issue of calibration with actual vehicles?

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that there is good progress with HIL and integration with other projects. Another added that this is a rapid, thorough development of a new test tool. This reviewer added that the progress in the early stage of the project appears strong. It isn't yet clear that this route will enable more rapid development of new solutions, but the approach appears to have good potential. This project should be funded for the next few years, while being evaluated for its ability to produce breakthroughs compared to other approaches. This reviewer added that the weaknesses / limitations of this approach weren't made clear in the presentation.

One other reviewer stated that he or she has not seen a timing plan as to when components will be available for testing. This reviewer would specifically like to see more detail on "Battery Efficiency and Vehicle Fuel Economy" information from the chart on slide 5. This reviewer agrees that the FE vs. SOC appears to be negligible. There should be controls in place to try and target small, but focused, gains in mpg. This reviewer would also like to see how some of the factors on slides 5 and 6 translate into gallons saved on urban, highway, and US06 conditions for 12,000 miles per year of driving.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first response suggested that the result could potentially be utilized by industry for development. Another reviewer commented that the data will be used to change designs or to show that technology is ready to be incorporated into an OEM product. One final person stated the optimization of battery charge rates, temperatures, and use cycles seems like it will spur battery and control system development. Whether or not the tool is useful to achieve this hasn't yet been demonstrated, but it has

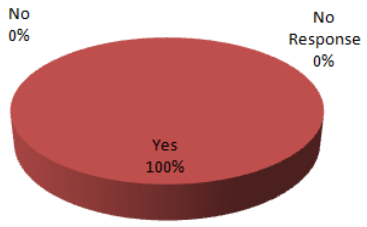
a good likelihood to occur as this early stage project advances. This reviewer asks, is the system sufficiently robust to cover the full range of battery technologies?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer asked, are there resources available to test a sufficient range of batteries? This reviewer thinks the project's success will depend heavily on the success of other, more real world data gathering projects. This project may be a little ahead of its need relative to other projects, although it will clearly be needed in the future. One other reviewer commented that the system is up and running, and the tweaking of systems appears to be occurring at the proper pace.

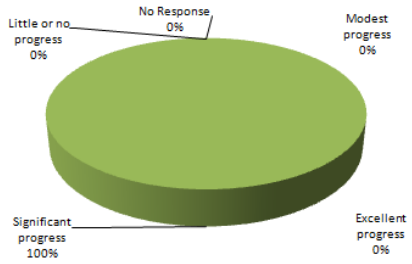
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Battery Hardware-in-the-Loop

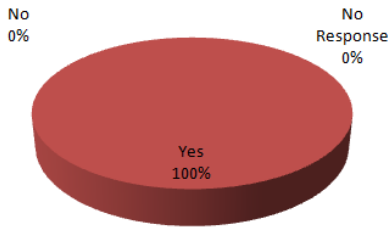
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



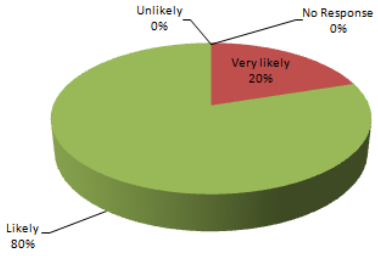
Question 3: Characterize the technical accomplishments and progress toward goals.



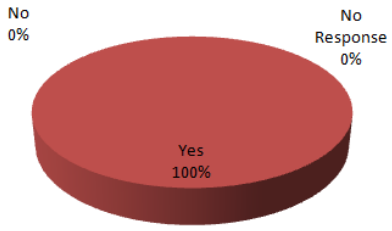
Question 2a: Are the goals of the project technically achievable?



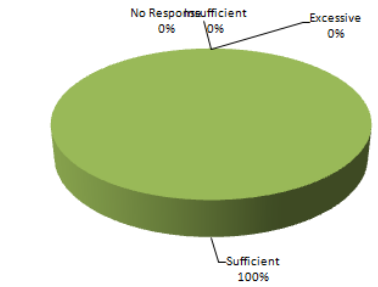
Question 4: How likely is the project team to move technologies into the marketplace?



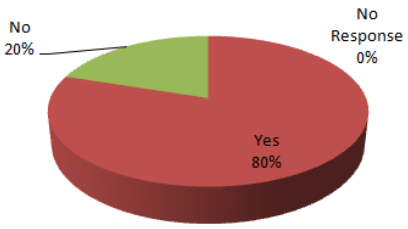
Question 2b: Have the technical barriers been identified and addressed?



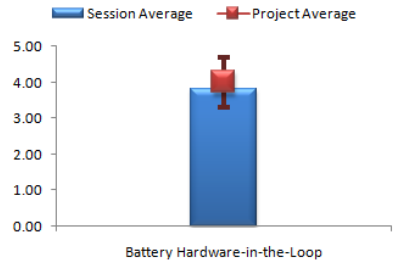
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Boundary Layer Lubrication (Oyelayo Ajayi, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented on the possible gains of 5% efficiency, while another person noted that weight savings are related to fuel savings. One individual responded that reducing engine losses has a one-to-one impact to reducing/displacing petroleum.

One other reviewer stated that a very high potential for petroleum reduction was claimed, but asked whether it was realistic to achieve this.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that there is the possibility of higher power density, which can reduce component size and weight. Another commented that the testing looks extensive and purposeful. Small changes in efficiency can translate into large fuel savings in this class of vehicles. One person stated that the fundamental approach to defining mechanisms and developing predictive models appears sound. This reviewer added that it is less clear if hard ceramic coatings will be deployed in the market. Is the scuffing test still a valid predictor for these hard coatings?

One final reviewer indicated that it is difficult to answer as yes or no. This is somewhat of a high-risk research area that has been ongoing for some time. That the goals will be achieved remains to be seen. The stated goal of 10-15 % fuel consumption reduction is unlikely.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that the group has derived a model to represent scuffing. Proof of concept achieved. Another person stated that the data looks extensive, and savings can be realized. It will be interesting to see how the savings will change if translated to 12,000-15,000 miles/year driving passenger cars or light-duty trucks. One other respondent noted there is a good blend of theoretical approaches and lab measurements, and good testing using tools not readily available outside of DOE (APS, for example). Measuring surface chemistry and chemistry in real time during tribology experiment is an important advance.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first respondent stated that, from the presentation, it looks as if an industry partner is participating. Another person commented that this basic work will likely lead to broader benefits, adding that direct commercial partners are less clear at this point. One final reviewer stated that this is longer-term research that is not yet ready for the marketplace.

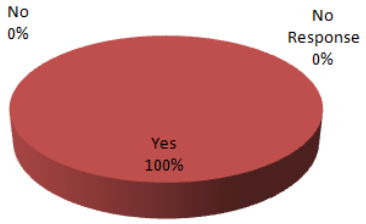
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

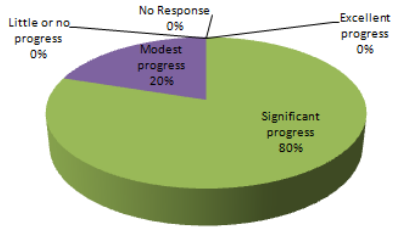
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Boundary Layer Lubrication

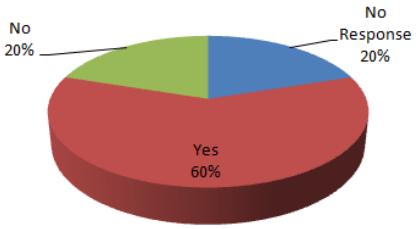
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



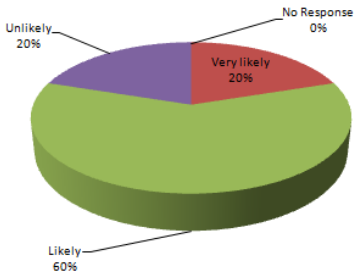
Question 3: Characterize the technical accomplishments and progress toward goals.



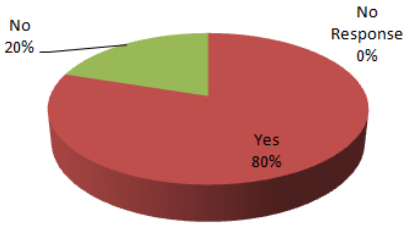
Question 2a: Are the goals of the project technically achievable?



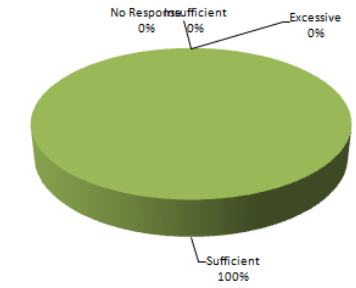
Question 4: How likely is the project team to move technologies into the marketplace?



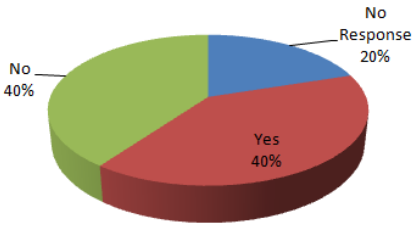
Question 2b: Have the technical barriers been identified and addressed?



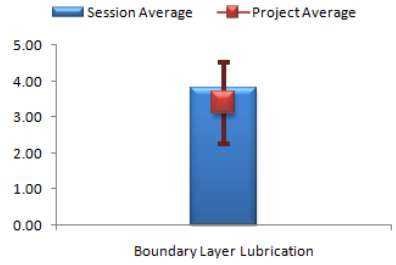
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Cool Cab Truck Thermal Load Reduction (Ken Proc, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the project has modest but important potential. The other person to respond stated that the goal is directly to reduce fuel use by highway trucks. However, the importance of overall fuel savings wasn't made clear. This reviewer asks if this is a refinement of technologies that should be left to OEMs.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer indicated that the close cooperation with OEMs should lead to direct deployment, while another stated cost will be an issue for adoption of these technologies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first response asked, what are the key invention and improvements made available from DOE's involvement? This appears to be a necessary piece of the overall program to eliminate idling, and thus should be done, but it appears to be of a lower value when considered as a standalone project. The other respondent added that the impact of this work has not been demonstrated.

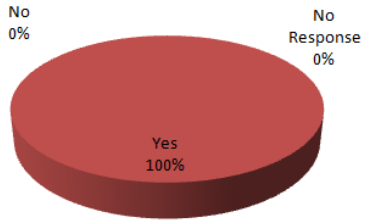
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent stated that there is strong OEM involvement, adding that later fleet demonstrations may be useful.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

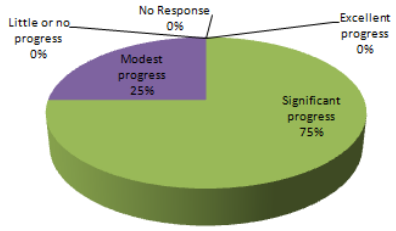
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Cool Cab Truck Thermal Load Reduction

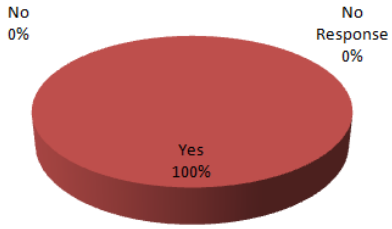
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



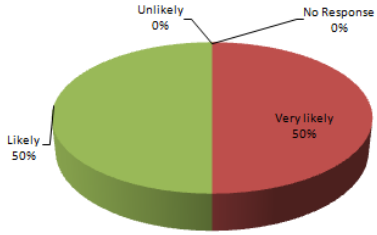
Question 3: Characterize the technical accomplishments and progress toward goals.



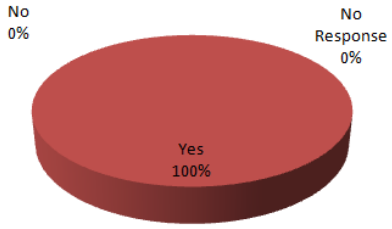
Question 2a: Are the goals of the project technically achievable?



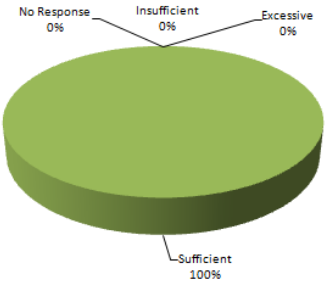
Question 4: How likely is the project team to move technologies into the marketplace?



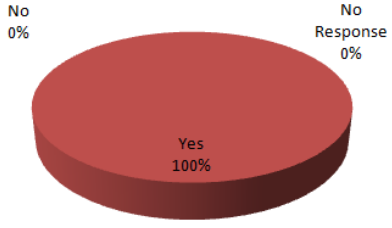
Question 2b: Have the technical barriers been identified and addressed?



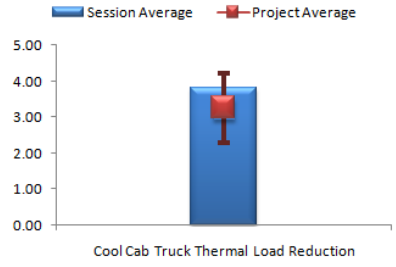
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Emissions Aftertreatment and Engine Cold-Starting Modeling (Stuart Daw, of Oak Ridge National Laboratory)

Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?

One reviewer stated that the emissions improvement controls and technologies enable fuel improvement technologies, allowing displacement of petroleum. Similarly, one person stated that this work addresses a significant issue in the technologies needed to reduce petroleum consumption. A reviewer noted that this program does not directly reduce petroleum consumption; however, it does model the potential emissions produced by advanced technology. This is necessary to ensure that the advanced technologies do not cause a dramatic increase or any increase in emissions. One final reviewer indicated that this aspect was not discussed in presentation. However, he or she assumes that emissions restrictions can limit achievable fuel reductions. Modeling emissions and fuel economy of engines thus would have a direct connection to petroleum displacement.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer stated that interactions with OEMs and engine manufacturers aren't clear. The deployment route wasn't made clear either, but the reviewer supposes that it will mainly occur through the publication of results. This project appears aimed more at identifying technical barriers so that others can overcome them. The other respondent noted that, comparing the model to testing, they seemed to correlate well, but it is unclear if the models will translate as use patterns are changed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

The first respondent said that the program has provided ethanol, diesel, and thermoelectric models for PSAT integration. Another reviewer commented that transient emissions modeling has been historically very difficult. A robust study should continue, since the single model-to-test comparison has shown good progress. One final response stated that this group appears to have generated lots of data with modest funding. This reviewer asks if the engine maps, which are generated from data obtained from existing vehicles, are sensitive to proprietary OEM control algorithms. Are the engine models sufficiently robust to accommodate control strategy variations? Is this making public data that OEMs already have, or is this generating data that OEMs wish to have?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person remarked that the results could be of value to government and industry to understand the influence of advanced technologies on emissions. Another person stated that this will move better measurement technologies and data into the public realm, but it is unlikely, in and of itself, to bring commercial technologies to the marketplace. One final reviewer indicated that there is a desire for lean burn, gasoline direct injection, diesel, etc. technologies to reduce fuel use, and improving emissions technologies will enable wider use of these innovations. If possible, this reviewer would like to see a tradeoff of what emissions constituents are worth relative to each other – i.e., what is the customer value of CO_2 vs. NOx in grams per mile?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

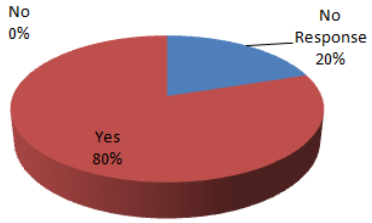
One reviewer stated that the program appears to generate lots of results with modest funding. Another added that ORNL and ANL are working well together. One reviewer commented that this program has provided emission models and maps for PSAT, along with developing diesel and thermoelectric models in a timely manner.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

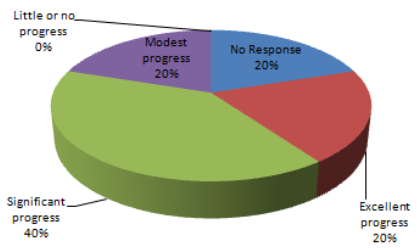
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Emissions Aftertreatment and Engine Cold-Starting Modeling

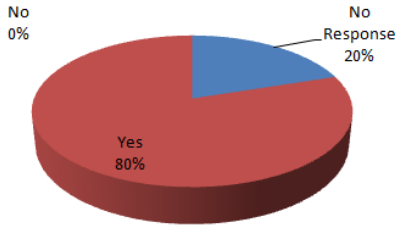
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



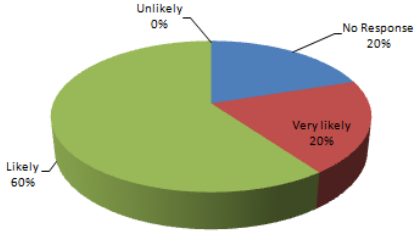
Question 3: Characterize the technical accomplishments and progress toward goals.



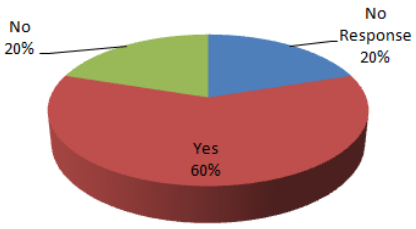
Question 2a: Are the goals of the project technically achievable?



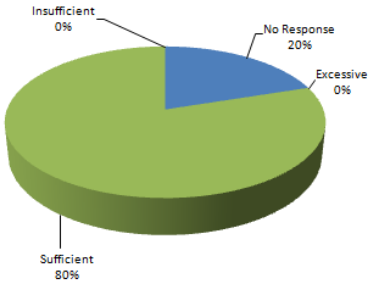
Question 4: How likely is the project team to move technologies into the marketplace?



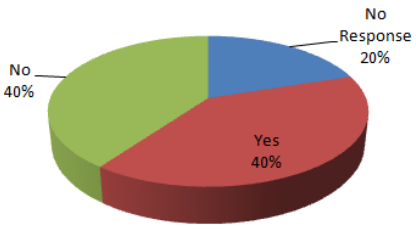
Question 2b: Have the technical barriers been identified and addressed?



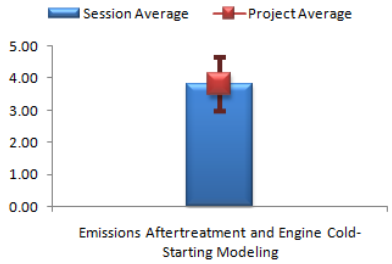
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Erosion of Advanced Radiator Materials (Dileep Singh, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that nanofluids are being investigated for improved cooling systems, and the objective of this project is to understand the impact of nanofluids on cooling system components. Another person stated that this is nice supporting work to the project Nano Fluids for Thermal Control Applications – 16822.

One response stated that there was an optimistic estimate of potential reduction, while another said that work on nanofluids has no relevance toward petroleum displacement.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that determining the effects of nanofluids on radiators is important to any commercialization of nanofluids and technically achievable. There are no significant barriers to achieving those goals. However, there are significant issues involving commercialization of nanofluids which are not being addressed by this effort.

Another reviewer noted that test data showing no additional wear, while one other person indicated that this is testing to evaluate the impact of nanofluids, but without any plan to solve the issue of erosion.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the researchers have identified component deteriorations caused by the nanofluids. Another response stated that the testing is looking to be on track and the simulation shows benefits.

One reviewer said that the preliminary data shows no erosion using the SiC nanofluids. However, this reviewer adds that they should have focused on more relevant materials (AlO, CuO) for their preliminary results. Particle sizes were not mentioned, and the feasibility of nanofluids was not established.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One person commented that reducing cooling system size requirements has many advantages, while another reviewer stated that the testing may help a company to commercialize their own products. One response noted that they established collaboration with commercial nanofluids companies, as well as with manufacturers of tires.

One person wrote that nanofluids have no commercial potential.

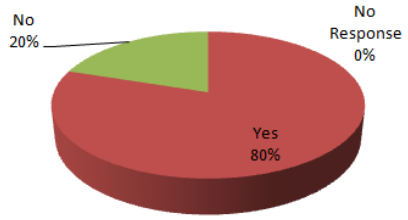
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One person suggested that companies that can benefit from this work should help fund it. The other respondent indicated that DOE should not be investing in nanofluids for enhanced heat transfer.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

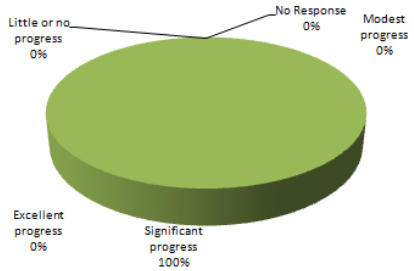
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Erosion of Advanced Radiator Materials

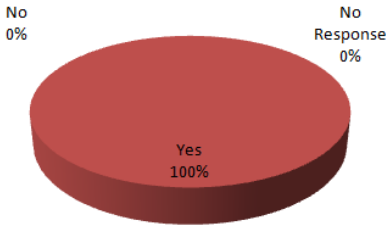
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



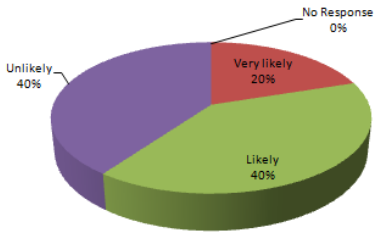
Question 3: Characterize the technical accomplishments and progress toward goals.



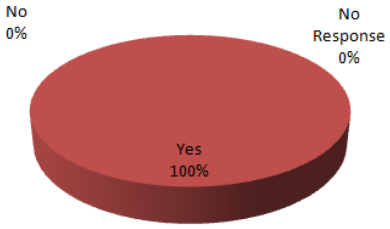
Question 2a: Are the goals of the project technically achievable?



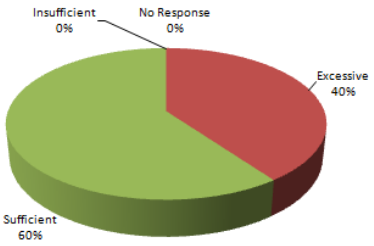
Question 4: How likely is the project team to move technologies into the marketplace?



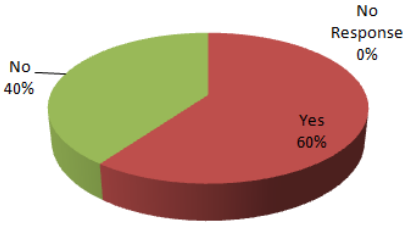
Question 2b: Have the technical barriers been identified and addressed?



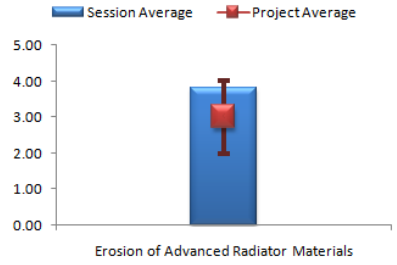
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Friction & Wear (Mike Killian, of Eaton Corporation)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer stated that the group has achieved a significant reduction in churning losses as well as a reduction in friction due to lube advancements. Another commented that reducing transmission losses has a 1-to-1 impact to reducing/displacing petroleum. One other reviewer noted the 2-4% fuel efficiency increase on heavy truck fuel. One final reviewer stated that there will be a small but important level of fuel consumption reduction that adds up over many vehicles over time.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person commented that the project seems logical and appears to have a rapid payback if fleets can be convinced. Another remarked that the testing looks extensive and purposeful. Small changes in efficiency can translate into large savings in this class of vehicles, and the $1,200-2,400 per year savings can drive rapid changes. One other reviewer indicated that the initial claim states that there is no impact on durability, but this must be proven.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that three of four research areas are meeting or exceeding targets, and the industrial partners have a clear path to commercialization. The other respondent noted that the data looks extensive, and savings can be realized. This reviewer added that it will be interesting to see how the savings will change if translated to the 12,000-15,000 miles/year driven in passenger cars or light-duty trucks.

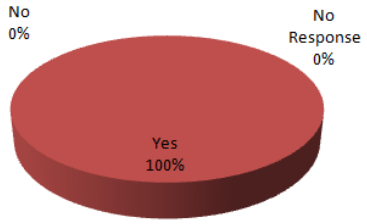
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that Eaton and Car are pulling, while another respondent stated that part of this project seems like commercial development rather than research. One other reviewer indicated that the $1,200 to $2,400 per year savings can drive rapid changes.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

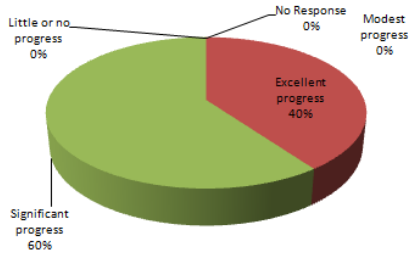
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Friction & Wear

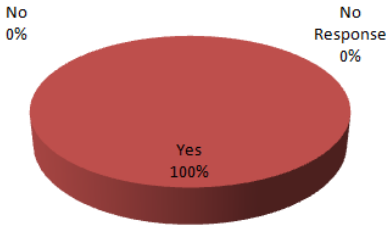
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



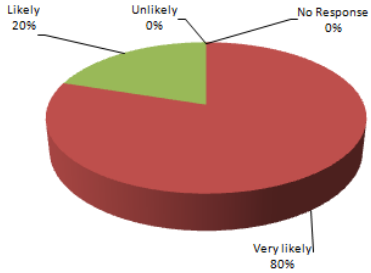
Question 3: Characterize the technical accomplishments and progress toward goals.



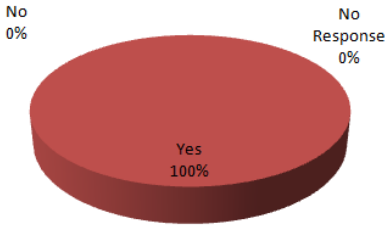
Question 2a: Are the goals of the project technically achievable?



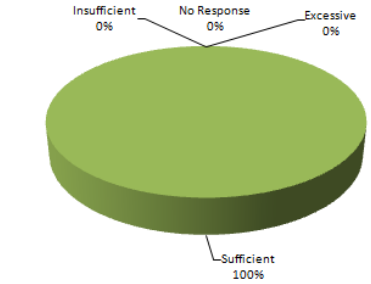
Question 4: How likely is the project team to move technologies into the marketplace?



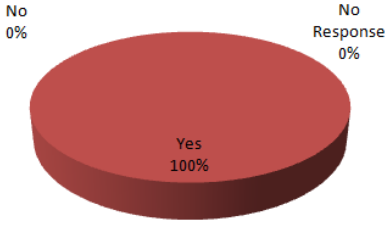
Question 2b: Have the technical barriers been identified and addressed?



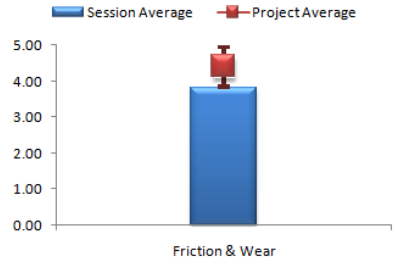
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GM Cooperative Research and Development Agreement (Aymeric Rousseau, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
There were no responses to this prompt.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent commented on the direct GM involvement, adding that deployment through GM is clear. This reviewer asked if there is a need to commercialize PSAT, or if Argonne can sustain the work for the long term.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Both respondents commented that the work is just starting. One added that the approach appears to be well thought out. Can Argonne sustain ownership of PSAT, or is it expected that PSAT may become a commercial code supported by a commercial entity?

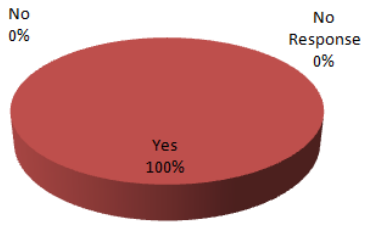
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent cited direct GM involvement.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent asked if more resources should be spent on integration with other industry standard software.

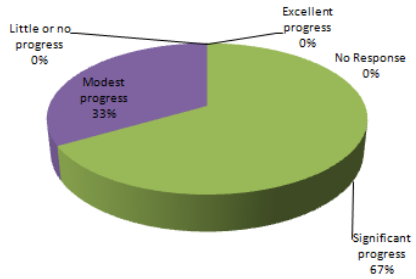
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GM Cooperative Research and Development Agreement

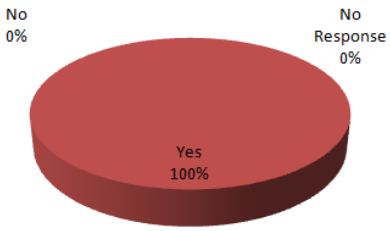
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



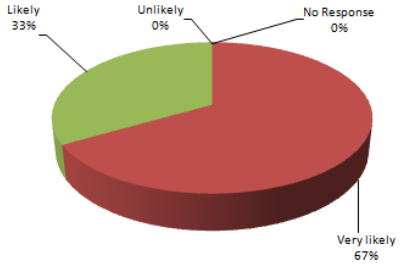
Question 3: Characterize the technical accomplishments and progress toward goals.



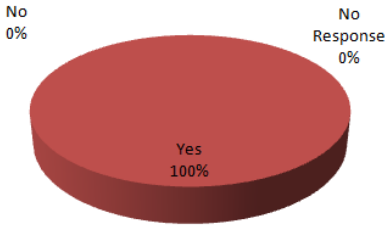
Question 2a: Are the goals of the project technically achievable?



Question 4: How likely is the project team to move technologies into the marketplace?



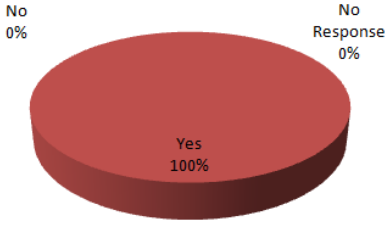
Question 2b: Have the technical barriers been identified and addressed?



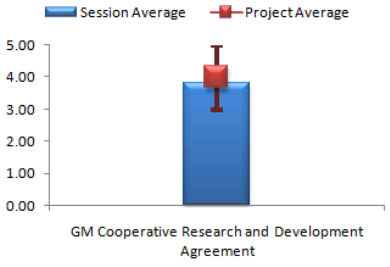
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Government Performance and Results Act and Multipath (Sylvain Pagerit, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this is a direct goal of the project, while another commented that they are satisfying DOE goals by estimating the impact of technologies. One other person indicated that this is a very high level look at technology potential.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The lone respondent stated that this is essentially a modeling study that can be easily performed. This reviewer doesn't see any technical barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent stated that the presentation only showed what could be accomplished. This also seems very similar to NREL's T3 project. This touches on more extra-agency models, but looking at the technology and how many barrels of petroleum it can displace is very similar to the T3 project. Considering that this tool is already trying to estimate the marketplace in 2050, is a second method to do this type of forecast really necessary?

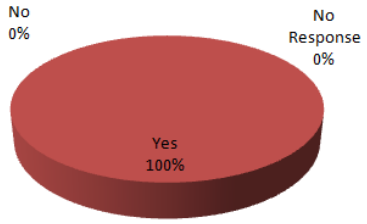
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent stated that this is more focused to overall potential. This information is more streamlined for DOE use than for OEM use.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that this seems to be a large effort cross-connecting with other models, but it seems to be properly staffed considering. Another individual suggested that the level of funding potentially seems high for this level of work.

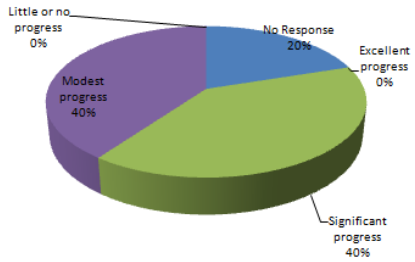
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Government Performance and Results Act and Multipath

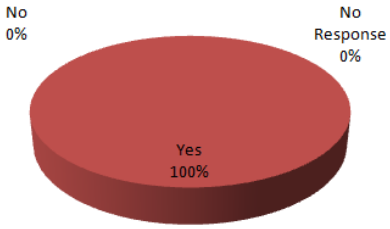
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



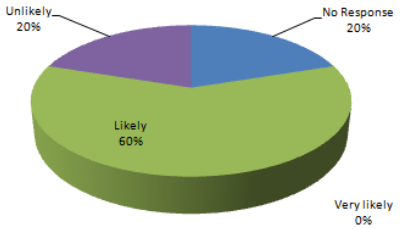
Question 3: Characterize the technical accomplishments and progress toward goals.



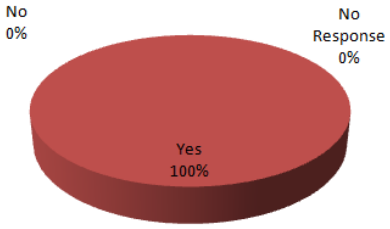
Question 2a: Are the goals of the project technically achievable?



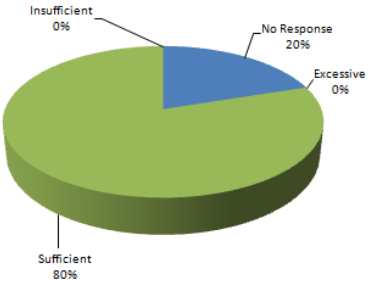
Question 4: How likely is the project team to move technologies into the marketplace?



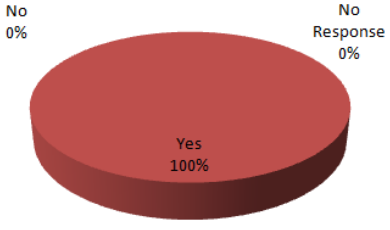
Question 2b: Have the technical barriers been identified and addressed?



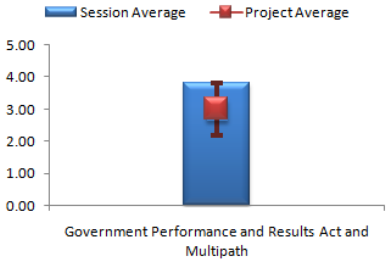
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Hardware-in-the-Loop Mobile Advanced Technology Testbed (Henning Lohse-Busch, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer indicated that this work validates and supports modeling efforts along with component testing. Another person stated that this aspect was not discussed in the presentation, but his reviewer assumes that this allows a measurement of components and linkage to modeling, and establishes the basis for other programs to obtain direct fuel savings. One respondent stated that DOE components generated from other technology team funding are to be benchmarked and tested through an HIL process at the labs, adding that this is one of those tools.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer commented that this project is obtaining basic research data and assumes that deployment will occur via publication of results. This wasn't clear from the presentation, and the technology deployment route wasn't discussed except for indirectly in linkages to other projects' slides. One other reviewer stated that ANL has shown that the system is functioning, but they are awaiting DOE projects to test components from the FreedomCAR portfolio.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that this program has shown some significant progress this year. They have overcome setup issues and have applied the system to support model validation and PHEV test procedures.

Another reviewer indicated that this is a strong program to develop a research tool that appears to be an essential part of future progress. That said, it isn't clear how this tool will result in innovations but it will certainly allow better testing and development of individual components in a more rapid and scientific manner than if all is done on actual vehicles. A final reviewer stated that they have not seen a timing plan regarding when components will be available for testing.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer commented that the results from this project will likely transfer into test procedures and/or product development for industry and government agencies, while one other reviewer added that the data will be used to change designs or show that technology is ready to be incorporated in an OEM product. One final reviewer noted that this is a basic research and tool development project. It will accelerate the progress of other projects but, in and of itself, it will do little to bring these technologies to market.

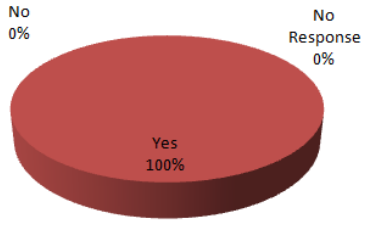
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One individual stated that the project appears to be making good progress with the existing level of funding. Another added that the system is up and running, and a tweaking of these systems appears to be occurring at the proper pace.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

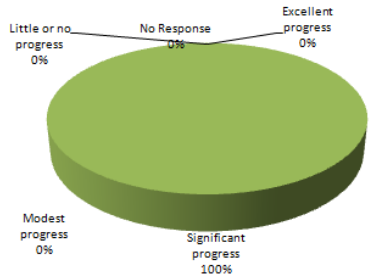
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Hardware-in-the-Loop Mobile Advanced Technology Testbed

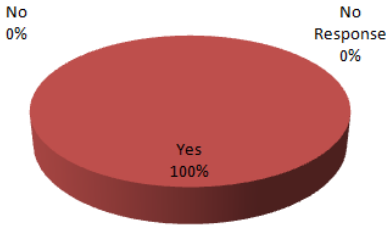
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



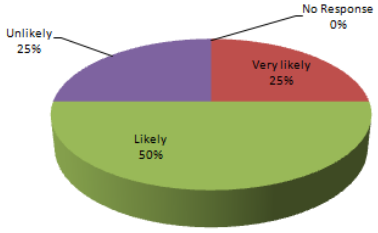
Question 3: Characterize the technical accomplishments and progress toward goals.



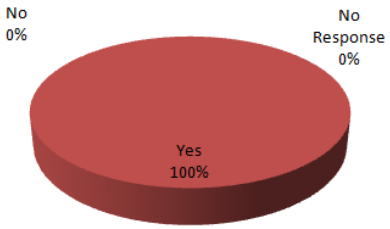
Question 2a: Are the goals of the project technically achievable?



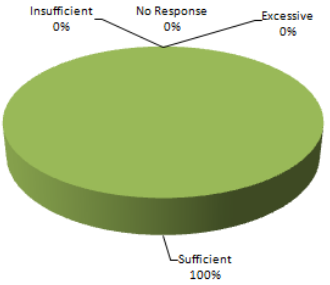
Question 4: How likely is the project team to move technologies into the marketplace?



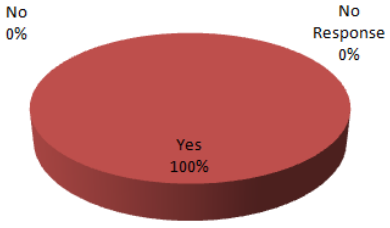
Question 2b: Have the technical barriers been identified and addressed?



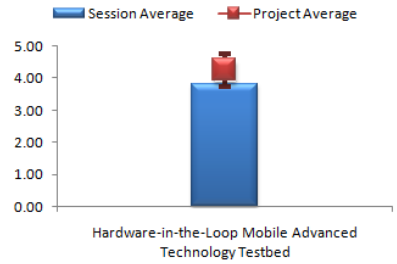
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



HEV Cold Temperature Impact Testing (Barney Carlson, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this study is crucial to understanding the effects of cold ambient temperatures on fuel consumption. Another person noted that this aspect was not discussed in presentation, but yes, this project does give direct displacement of petroleum.

One final reviewer noted that the study is quantifying what additional fuel might be saved by using advanced warm-up components or strategies.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response indicated that the project appears to be at the stage of collecting data and developing an early understanding of this data. Routes to deployment weren't made clear, but they don't appear necessary at this stage of the work. Likewise, the strategy appears to be an identification of technical barriers to set the stage for others to overcome them. Thus, this project alone should provide insight into testing techniques and technical barriers of cold weather use of hybrids, but it doesn't appear capable of developing routes to overcome the barriers in and of itself.

The other respondent stated there needs to be some comparison to conventional vehicles, and how much they lose at cold temperatures. Also, the adjustments for the label currently address what customers are seeing in-use for fuel economy across ambient temperatures. It probably needs to be pointed out that additional testing for labels is not needed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that this project is a very important issue for HEVs. Another individual commented that the group performed cold weather testing in ambient conditions, adding that the next step is to utilize a controlled climatic test cell to provide consistent results. One reviewer said that this is a good collection of data and a beginning of understanding this data. Solutions to overcome difficulties posed by low temperatures haven't yet been developed. Thus, this project has served to measure and make clear the technical barriers, but eventual solutions aren't yet clear.

One final reviewer stated that they need more comparison testing to conventional systems. This reviewer would also like to see the breakdown in added fuel due to lost regeneration, lost autostop, and the rest (which would presumably be driveline warm-up and what is lost to ambient temperatures, from higher temperature differences).

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer commented that the results from this test will be valuable to industry for the development of components and systems. Another noted that rapid warm-up is being addressed by several manufacturers. Knowing how much can be gained by building fuel economy robustness across ambient temperatures will help set priorities for the project.

One reviewer indicated that this is a measurement project, such that it is not yet at a stage of developing solutions. The technology to transfer appears to be the measurement methods and the understanding of technical barriers. Does a market and business case analysis need to be associated with this project? For example, is leaving the car plugged in overnight and keeping the battery heated feasible? Block heaters are now common in the northern US and Canada where many people plug their car in on winter nights – why not do this for EVs?

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that sufficient progress has been achieved and future testing has been scheduled. Depending upon the results, this program may demand more resources. Similarly, another reviewer recommends increasing funding and coupling the current project scope to market and business case analyses, adding that this area may discover a major barrier to implementation.

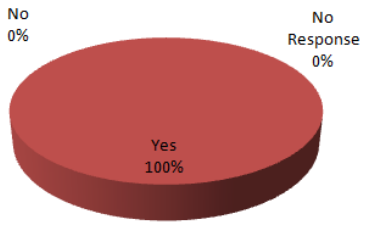
One final response notes that ANL seems to have vehicle availability, and the timing is appropriate for the level of staffing.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

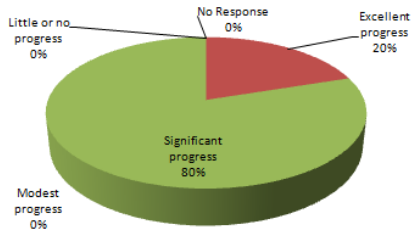
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: HEV Cold Temperature Impact Testing

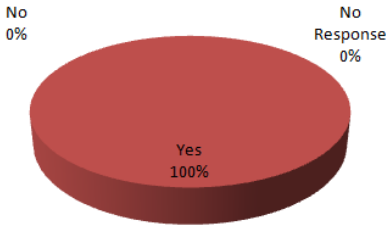
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



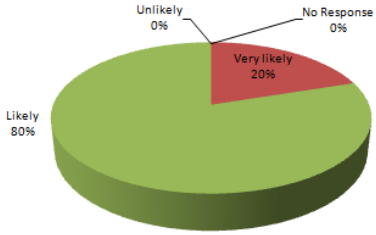
Question 3: Characterize the technical accomplishments and progress toward goals.



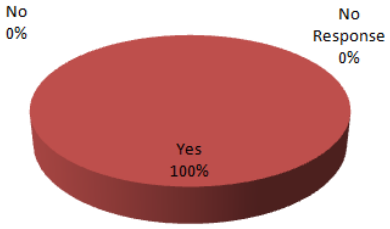
Question 2a: Are the goals of the project technically achievable?



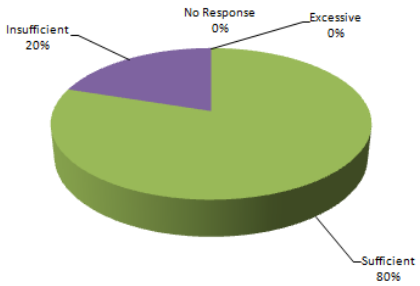
Question 4: How likely is the project team to move technologies into the marketplace?



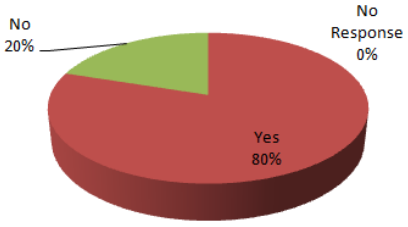
Question 2b: Have the technical barriers been identified and addressed?



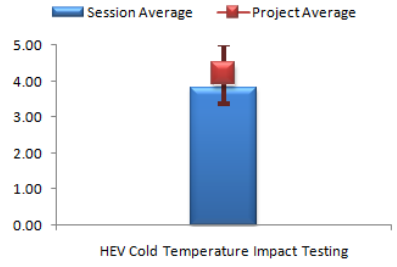
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Medium-Duty/Heavy-Duty Advanced Technology Evaluations (Kevin Walcowicz, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person noted that this is specifically a study of reducing fuel usage. The reviewer added that mid-range trucks use less fuel than passenger cars or heavy trucks, but they still represent a large category. The tasks have a good alignment to DOE's mission. Another reviewer stated that reducing fuel consumption via hybridization is a popular method of displacing petroleum. This is a nice supporting project on the heavy vehicle side to INL's Non-PHEV Evaluations and Data Collection 13342 and 13271.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the project provides useful data output, while another wrote that the project is studying largely deployed technologies to encourage further deployment on a large scale. This reviewer adds that there are strong links to fleets and manufacturers. The demonstration approach appears successful to encourage widespread usage. Users in this category are often weak about adopting fuel saving technologies. This reviewer asks whether this study should demonstrate the value of hybrids compared to other available technologies. Is an improved adoption strategy needed?

One final reviewer commented that this is a data collection project and does not have any difficult technical barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person commented on the large amount of data to sort through, adding that it provided a nice look at many factors in driving hybrid vehicles. The other respondent stated that the comparison of old and new technologies in existing vehicles clearly demonstrates strengths and weaknesses of these technologies. This reviewer asks, is there an adequate dissemination and publication of results for fleets to be fully aware of technology benefits? For example, will this group coordinate with the EPA SmartWay program to help extend SmartWay to this sector of trucks?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer pointed to the published data, while another person stated that learning from this data can drive changes to future product. One other response noted that the group is working with largely deployed technologies and with OEMs. Should there be more work with more fleets? Are UPS and Fed-Ex fleets enough to convince a large portion of the market to adopt these technologies?

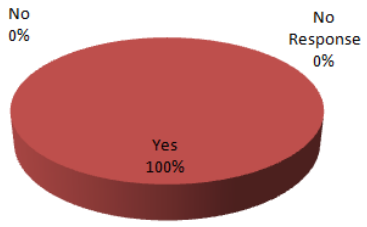
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer asked, are resources sufficient to encourage adoption by smaller fleets and individual owners? Are resources sufficient to bring OEMs on board? The other person to respond stated that the number of vehicles looks good and manpower is adequate.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

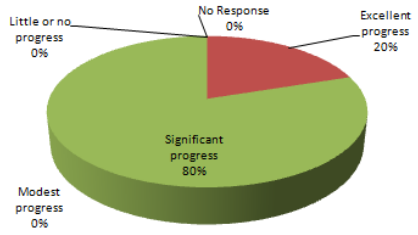
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Medium-Duty/Heavy-Duty Advanced Technology Evaluations

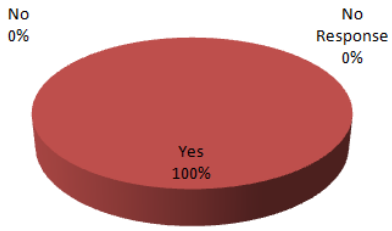
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



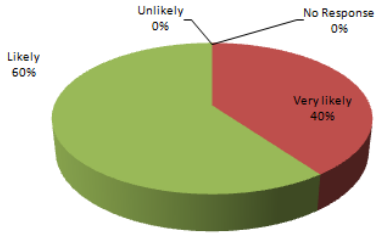
Question 3: Characterize the technical accomplishments and progress toward goals.



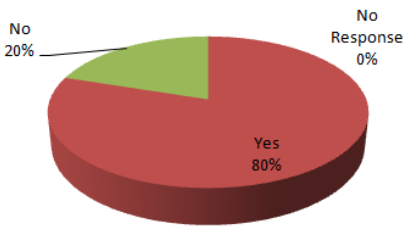
Question 2a: Are the goals of the project technically achievable?



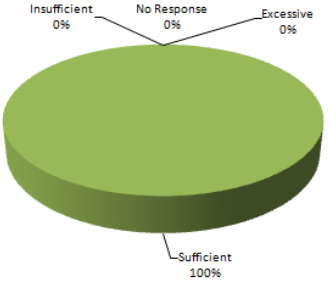
Question 4: How likely is the project team to move technologies into the marketplace?



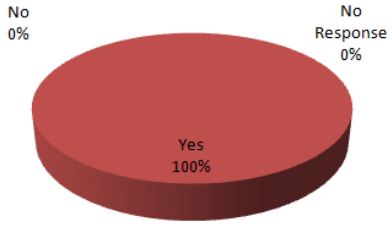
Question 2b: Have the technical barriers been identified and addressed?



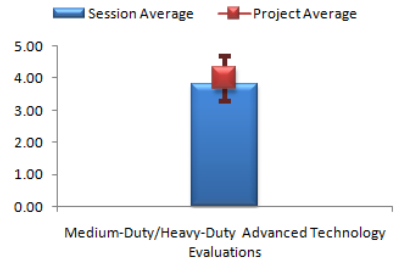
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Nano Fluids for Thermal Control Applications (Wen Yu, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that reducing engine losses has a 1-to-1 impact on reducing/displacing petroleum use. Another person commented that this would improve heat transfer, thereby reducing radiator size and aerodynamic drag, and also reducing coolant pump losses.

One other reviewer felt that the potential is relatively small, and was not quantified. This needs to be addressed in the future. One final reviewer commented that the work on nanofluids has no relevance toward petroleum displacement.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that this seems to be the proper class of vehicle to take this on. It looks applicable to HV motor and battery cooling as well, and might be an interesting next step. Some of the reductions in cooling needs could lead to a secondary advantage of reducing aerodynamic loads due to ram air cooling requirements. Another person stated that this work seems like it should be done in cooperation with a company that wants to develop and commercialize these fluids, with help in specialized measurements and facilities from ANL.

One reviewer indicated that the objective of increasing convective heat transfer using colloidal suspensions of nanofluids is not realistic, so the goals of the project are not achievable. Technical barriers associated with particle aggregation and depositions on surfaces have not been properly addressed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer said that testing is looking to be on track and the simulation shows benefits. Another individual commented that the flowmaster simulations have been described, but the results are not quantitative.

To contrast, one final reviewer stated that enhancements in thermal conductivity using nanofluids reported at ANL have been discounted by most other researchers who have founded agglomeration of particles using similar materials. No data on convective heat transfer or viscosity was presented. The reviewer added that the hot wire technique is known to produce anomalous results.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer noted that the group is presently working with commercial nanofluids and working with Michelin Tire for an application of nanofluids. Another person added that reducing the cooling system size requirements has many advantages.

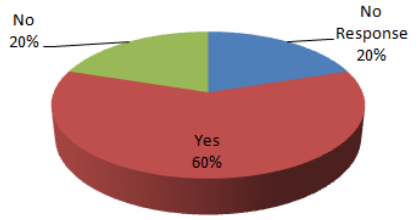
One reviewer stated that nanofluids have no commercial potential.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented that this type of work should be partially funded by a commercial company interested in making a product. The other respondent wrote that DOE should not be investing in nanofluids for enhanced heat transfer.

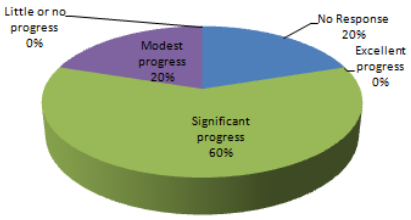
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Nano Fluids for Thermal Control Applications

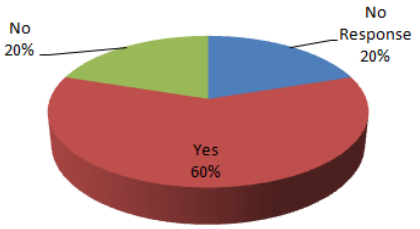
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



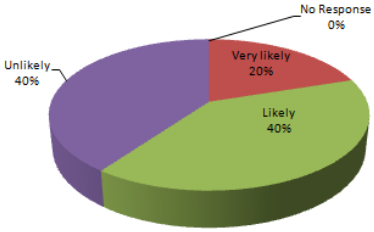
Question 3: Characterize the technical accomplishments and progress toward goals.



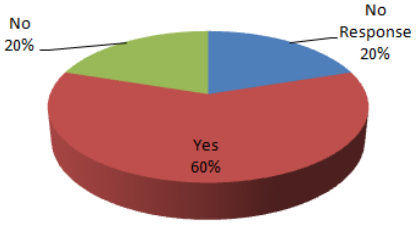
Question 2a: Are the goals of the project technically achievable?



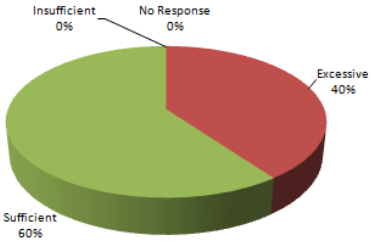
Question 4: How likely is the project team to move technologies into the marketplace?



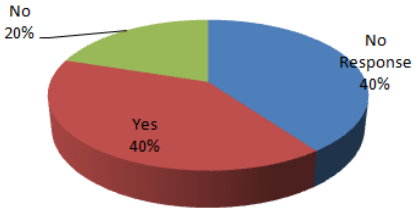
Question 2b: Have the technical barriers been identified and addressed?



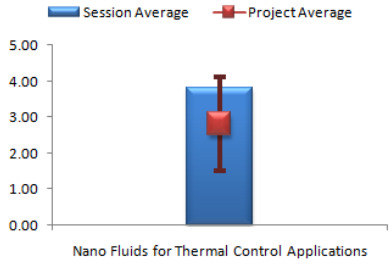
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Non-PHEV Evaluations and Data Collection (Jim Francfort, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this is a direct study of petroleum replacement by alternative energy vehicles. A second reviewer added that they are testing present vehicle technologies, which provides guidance for the further direction of component programs. Another person commented that reducing fuel consumption via hybridization is a popular method of displacing petroleum.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the group works with commercial and R&D companies to analyze the viability of commercialization. Another response stated that they are testing commercial or near-commercial vehicles. The group is studying deployed technologies, and this data should encourage further development and sales of these vehicles.

One reviewer commented that this is a data collection project and does not have any difficult technical barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that the program gives a clear demonstration of the value of deployed technologies. Another reviewer commented that there is a large amount of data to sort through, providing a nice look at many factors in driving hybrid vehicles. One other reviewer commented that this is not a RD&E program. However, the program does provide data to private and public organizations to determine the direction and viability of HEV technologies.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first respondent indicated that there is good interaction with industry and states, while another person added that the project works directly with OEMs and third party companies that have technologies available for sale. The data collected can be utilized to improve these technologies. One reviewer noted that this project is studying deployed technologies and encouraging their widespread adoption. One final response, similarly, suggested that the information from data can drive changes to future products.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One person commented that new technologies are tested within an acceptable time to provide feedback for technology improvements. Another stated that the number of vehicles looks good and manpower is adequate.

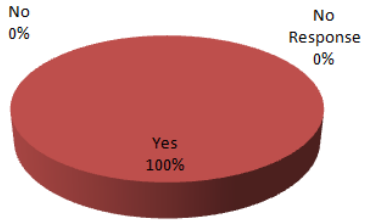
One final respondent suggested that it would be nice to see larger-scale testing of fuel cell hydrogen vehicles. This reviewer asks: will NEV vehicle use grow to be an important segment? Is studying this segment the best use of DOE resources compared to doing increased studies of passenger car / highway hybrid vehicles?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

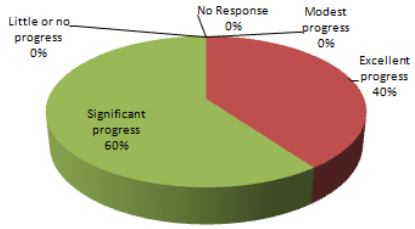
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Non-PHEV Evaluations and Data Collection

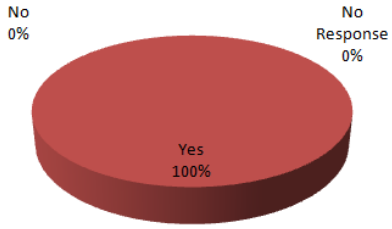
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



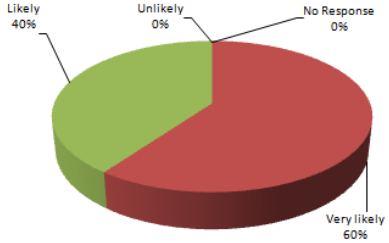
Question 3: Characterize the technical accomplishments and progress toward goals.



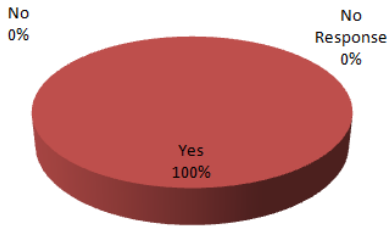
Question 2a: Are the goals of the project technically achievable?



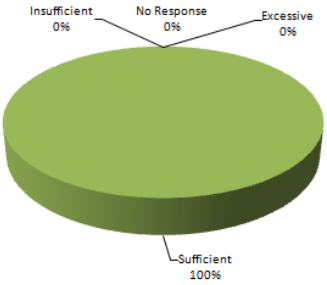
Question 4: How likely is the project team to move technologies into the marketplace?



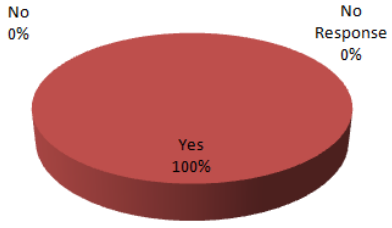
Question 2b: Have the technical barriers been identified and addressed?



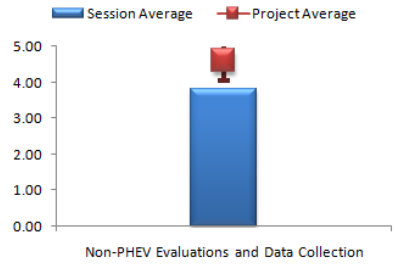
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Nucleated Boiling Wen (Yu, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that reducing the size and weight of radiators has a clear link to reduced use of fuel, while another commented that reducing engine losses has a 1-to-1 impact on reducing/displacing petroleum. One reviewer also commented on the reduction in coolant system and aerodynamic drag.

Another person stated that the work on pool boiling to decrease cooling system weight is relevant to DOE objectives. However, this reviewer adds that it seems impractical. One other reviewer wrote that the justification for the estimates given in the summary are not justified from a vehicle system's level.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response stated that this seems to be the proper class of vehicle to take this on, but it could be applicable to light-duty vehicles as well.

Another reviewer noted that the technical barriers were identified; however, no description was given for overcoming these barriers. The group needs to investigate transient conditions. How will a higher pressure cooling system affect component requirements? Similarly, one person commented that the range of the transient regime of engine radiator operation in the field hasn't been identified. It isn't clear if this application of nucleated boiling can be applied in actual vehicles. This is a good study and should continue, but a later stage should examine if commercial application is actually possible.

Another individual noted that the team's experience with boiling heat transfer applied to an on-road vehicle system/engine is relatively low. One final reviewer stated that the goals of the project to characterize pool boiling heat transfer is certainly achievable and has been done been may others. However, the technical barriers to implementing this technology to cool engines in heavy vehicles are significant and are not being addressed by this program. Boiling heat transfer using water/ethylene glycol has a number of problems, such as viscosity and pressure increases.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Results were generally positive in this section. One reviewer stated that there has been good experimental progress. Is there previous literature and experiments available? One other person stated that the testing is looking to be on track and the simulation shows benefits. Another commented that the project has successfully measured pool boiling heat transfer and their results fit well to well-established correlations. They have modified this correlation to account for the composition of mixed fluid systems. These are low technical barriers, but they have been accomplished.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer stated that reducing cooling system size requirements has many advantages, while another person stated that the work has yet to demonstrate that this technique could be applied to cooling in a vehicle with transient loads.

One response stated that this may cause changes in other coolant components that may not be accepted by industry. Similarly, another reviewer indicated that there will be strong industry reluctance to change mechanism of radiator operation. Nevertheless, strong experimental results may overcome this reluctance. One final person responded that it seems unlikely that this has commercial potential, given the barriers described above.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

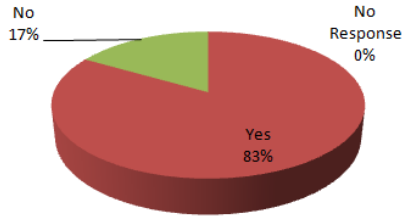
The lone respondent stated that DOE should not be investing in boiling heat transfer in the engine block due to the hurdles in commercializing this concept.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

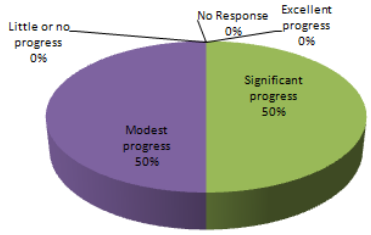
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Nucleated Boiling

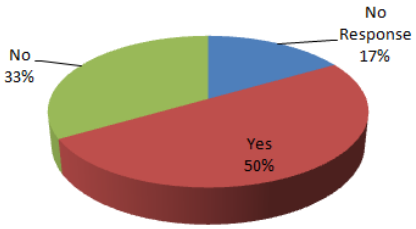
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



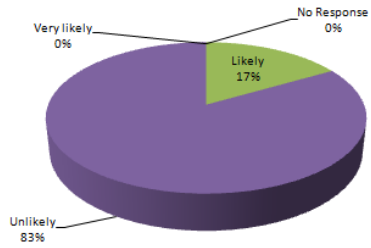
Question 3: Characterize the technical accomplishments and progress toward goals.



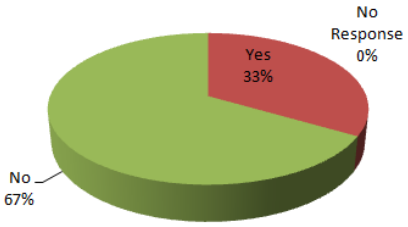
Question 2a: Are the goals of the project technically achievable?



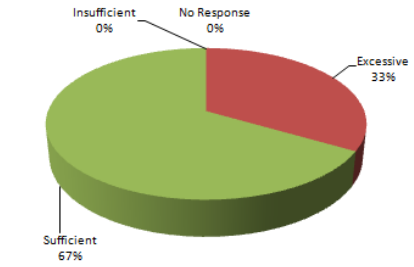
Question 4: How likely is the project team to move technologies into the marketplace?



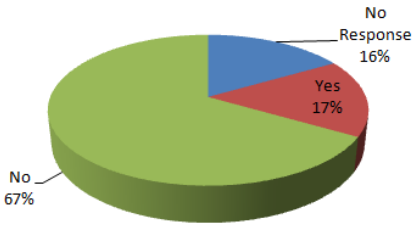
Question 2b: Have the technical barriers been identified and addressed?



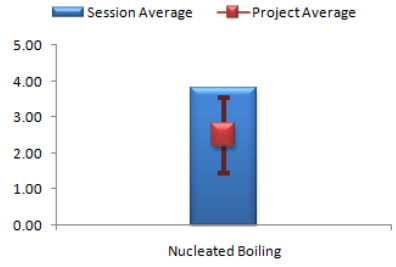
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Parasitic Energy Losses (George Fenske, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer commented that reduction in friction is and will always be an area to continue research. From a system level, this will reduce petroleum production. Similarly, one other person stated that reducing losses has a 1-to-1 impact to reducing/displacing petroleum. Another reviewer stated that this accounts for up to 10% of engine losses, giving a clear link to petroleum savings.

One final reviewer stated that this research is widely applicable to many vehicle platforms. This reviewer also asked whether the very high potential and market penetration that was used to show a large petroleum reduction was realistic.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person stated that their strategy appears to be a demonstration of technology followed by convincing commercial partners to come forward. This reviewer added that it may be helpful to have commercial partners identified early if this has not already been done.

Another person stated they were not sure how the energy pie would look if this was true: "Reduce heavy truck parasitic losses (friction, aero, rolling, etc.) …. from 39 percent of engine output … to 24 percent…" This reviewer asks, wouldn't it be better to phrase it as a reduction of individual losses? Couldn't the percentage be changed by just increasing losses elsewhere? He or she likes the weighted approach to the engine mapping. The Advanced Combustion Tech Team talked about doing the same thing, but the reviewer doesn't know whether that was taken on. One final reviewer commented that cost is of course an issue, and then asked about the impact on engine reliability.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that the models have shown a 3-5% improvement in fuel economy and the researchers are in the process of testing a single-cylinder. Another felt the data looks extensive and savings can be realized. It will be interesting how the savings will change if translated to 12,000-15,000 miles/year driving in passenger cars and light-duty trucks.

One other reviewer commented that the project appears technically sound, but is still early in getting data. A final reviewer stated there was modest progress from on-going work.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first response stated that savings can drive rapid changes, while another person added that some technologies have already been commercialized. To contrast, one reviewer felt that the commercial partners in the project don't appear to be clearly on board.

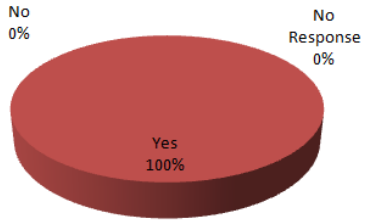
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that there is a strong collaborative team.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

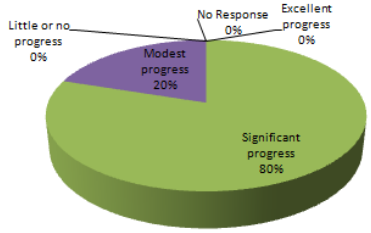
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Parasitic Energy Losses

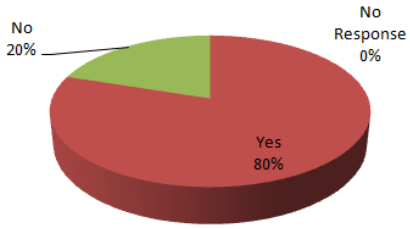
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



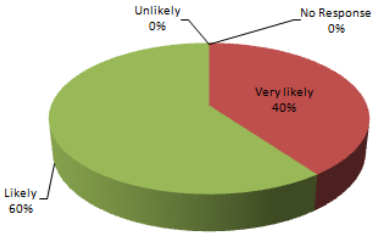
Question 3: Characterize the technical accomplishments and progress toward goals.



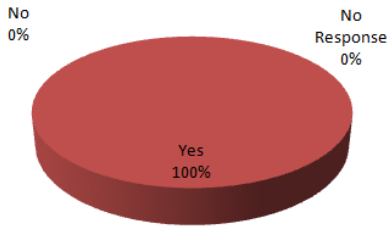
Question 2a: Are the goals of the project technically achievable?



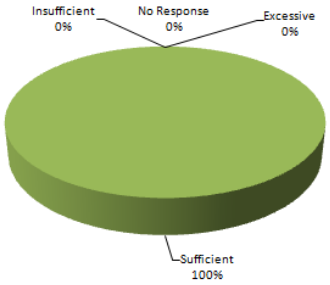
Question 4: How likely is the project team to move technologies into the marketplace?



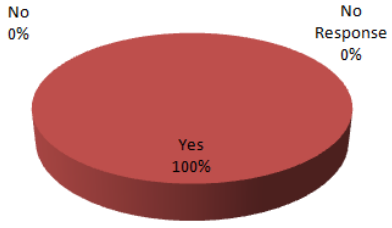
Question 2b: Have the technical barriers been identified and addressed?



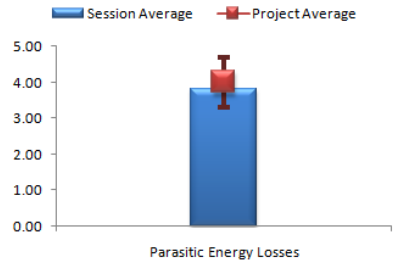
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



PHEV Component Sizing (Phil Sharer, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer indicated that this work supports DOE PHEV work, while another noted that is assists in defining component sizing, which is used to determine the direction of R&D. One other reviewer stated that this project is supporting cross-technology team requirements. Another individual indicated that this was not discussed in the presentation but will clearly allow a major impact.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first response noted that the group has gathered component data, developed a model, and validated the model. These results are then used to determine component sizing and performance for optimization. Another reviewed stated that coordination with tech teams and OEMs on those teams appears important for success. This project appears more directed at identifying barriers than about developing solutions. This reviewer thinks that this is prudent and correct for this stage of the project. One final reviewer commented that simulation programs are in place at ANL, and this is the utilization of those tools.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person indicated that this is a good start with a strong use of the existing DOE infrastructure. The respondent began by noting that the next steps indicated in slide 6 are several factors larger than the information presented on the previous slides. The reviewer added that the development of additional "real world" cycles is probably not of great importance for this project, but a more robust set of vehicle needs might be (things like the amount of power and energy needed to start the engine at -30 to -40°C). The power and cooling requirements to drive a 6% grade for 20 miles at 55 mph at 50°C ambient would be better for sizing than just another drive profile at 20°C ambient.

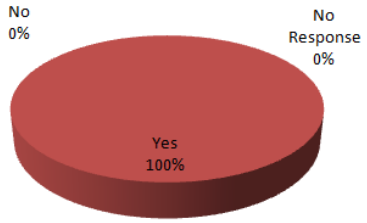
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer remarked that it appears OEMs will use the sizing and analysis data, and thus this data and strategy will move to market, but new technologies are unlikely to result from this work. The other respondent also indicated that OEMs will use the technology that is generated by the ESS and EE technology from these requirements, but the actual sizing will be done based on specific vehicle needs.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that there is good progress with limited funding.

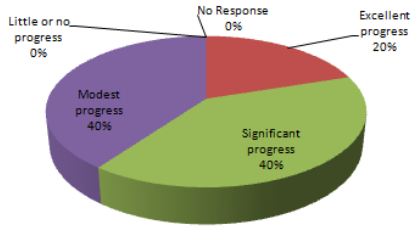
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: PHEV Component Sizing

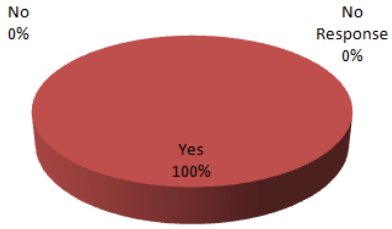
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



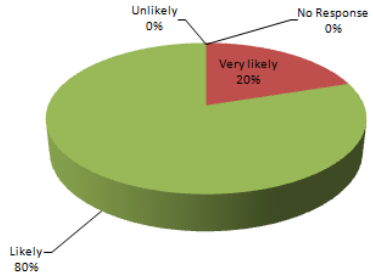
Question 3: Characterize the technical accomplishments and progress toward goals.



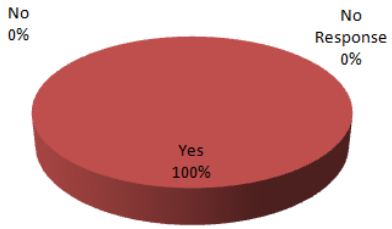
Question 2a: Are the goals of the project technically achievable?



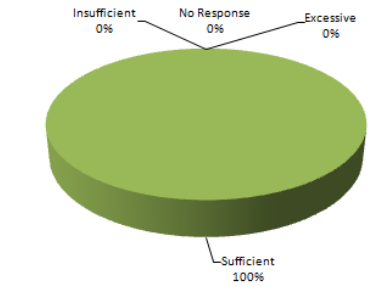
Question 4: How likely is the project team to move technologies into the marketplace?



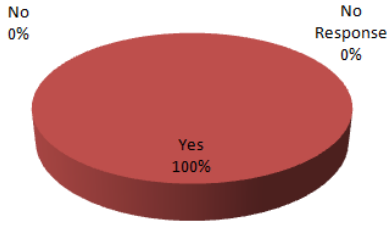
Question 2b: Have the technical barriers been identified and addressed?



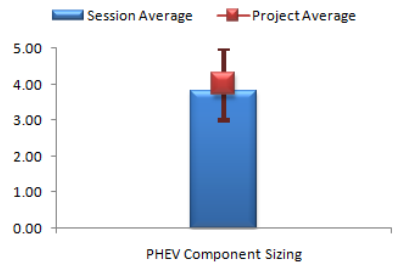
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



PHEV Control Impact and Optimization (Dominik Karbowski, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer noted that PHEVs directly reduce petroleum consumption, while another person added that this project supports DOE's PHEV work. One reviewer commented that the study is directly looking at petroleum displacement strategies. Another individual noted that the researchers are developing optimized control strategies to determine the pathway towards the lowest fuel consumption.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer remarked that there is good linkage through the entire DOE plug-in hybrid team to transfer knowledge to OEMs. Another reviewer said that there is a nice blend of testing and simulation data, and that this project is well-integrated with other ANL projects.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person commented here on the nice results showing the value of a blended strategy compared to EV/CS mode, noting that the control strategy is sensitive to assumptions of trip length. Does this mean that the vehicle should ask the driver how far they expect to go on a given trip? Will this lead to GPS integration, where the driver always indicates destination and the vehicle, in real-time, calculates the best control strategy?

The other respondent stated that the conclusion of this study is that the battery should be empty at the end of driving – not empty too soon, nor should it have energy left at the end. This reviewer would like to see some comparison of how much longer the driving distance is for the Best Charge Depletion Controls to equal the AER Case. The reviewer added that this could drive the size of the battery for powertrains that will utilize Charge Depletion only, without any AER.

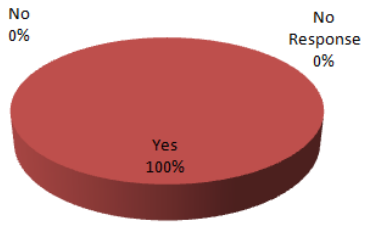
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer commented on the strong participation of OEMs, while the other respondent stated that battery sizing is paramount in managing vehicle cost.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent suggested that the resources seem high for this level of work.

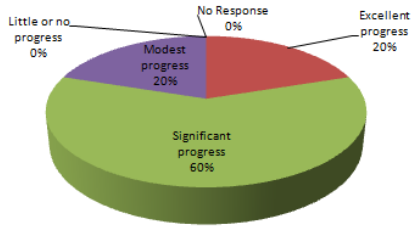
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: PHEV Control Impact and Optimization

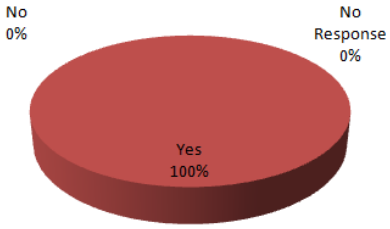
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



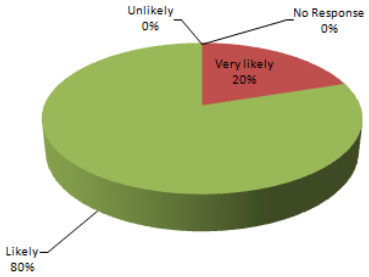
Question 3: Characterize the technical accomplishments and progress toward goals.



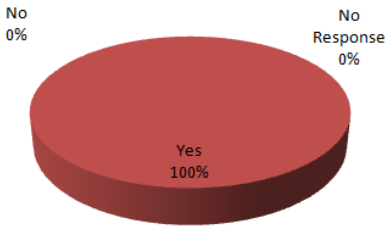
Question 2a: Are the goals of the project technically achievable?



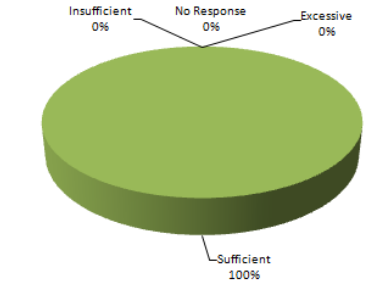
Question 4: How likely is the project team to move technologies into the marketplace?



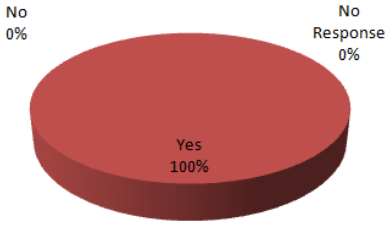
Question 2b: Have the technical barriers been identified and addressed?



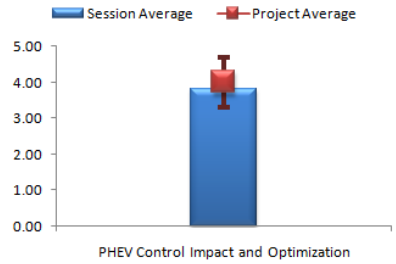
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



PHEV Evaluation and Data Collection (Jim Francfort, of Idaho National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this will result in consumers using electricity instead of gasoline for vehicle propulsion. Another person noted that plug-in hybrid use will help reduce petroleum usage, adding that there is a clear linkage here. One response stated that there is a very good, direct, near-term petroleum reduction impact. One final reviewer stated that the program provides data on present technology vehicles. This provides guidance for future project selection, leading to reduced petroleum displacement.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer noted that this project works with commercial and R&D companies to analyze the viability for commercialization. Another commented that field tests and collaboration with manufacturers, as well as linkage to modeling and policy, are strong points to encourage deployment.

One reviewer stated that this is a data collection project and does not have any difficult technical barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One response stated that this is an impressive, quick start, adding that it is a bit too early to know how the expected data will influence the eventual deployment of the technology. By necessity, the data is heavily oriented toward a few vehicle models and only a couple convertors, but it appears to have a high potential. The other respondent stated that the data is very interesting, and can be used to support the J1711 rewrite, but these early aftermarket PHEVs should not be the main input to the new utility factors.

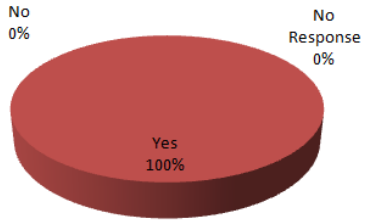
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer noted the fleet and industry testing, while another person stated that the test results and data are the products to be transferred. One final reviewer commented that PHEVs are in design at major OEMs, adding that this data can help in the control strategies development and component sizing work.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The first reviewer commented that there is strong funding, while the other respondent felt that the number of vehicles looks good and that the manpower is adequate.

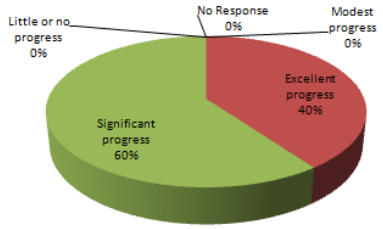
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: PHEV Evaluation and Data Collection

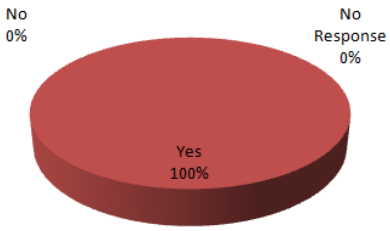
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



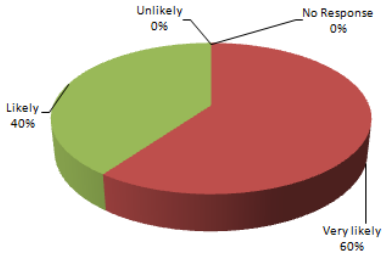
Question 3: Characterize the technical accomplishments and progress toward goals.



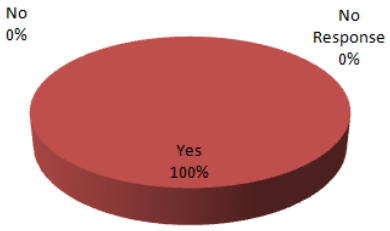
Question 2a: Are the goals of the project technically achievable?



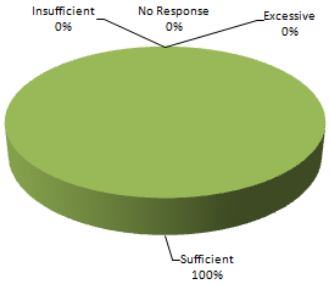
Question 4: How likely is the project team to move technologies into the marketplace?



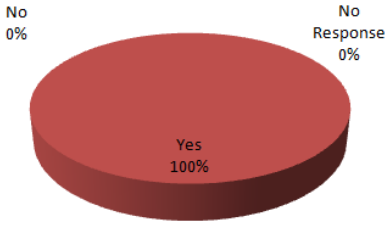
Question 2b: Have the technical barriers been identified and addressed?



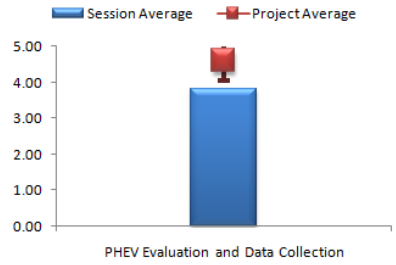
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



PHEV Test Procedures (Michael Duoba, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the program does not directly reduce consumption, but it does provide a method to measure consumption of petroleum and electrical energy. This is essential for measuring advancements in technology. One person noted that electricity used to propel the vehicle directly displaces petroleum, while another commented that the PHEV has very high potential. One reviewer commented that the DOE objectives weren't discussed in the presentation, but added that accurate test procedures appear critical to knowing how much petroleum will be displaced. Thus, while not directly contributing to petroleum reduction, it appears to be critically needed for the program overall.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the group was showing leadership in this standard development. Another noted the strong ANL leadership in development of SAE, JARI, and ISO methods that will be used by entire industry. The industry and government acceptance and use of the method will constitute a clear success of deployment. This appears likely. One person added that the input from this project will contribute to a method to measure energy consumption.

One final reviewer stated that using input from all stakeholders was a must for the procedure development. The SAE agreement to the procedure is also a must.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that the group is addressing the complex issues for testing PHEVs. Another response noted that they are in the process of developing a method to overcome the challenges of measuring energy consumption of a PHEV. It addresses blended and all-electric range vehicles by utilizing a utility factor. Barriers, such as the length of the test, still exist; however, this program is making progress to overcome those barriers.

One person commented that the development of a standard industry test method appears to be progressing well. This reviewer asks if there is risk that OEMs will figure out how to "game" the test to be able to market artificially high mileages without these claims being adequately explored. Will there be adequate calibration with real world results? One final person indicated that the need for a consistent relationship to compare is needed.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer commented that, since the participants in J1711 include industry and government agencies, it is very likely to partially or fully transfer this into the marketplace. Another person agreed, stating that the results of this work and standards development will likely be adopted by various organizations. One reviewer indicated that there is a clear need for a test method, which someone will develop. The ANL group appears to have a leadership position and thus have a good likelihood of becoming the standard if the project continues to be well led and if it has adequate resources.

One final respondent remarked that using input from all stakeholders was a must for procedure development, and SAE agreement to the procedure is also a must.

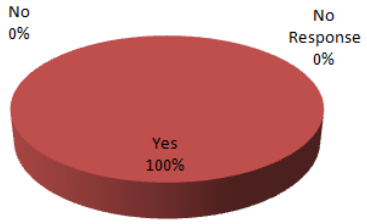
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One person stated that the program is making sufficient gains, while another commented that ANL has a good deal of experience working with the OEMs and other laboratories.

One reviewer asked, is more funding needed for calibration with real world conditions and to ensure integration and collaboration with other standards being considered world-wide?

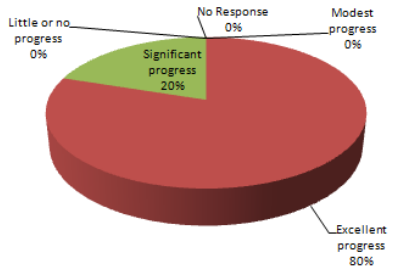
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: PHEV Test Procedures

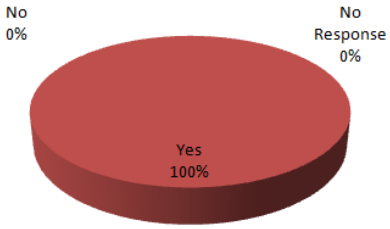
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



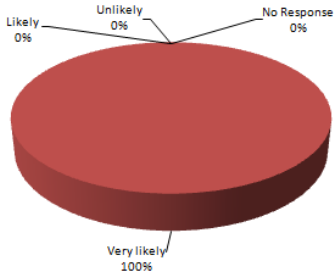
Question 3: Characterize the technical accomplishments and progress toward goals.



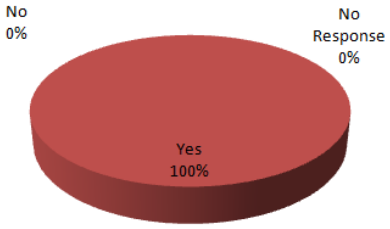
Question 2a: Are the goals of the project technically achievable?



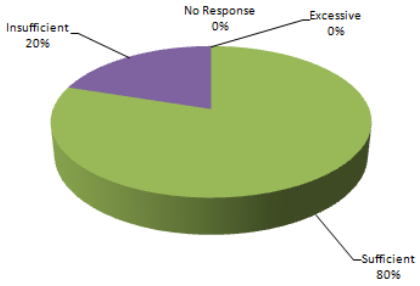
Question 4: How likely is the project team to move technologies into the marketplace?



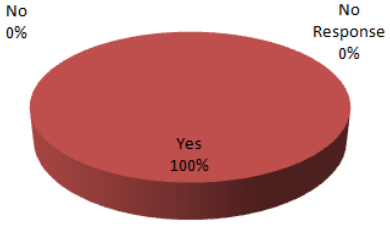
Question 2b: Have the technical barriers been identified and addressed?



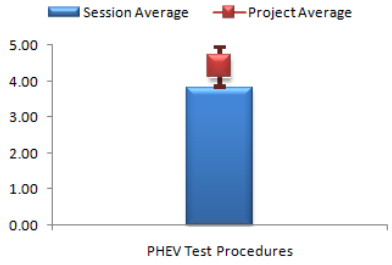
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



PHEV Value Proposition Study (Richard Smith, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this project is investigating potential business opportunities to improve the value to a PHEV customer, thereby encouraging PHEVs, while another person added that PHEVs will displace petroleum. One final reviewer stated that this was not discussed in the presentation, but the value proposition / business case appears to be critical to move forward.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first respondent stated that the review with 120 industry experts is impressive. However, there is concern that the approach is more about obtaining consensus to obtain political points and funding rather than to obtain a real understanding of the market place and needs for understanding the value proposition, particularly of the end users. The reviewer is familiar with market assessment and business development methodologies of the venture capital community and of the business community. This project seems to have another approach. If this study were done by Ideo, Sagentia, Innovia, or other commercial value proposition development companies, would there be a different conclusion? Will marketing to consumers and status / fashion be an important part of consumer choice? This study assumes that by 2030 fad and fashion won't be as important and thus it will boil down to economics. The reviewer adds that the study also seems to avoid some key policy questions (like scenario of severe carbon caps) and perhaps does not take sufficiently into account probable gains of IC engines.

The other person responding supposes that generating this information is "technically achievable," but it is difficult to translate what the consumer says is wanted into what is required. A Prius is not the lowest cost of ownership vehicle, the roomiest, best handling, quietest, or fastest, yet is among the highest selling cars. He or she would like to see if there are translatable factors in its value proposition to PHEVs. The reviewer suggests making sure that V2G is defined properly to the survey groups. If V2G significantly impacts battery life, the relatively small amount of earnings from V2G would be vastly outnumbered by battery replacement costs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that it is difficult to accurately predict the component cost and performance for 2030. That, along with the difficulty in predicting the market influences for 2030, makes it challenging to place high value in the results. The results can only be as accurate as the assumptions.

One person indicated that the work is just starting, while another added to this by saying that lots of questions and data collection remain. One person also noted that the project is just beginning; it is too early to know its technical accomplishments. The study plan and approach appear solid. Will a sensitivity analysis be done on the starting assumptions?

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer stated that the project results may provide direction for project funding to support the industry in PHEV research. Another indicated that, if value can be shown, vehicles designs will be impacted.

One other reviewer commented that this isn't a technology development project, but rather a value proposition project. This reviewer strongly supports the project objectives, but is concerned that the approach may not be the best one.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

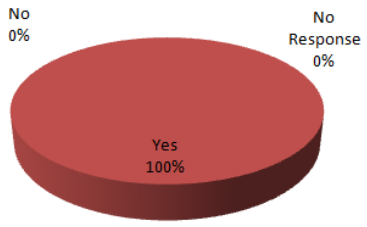
The lone respondent asks whether there should be more funding to allow partnering with a professional value proposition firm. A DOE laboratory doesn't appear to have a strong background in this area.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

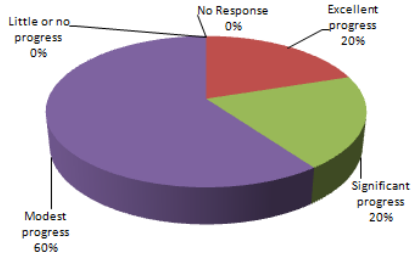
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: PHEV Value Proposition Study

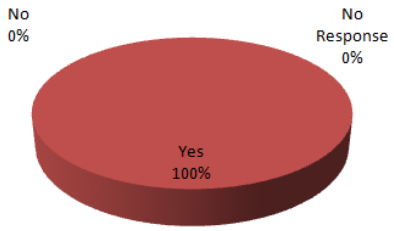
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



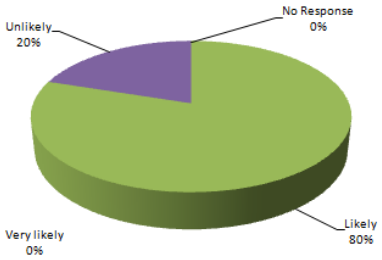
Question 3: Characterize the technical accomplishments and progress toward goals.



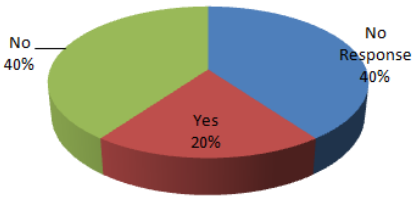
Question 2a: Are the goals of the project technically achievable?



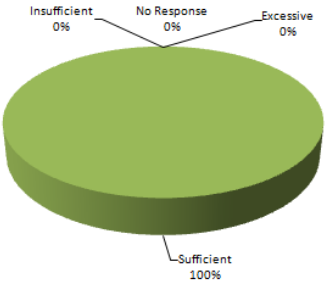
Question 4: How likely is the project team to move technologies into the marketplace?



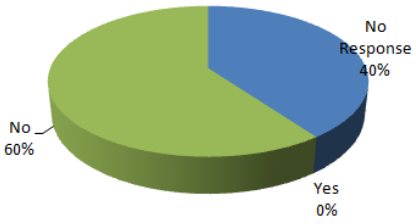
Question 2b: Have the technical barriers been identified and addressed?



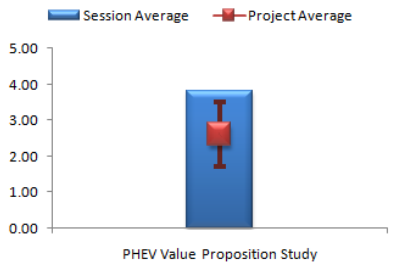
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thermoelectric Analysis, Integrated Vehicle Thermal Management Systems Analysis/Modeling (Tony Markel, of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that the group performs modeling to determine direction for advanced technologies. Another noted that all four sub-areas focus on improving the use of the battery pack to reduce petroleum use. One other person indicated that this effort provides general support to DOE for HEVs and PHEVs.

One reviewer stated that this was not discussed in the presentation.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that measuring data and processing it for analysis is straightforward, while another person commented that having a better understanding of these technologies will enable deployment.

One reviewer indicated that the route to transfer knowledge to OEMs or others wasn't clearly presented. This reviewer assumes that this will mainly occur through the publication of results and work with other project teams.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that the approach to plug-in hybrid modeling appears clear. Thermal mapping and integration may be repeating work already well in hand by OEMs. Does this work need more collaboration with OEMs? Are OEMs requesting this work or is the effort to make publicly available information that is considered proprietary by OEMs? It seems clear that thermoelectric work should slow down or stop. Can the work be closed with an analysis of the efficiency the thermoelectrics need to obtain to become useful in automotive markets, and thus be useful as a guide for research in that area?

The other respondent indicated that there is some concern about generating new drive cycles, such as how the PHEV will be compared to conventional technologies if different cycles are being used. Route-based controls is a good pre-competitive area for FreedomCAR research. This reviewer questions whether or not drivers will likely be monitored for reduced consumption. Recovering waste heat is also a good pre-competitive area for FreedomCAR research. Is there also something to be gained by directly using exhaust heat to warm driveline components? The integrated thermal management is a great idea to reduce cost in hybrids, but make sure efficiency maps are based on thermal operating temps for motors, batteries, power electronics, and transmissions. This reviewer adds that single operating temperatures may have adverse efficiency and life effects, outweighing potential cost gains.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person stated that the results are to be utilized by industry and government to provide input into the direction of advanced technologies. The other respondent added that route-based controls and waste heat recovery are greatly untapped in the current automotive marketplace. These technologies need to be driven to be low hanging fruit for OEM use.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

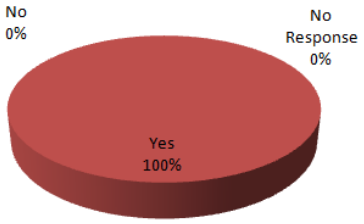
One reviewer stated that the thermoelectric work needs to be phased down. Another person suggested that the current resource allocation seems high for this level of work.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

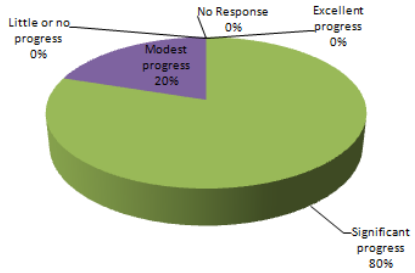
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thermoelectric Analysis, Integrated Vehicle Thermal Management Systems Analysis/Modeling

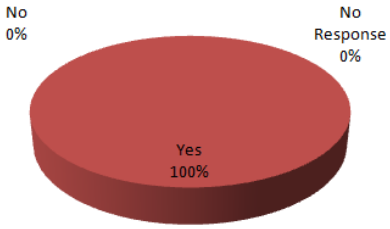
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



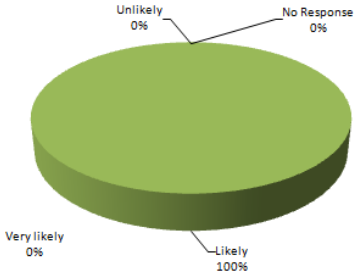
Question 3: Characterize the technical accomplishments and progress toward goals.



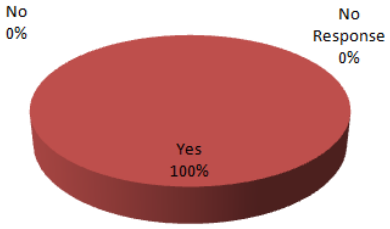
Question 2a: Are the goals of the project technically achievable?



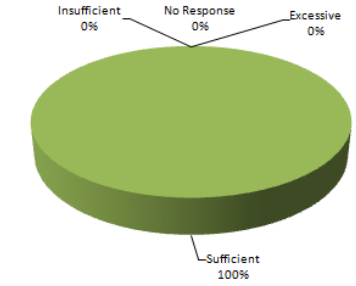
Question 4: How likely is the project team to move technologies into the marketplace?



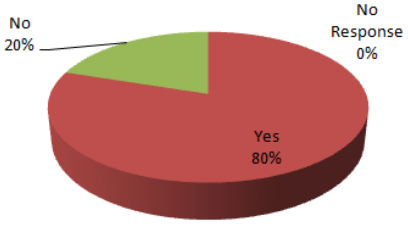
Question 2b: Have the technical barriers been identified and addressed?



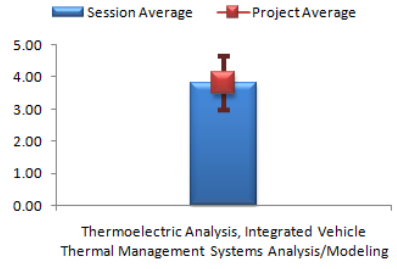
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Thru-the-Road PHEV and Ultracapacitor Integration (Ted Bohn, of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer noted that this will result in consumers using electricity instead of gasoline for vehicle propulsion, and another person added that PHEVs have a large potential for petroleum reduction. One individual commented that this program will analyze the possible benefits of an ultracapacitor / battery combination to improve the performance of the electrical storage system in a HEV/PHEV. One final reviewer stated that the DOE objectives weren't discussed in the presentation. However, the objective of promoting hybrid and plug-in technologies will directly displace petroleum usage.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer stated that the project is providing early testing to aid the deployment of PHEVs. Another person commented that the strategy appears more directed to obtaining basic knowledge that will enable future progress and get around limitations of OEMs not wanting to share internal knowledge (for example, controller algorithms). This reviewer adds that a direct route to deployment wasn't made clear, but it doesn't appear necessary at this point in the early stages of the project. Likewise, this project appears more aimed at identifying technical barriers than in overcoming them at this stage. The project is at an early stage, and thus this is normal and acceptable. One final response indicated that the experience from the Prius benchmarking and MATT's development should help get the program in a position to generate the data regarding gasoline displacement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One response stated that there has been very good progress in a relatively short period of time for this sort of work, while another person similarly commented that the project is at an early stage but appears to be on a solid path to make future progress. One reviewer noted that a test vehicle was modified and used to perform testing to support J1711.

One final individual, in contrast, suggested that controls modifications may hold up the program longer than expected or planned.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Responses to this prompt were generally positive. One reviewer commented that the results from test vehicles can be utilized by government and industry for the development of products and test procedures, while another person added that the early demonstration and testing of PHEV and ultracapacitor technologies will aid in their transfer. One reviewer noted that OEM's are stating that PHEVs are a near-term technology. Data from this project could be used in component sizing and development of future PHEV designs. One person commented that the study is at an early stage but is working directly with suppliers and OEMs. Thus there appears to be a solid basis for future technology transfer.

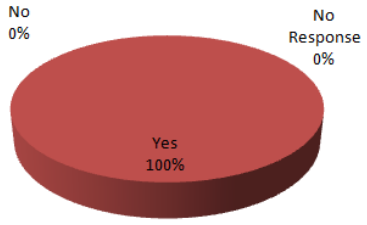
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One response stated that the project has made sufficient progress to test vehicles to support J1711 testing and is on schedule to initiate capacitor/battery testing in 2008. Another said that having a better tie to the OEM controls would be useful, but proprietary information could hold up progress if that avenue is chosen exclusively.

One final reviewer stated that marrying ultracapacitors and batteries and extending this effort to marrying other types of power sources appears to have merit to balance the strengths and weaknesses of various technologies. Supplies tied to one technology are unable to do this, and this is a great area for DOE to show leadership across technologies and companies. This reviewer recommends increasing the budget of this project.

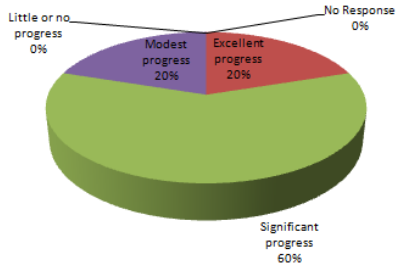
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Thru-the-Road PHEV and Ultracapacitor Integration

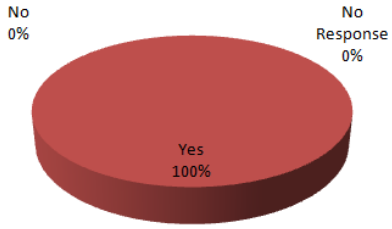
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



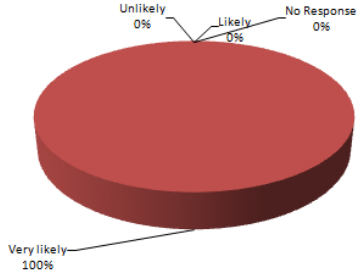
Question 3: Characterize the technical accomplishments and progress toward goals.



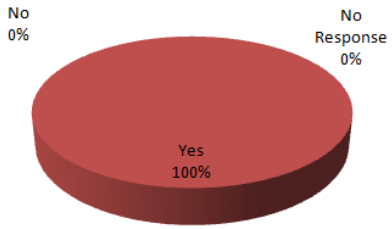
Question 2a: Are the goals of the project technically achievable?



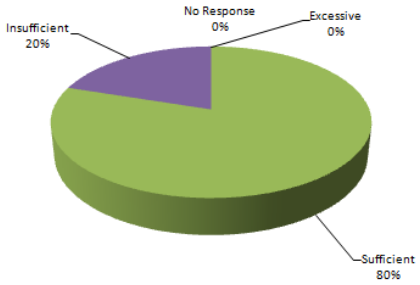
Question 4: How likely is the project team to move technologies into the marketplace?



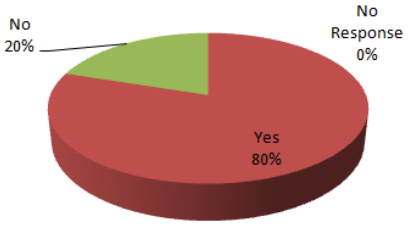
Question 2b: Have the technical barriers been identified and addressed?



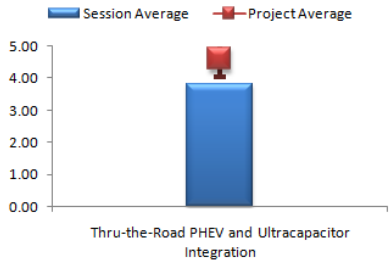
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



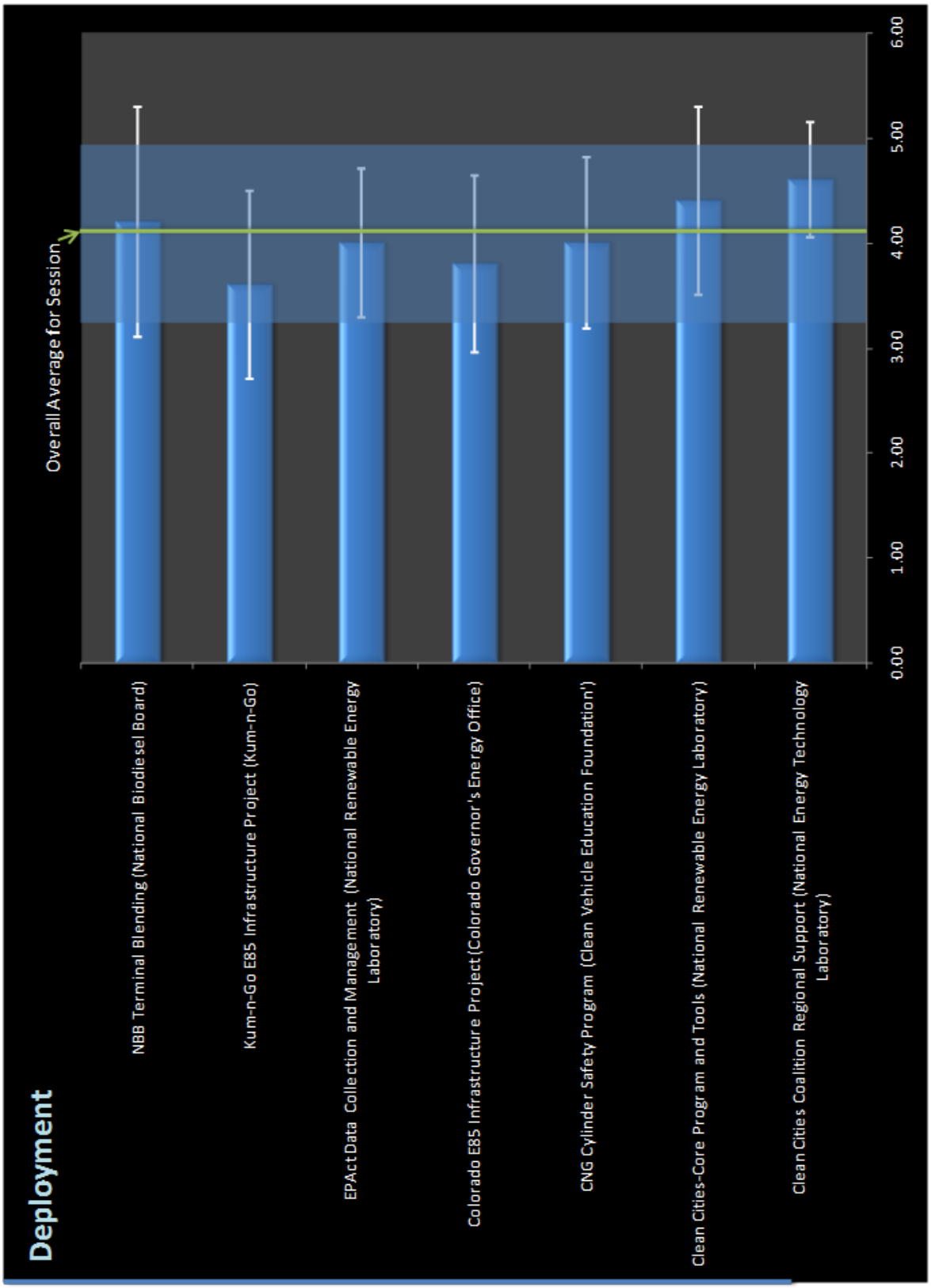
15. Deployment

Introduction

The VT deployment activity includes the Clean Cities and EPAct work to encourage the use of alternative fuel and advanced transportation vehicles. Clean Cities strives to advance the nation's economic, environmental, and energy security by supporting local decisions to adopt practices that contribute to the reduction of petroleum consumption. Clean Cities has a network of approximately 90 volunteer coalitions, which develop public/private partnerships to promote alternative fuels and advanced vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction. The Energy Policy Act of 1992 (EPAct) was passed by Congress to reduce our nation's dependence on imported petroleum by requiring certain fleets to acquire alternative fuel vehicles, which are capable of operating on nonpetroleum fuels. The U.S. Department of Energy administers the EPAct regulations through the Federal Fleet Requirements, State and Alternative Fuel Provider Rule, Private and Local Government Fleet Rule, and Alternative Fuel Designation Authority.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
15-3	Clean Cities Coalition Regional Support (Kay Milewski, National Energy Technology Laboratory)	4.60	0.55
15-6	Clean Cities-Core Program and Tools (Paul Bergeron, National Renewable Energy Laboratory)	4.40	0.89
15-9	CNG Cylinder Safety Program (Hank Seiff, Clean Vehicle Education Foundation')	4.00	0.82
15-12	Colorado E85 Infrastructure Project (Stacey Simms, Colorado Governor's Energy Office)	3.80	0.84
15-15	EPAct Data Collection and Management (Paul Bergeron, National Renewable Energy Laboratory)	4.00	0.71
15-18	Kum-n-Go E85 Infrastructure Project (Ben Steely, Kum-n-Go)	3.60	0.89
15-21	NBB Terminal Blending (Jill Hamilton, National Biodiesel Board)	4.20	1.10
	Overall Session Average and Standard Deviation	**4.09**	**0.83**


Deployment
Overall Average for Session
0.00
1.00
2.00
3.00
4.00
5.00
6.00
NBB Terminal Blending (National Biodiesel Board)
Kum-n-Go E85 Infrastructure Project (Kum-n-Go)
EPAct Data Collection and Management (National Renewable Energy Laboratory)
Colorado E85 Infrastructure Project (Colorado Governor's Energy Office)
CNG Cylinder Safety Program (Clean Vehicle Education Foundation')
Clean Cities-Core Program and Tools (National Renewable Energy Laboratory)
Clean Cities Coalition Regional Support (National Energy Technology Laboratory)

Clean Cities Coalition Regional Support (Kay Milewski of National Energy Technology Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person commented that the project provides the support and accountability necessary to ensure effective coalition activities, while another noted that it provides support for local coalitions. Similarly, one person noted that the project is part of the Clean Cities Program in VT, alternative fuels, and outreach through the local coalitions and coordinators. Another simply wrote that it always has and always will support petroleum displacement.

Another reviewer, in a lengthy response, provided comments on the success of the team. They build and strengthen coalitions, assist coordinators, provide technical assistance, and provide outreach. They serve as the project management of the regional support activities and coalition support contracts. There are six Clean Cities regions and Project Management Center representatives. The team members collect data on fuel use through a subcontract with RDS ($10K each) to incentivize coalitions to give the needed data to NETL. There are 80 contracts established out of a total of 85 coalitions, as well as contracts for regional and national meetings. Coalitions receiving funds must complete an annual survey and make sure that the data center website is up-to-date and given info on success stories. There were 82 annual surveys completed (an increase over 2005, which had 66), with improved data. Support contracts have increased response rates on the alternative fuel price report. There are already established contracts for 2008 ($12,500), with 75 contracts established to date. There is a revised reporting requirements checklist (100 percent response rate for Q1 Alt Fuel Price Report data). There were 16 projects awarded through a recent solicitation: for refueling infrastructure for E85 (13 projects), incremental cost for AFVs (1 project), and 2 idle reduction/training projects for school districts. They have had lots of partners in these efforts.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
The first reviewer indicated that there is regional diversity and solid metrics for tracking actions and successes, while another person felt that there was a good understanding of the technical and commercial challenges facing the program. One reviewer stated that the project was providing financial support and information and coordinating activities to share successes and the identification and resolution of barriers from various coalitions. Another person, similarly, noted that the project was issuing solicitations and assisting the coalitions in furthering their work.

Separately, one person stated that there were not enough funds in grants, and asked, what about grants for fuel providers in getting info? This reviewer stated that the fueling station locations were not up to date, and that fuel providers do not provide info to NREL.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Results were generally positive in this section, with one reviewer stating that the project seems to be using resources effectively to support coalition activities. Another noted that the team has increased the reporting data from the Coalitions and is working to give the Coalitions the tools they need to further their goals. Another cited the fuel price reports and the good response rate, administration of

the coalition support contracts, and the 2006 grant awards. One other reviewer stated that the barriers are very large, but progress is being made and this is accelerating.

In contrast, one person stated that there was too much effort on biomass infrastructure projects, like E85, and not sufficient effort in incremental cost reduction grants.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer wrote that there is continuous work needed to overcome the technology and infrastructure barriers; however, there are lots of regional and national barriers to overcome. The project's effective execution is only part of changing the marketplace significantly. One other person said that fuel efficiency and alternative fuels technologies are increasingly attractive in the marketplace.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

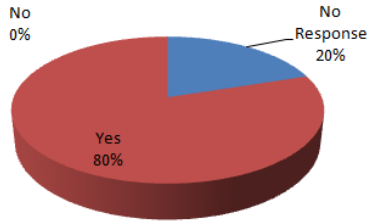
One person commented that, as stated previously, the project is succeeding in meeting its goals within current budgeting, but greater funding could grow the goals and successes. The other respondent stated that the project needs higher DOE budget requests and should expand into renewable natural gas.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

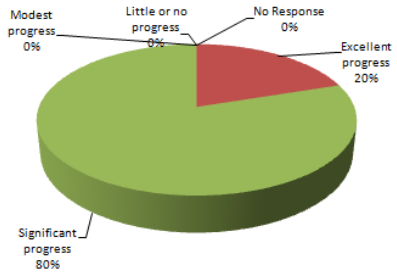
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Clean Cities Coalition Regional Support

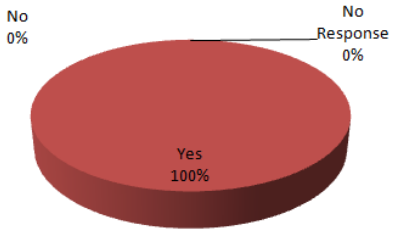
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



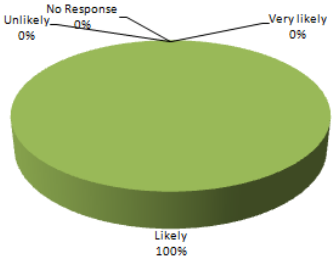
Question 3: Characterize the technical accomplishments and progress toward goals.



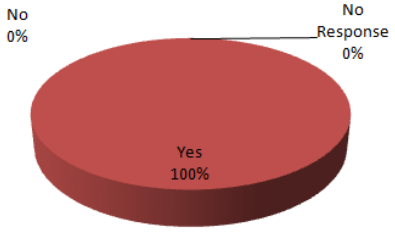
Question 2a: Are the goals of the project technically achievable?



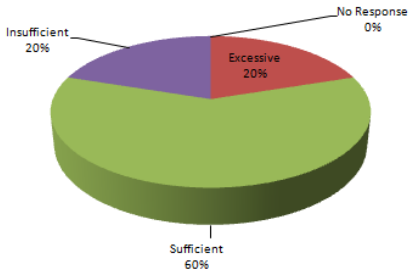
Question 4: How likely is the project team to move technologies into the marketplace?



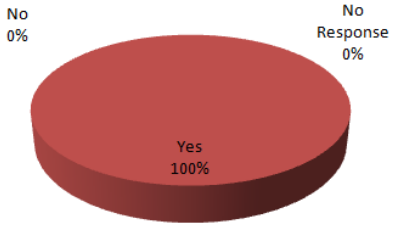
Question 2b: Have the technical barriers been identified and addressed?



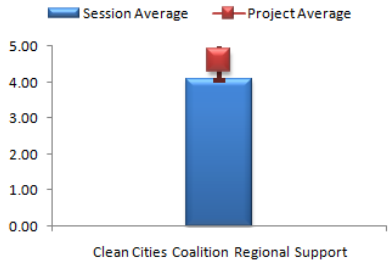
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Clean Cities-Core Program and Tools (Paul Bergeron of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive in this section. One person wrote that the program's activities promote up- and down-stream adoption of vehicles and fuels and infrastructure. The program is sensitive to the necessity of diverse approaches. Another commented that it is the most effective Federal deployment program around. One other reviewer strongly emphasized that petroleum reduction is the overall program objective.

Another respondent noted that the program is trying to overcome barriers to deployment of AFVs, supporting infrastructure, and consumer education/awareness (AFDC) through activities such as Tiger Teams, Google map technologies (to improve station geocoding), and sharing info with Mapquest. The project is developing in-house GIS capability; engaging in partnerships with AAM; cosponsoring an E85 study; developing new fact sheets ("What's an FFV"), technology bulletins (E85 dispenser), and webcasts; and has initiated an RSS feed for AFDC (simple syndication). Regarding technical support, they are initiating a Verizon fleet analysis and have developed template presentations for coordinators.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were again generally positive here. One person wrote that the strategy emphasizes diversity and the dissemination of technical information, which are critical. It leverages national and regional partnerships. Another person commented that the deployment strategy leverages local stakeholder resources and local decision makers, while providing a wide range of national information resources. Similarly, one person wrote that AFDC, Tiger Teams, and in-house technical expertise provide effective strategies. Another stated that this education and increased awareness is needed.

One final response stated the program takes a comprehensive approach to addressing the barriers associated with advancing energy efficient and alternative-fueled vehicles and the supporting infrastructure. There is a clear understanding of future activities to undertake: increase coordination with DOE biomass program, develop new fleet tools, and update key materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person here cited the increases in petroleum displacement success and recent budget improvements, while another commented that the GGE/displacement measurement shows that the program is exceeding annual goals. One reviewer commented that Clean Cities and AFDC are widely recognized and respected sources of technological expertise that is unbiased, technically sound, and targeted to industry and stakeholder needs.

One person said that the work can always improve. Another stated that working with Mapquest (e.g., GIS E85 station candidate locator) and Google are good strategies to identify opportunities and reach the largest audience.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Results were generally positive. One person cited the increases in petroleum displacement success and recent budget improvements, while another referenced the activities noted in the presentation. One person commented that increasing funding is important. Increasing sophistication of information dissemination tools also plays a role. Another reviewer stated that NREL has historically been involved in the Clean Cities program and has developed a number of tools and resources to educate consumers, industry and other key stakeholders about the technologies that represent the Clean Cities portfolio.

To contrast, one person stated that there was too much emphasis on biomass.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that, while the program uses its funding effectively in advancing objectives, the program's success could be expanded in proportion to additional resources. Another person wrote that there is always room for improvement, but resources are being utilized effectively.

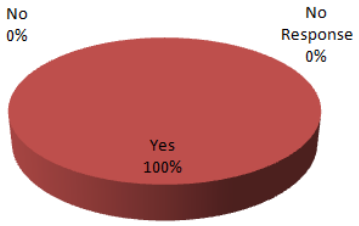
One final person commented that, regarding E85, the total energy costs for this fuel need to be reexamined more thoroughly. The reviewer asked what its effect is on full-cycle energy consumption, emissions, and food supply/prices.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

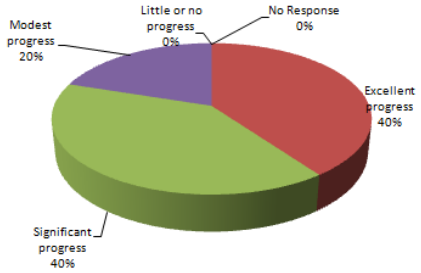
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Clean Cities-Core Program and Tools

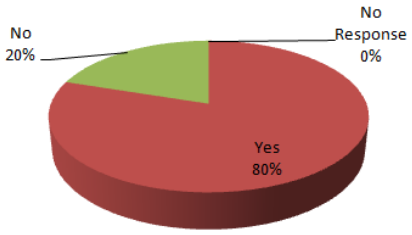
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



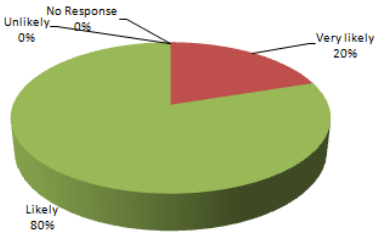
Question 3: Characterize the technical accomplishments and progress toward goals.



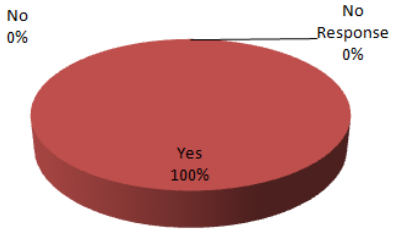
Question 2a: Are the goals of the project technically achievable?



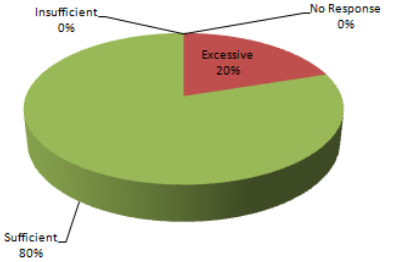
Question 4: How likely is the project team to move technologies into the marketplace?



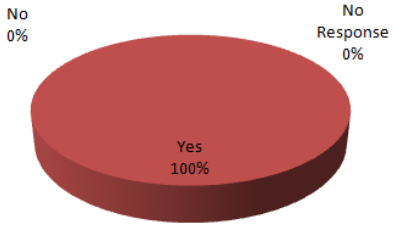
Question 2b: Have the technical barriers been identified and addressed?



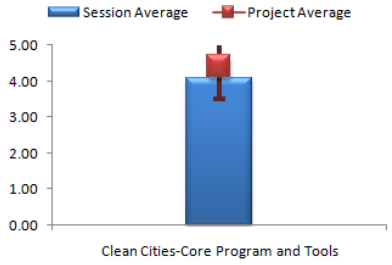
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



CNG Cylinder Safety Program (Hank Seiff of Clean Vehicle Education Foundation')

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that CNG is a proven and economical alternative fuel for many applications, while another similarly wrote that CNG use displaces petroleum, and ensuring safety is critical for potential customers. Another person stated that safety standards, as well as technical and consumer education, are necessary for the use and expansion of natural gas as an alternative fuel. Following this same idea, one reviewer began by stating that the goal of the project is to assure the safety of NGV fuel systems, and this project is important to keeping current and future NGVs on the roads. The person adds that there are 7 million NGVs worldwide. This project is effectively attempting to tell people who own NGVs to properly use and maintain the CNG fuel cylinders. In addition, the project is addressing related codes, making sure there is available training and inspection programs, assuring coordination among vehicle users, and providing information to potential hydrogen vehicle users/manufacturers.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the project is using outreach effectively to respond to safety and education concerns, while another commented that they provide a good understanding of safety issues and how to improve the safety inspection process for cylinders. Another person added that proving and improving safety is critical to growing the CNG market opportunities. One final reviewer noted that, when one performs a Google search for "CNG gas cylinder safety," their website comes up first – attempting to increase public awareness/education. The program advertised 76 times, granted 224 scholarships for people who take training and become certified inspectors; certified inspectors have received criteria, had 3 inspectors certified through the program who then interface with test certifiers, also ensuring that accidents are investigated and information imparted widely. The program is also helping with the development of hydrogen codes and standards. They are assuring that the lessons learned from incidents are making their way into codes and standards.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that the project has met benchmarks for education and media presence, while another stated that this is important work that needs to be undertaken to ensure the safe and effective deployment of NGVs. One individual remarked on the wide range of outreach activities (e.g., scholarships, advertisements, work through the industry). One final respondent wrote that CNG is a proven alternative that enjoys increasing economic benefits as petroleum fuel prices grow faster than natural gas prices.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Responses were generally positive here. One person stated that, while the project is a small element of a larger scale NGV equation, it is an important piece of that puzzle. Also, the natural gas model has great lessons for the hydrogen effort. Another individual wrote that without this type of work, this reviewer doesn't believe the industry will see an increase in NGVs and/or hydrogen-fueled vehicles in the future.

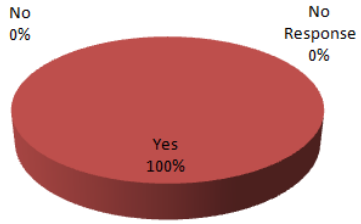
One reviewer commented on the program's work to increase recognition of safety and how to obtain cylinder certification/recertification, while one other person stated that addressing CNG safety concerns is an important activity, and this project seems to be effectively providing objective information in this regard.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One person commented that the project is in its third year and appears to be quite effective. Another reviewer simply stated that the resources are never enough.

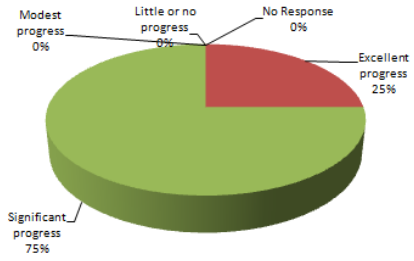
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: CNG Cylinder Safety Program

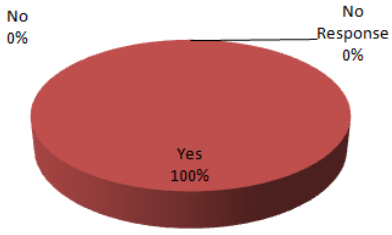
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



Question 3: Characterize the technical accomplishments and progress toward goals.



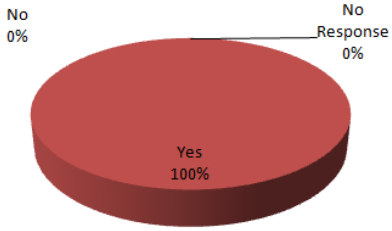
Question 2a: Are the goals of the project technically achievable?



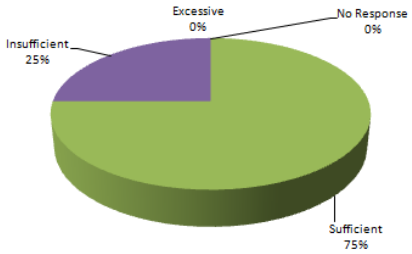
Question 4: How likely is the project team to move technologies into the marketplace?



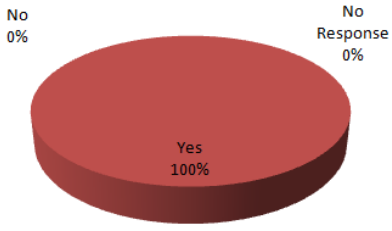
Question 2b: Have the technical barriers been identified and addressed?



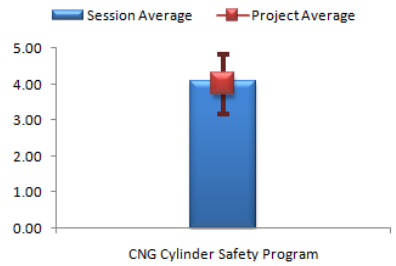
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Colorado E85 Infrastructure Project (Stacey Simms of Colorado Governor's Energy Office)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive here, with one person stating that the project promotes deployment of alternative fuel as well as consumer and media understanding of E85. One reviewer noted on how the Coalition is increasing awareness, usage and infrastructure for E85 and biodiesel in Colorado. One other person stated that this is a direct promotion of biofuels, while another noted that both E85 and biodiesel displace petroleum.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were slightly mixed but generally positive in this section. One person wrote that the project has appropriately identified tangible (infrastructure) and intangible (media perceptions) barriers, along with the strategies to address them. Another commented that the deployment strategy is to overcome biofuels misconceptions, help consumers see value in biofuels, secure support from many different sectors so not perceived as a "government" program, and add technical and marketing expertise in addition to locating stations. The coalition has created press materials and secured the Governor's participation for grand openings. It has increased biofuel stations from 13 in 55 by the end of 2007. Major retailers have committed to offer E85 and biodiesel at more than 20 stations in the next 12-18 months. The coalition first worked with early adopters and is now branching out to other target audiences. These early adopters were used as a case study for why other entities should want to add biofuels to their mix. The coalition recognizes that the amount of E85 used is also related to the price of unleaded gas.

One reviewer cited the emphasis on public/private partnerships, support for additional biofuel sites, and the range of outreach activities. Another individual stated that providing technical and marketing support is key. Lastly, one reviewer felt that this was a well-developed coalition, but its goals were not well described, nor were activities for educating the public made clear. The reviewer was not sure if the barriers can be entirely overcome.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Results were generally positive in this section, with one person commenting that the project has met and exceeded goals for deployment and has been successful in generating positive media attention. Another wrote that the coalition has brought together the key stakeholders necessary to further the use of E85 and biodiesel. Importantly, they recognize that price is a key factor as to the usage of the fuels. One reviewer commented that the goals have been met, and this is a proper reallocation of DOE funds. One person commented on the significant growth in station establishment, while another cited the success in reaching 55 biofuel stations in Colorado.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that the project has been successful in expanding fuel availability and has plans to expand on that success. The program has established a template for other coalitions to use to repeat the project's accomplishments. Another response stated that they have held a number of

outreach events and have worked with other key stakeholders to further the use of E85 and biodiesel in the state. One other person commented on the coordination of available resources.

Another reviewer stated that there have been good attempts to identify locations, but there are insufficient efforts to educate potential consumers and the program needs a proper redirection for station location.

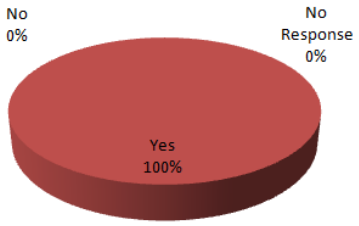
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One person stated that the funding appears to have been sufficient to leverage other funders and diversify the stakeholders with an investment in project success. Another stated that there is always room for more resources. One reviewer commented on the $388,000 reimbursable DOE grant, with the total project valued at $1.09 million. This person added that GM has provided a lot of support (including outreach and promotion), and that they have exceeded their grant pledge.

To contrast, one person stated that the DOE financial support was excessive, and that there was insufficient operator participation. They added that the funding matrix is good.

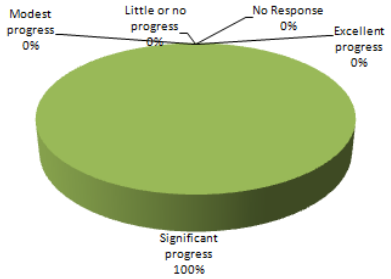
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Colorado E85 Infrastructure Project

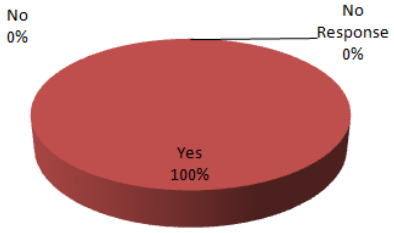
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



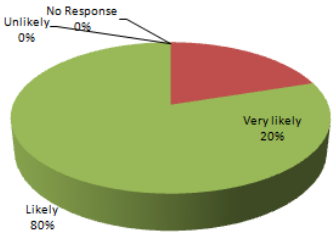
Question 3: Characterize the technical accomplishments and progress toward goals.



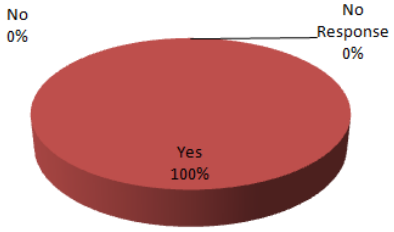
Question 2a: Are the goals of the project technically achievable?



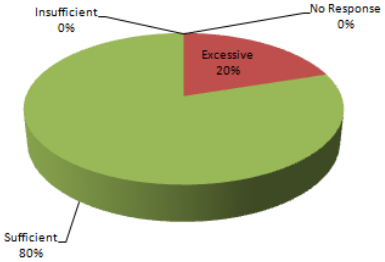
Question 4: How likely is the project team to move technologies into the marketplace?



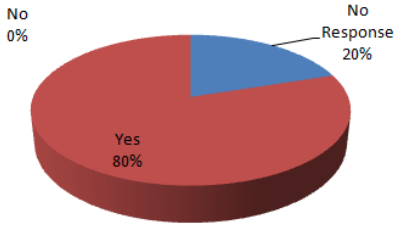
Question 2b: Have the technical barriers been identified and addressed?



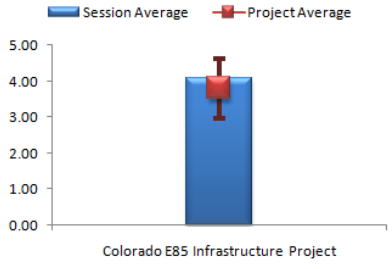
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



EPAct Data Collection and Management (Paul Bergeron of National Renewable Energy Laboratory)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive here. One reviewer stated that the data management and tracking are necessary to measure compliance and benefits of alternative fuel vehicles and alternative compliance. Another commented that the data collection and analysis is a critical component of management of petroleum reduction activities and determining progress towards the goals. One person stated that the goal conforms 100%, citing strong relevance and adding that it is of great use to Clean Cities Coordinators.

Another reviewer stated that NREL directly supports DOE's responsibility to implement the EPAct state and fuel provider regulations, and does this through data collection with a secure, active, and flexible data management system. Similarly, one person wrote that the program provides direct support to DOE's EPAct State and Local Provider Fleet Program. Another stated it provides tools and data to help fleets comply, since mandating AFVs has limitations and the alternative fuels compliance option allows for greater fleet flexibility.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the secure database and the quality-checks on data entry are important safeguards, while another stated that data collection and analysis is a critical component to managing petroleum reduction activities and determining progress towards these goals. In a more detailed response, one person commented on how the program uses a secure Oracle database and allows fleets to have a flexible approach to meeting EPAct goals, which is beneficial so that greater reductions in gasoline usage are achieved. NREL has an online control room to access the database and has a control room that allows for tracking a variety of data (reviewing fleet compliance history, executing credit trades and approved exemptions). Three mechanisms are available for reporting: an online form, spreadsheet, and hard copy. An online alternative fuel compliance tool allows the fleets to determine if this approach would be more beneficial for their fleet. They can use eight different technologies to meet the plan. They can also report partially or fully at any point in the year, plus they have constant phone help available.

One reviewer stated that the program is reactive versus proactive in terms of who should or could comply. Another individual commented that the program needs to be accessible, predictable and transparent to users who are trying to comply. The effectiveness of NREL in establishing these metrics contributes to the near-100% compliance with the EPAct fleet requirements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer commented that the current data collection and management system provides a good launch point to achieve future growth due to petroleum pricing growing faster than non-petroleum alternatives. The existence of substantial credit trading indicates the current success and growing opportunities for future strengthening. Another cited the program's 99% compliance rate

since 1997, adding that there have been more than 4,000 annual reports, 306 exemptions, and 238 trade transactions.

One reviewer noted the program's electronic options, noting the tools were good overall. There is slow progress in meeting Congressional studies (not AC), but added that there is great progress in data collection and in the available tools. One final reviewer stated that the program implementation for AFV's has been successful within the program's limits. Establishment of alternative compliance has the potential to address the barriers that the original program could not. The additional flexibility provided in EISA07, properly implemented and measured, has the potential to make the program even more effective in displacing petroleum and building advanced technology and alternative fuel options in the fleet.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer stated that fleets are a demonstrated market of first resort. Regulatory support for fleet purchases and advanced vehicle infrastructure investments not only ensures the direct investments but grows markets, builds economies of scale, and speeds deployment. Another person commented that the degree to which fleets are complying with the requirements both through the normal AFV purchase and the alternative compliance program, and added that they will be working to support EISA DOE rulemaking process to establish EISA credits and create procedures and modify the database accordingly. This program will be implemented in FY 2009 for use in 2010.

Another response stated that reconstituted goals and EPAct mandates on regulated fleets provide a reasonable degree of confidence. There are noted issues, including the actual use of biofuels in flex-fuel vehicles. More monitoring and verification in this area is needed. Another concern is credit trading and whether there is enough verification of the trades and enough database analysis. One person added to this, stating that data collection and management provides a needed component to complement the growing availability of alternative fuel and vehicles and growing acceptance of them in the market that will only accelerate as petroleum prices grow faster than alternative fuel prices.

One final respondent stated that he or she was unsure, and it may depend on who uses the models. This reviewer goes on to ask whether someone who is not required to meet the goals uses the models to calculate fuel reduction goals and financial rewards.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

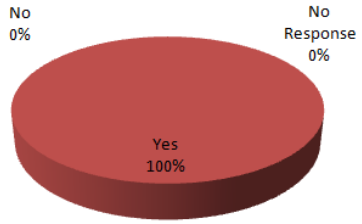
One person stated that new rulemakings and support for alternative compliance will require additional resources, while another reviewer stated that users should pay for the resources. One final respondent stated that there is always a need for additional resources to support the growing opportunities for petroleum reduction.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

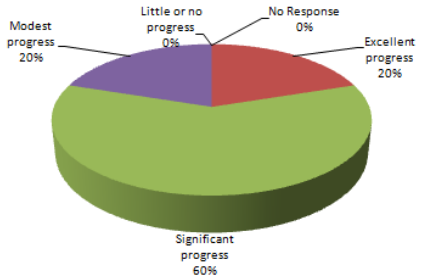
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: EPAct Data Collection and Management

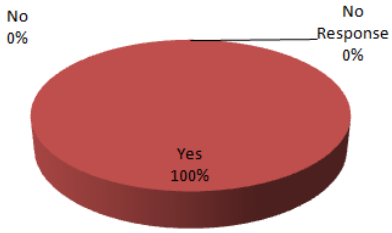
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



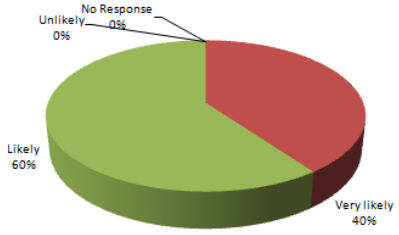
Question 3: Characterize the technical accomplishments and progress toward goals.



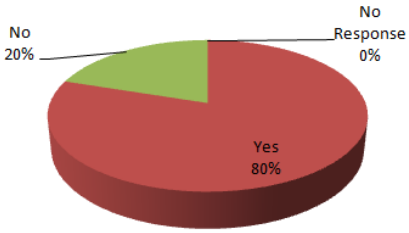
Question 2a: Are the goals of the project technically achievable?



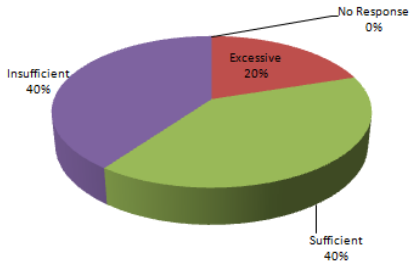
Question 4: How likely is the project team to move technologies into the marketplace?



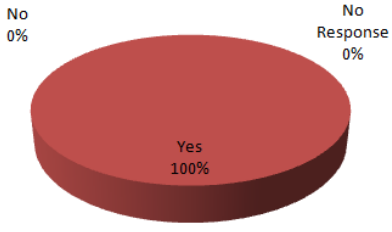
Question 2b: Have the technical barriers been identified and addressed?



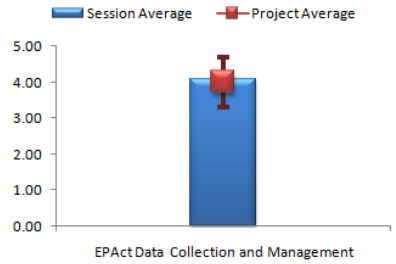
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Kum-n-Go E85 Infrastructure Project (Ben Steely of Kum-n-Go)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person indicated that the project has been demonstrably successful in installing infrastructure and proliferating the alternative fuel option. Another wrote that E85 can significantly displace petroleum. In contrast, one reviewer suggested that DOE may want to revisit the total energy costs of E85, adding that the national media are reporting that total fuel production, delivery, and usage may exceed the oil displacement benefits.

One person commented that the program is enhancing US E85 infrastructure, increasing awareness of product, and increasing demand for product. This reviewer commented that, in 2006, there was infrastructure installed at three locations (new construction), while in 2007 there were five new locations and nine retrofits. The construction, capital, siting, product availability and equipment, infancy of demand, market saturation (South Dakota), misconceptions, and obtaining public sector fueling sites are some of the barriers Kum & Go is trying to overcome as part of this project.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the barriers are well developed and identified, while another said that there is a good range of regional/local marketing strategies for increasing the number of E85 retail locations. Also, partnerships with manufacturers (e.g., GM) will help. One other individual commented that there seems to be a carefully constructed strategy for evaluating and establishing fueling sites and tracking their performance. In addition to the direct deployment activities, the project promotes additional deployment by establishing a visible business case and helping to increase the demand/market. One person cited the four new locations under construction, along with 10 additional new sites planned during 2008 and four or more at Kum & Go sites. There are currently 18 locations to date, making them the number one retailer in Iowa at this point, and ranked in the top ten on location count. This reviewer could see 40+ E85 retail stations beyond 2008.

One final reviewer felt that the deployment strategy was not clearly described.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person commented that there is a vast untapped potential market for E85, while one person stated that the project is creating numerous successful facilities, which increases the availability of alternative fuel and increases consumer and retailer understanding of the fuel. Another reviewer indicated that, in addition to public education and outreach (described below), they have installed the infrastructure and worked with other stakeholders to advance E85. They have been using YouTube, publications and other media sources to promote the product, and the Secretary of Agriculture commended them as top E85 retailer. They have planned 15 grand openings, conducted annual E85 Days, and continued relationships with other stakeholders (ALA, GM, agricultural boards, etc.). One other reviewer acknowledged that there were difficult barriers to overcome, including market limits from OEMs, but stated there were well-done press and education and outreach activities.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person noted that they are making progress, while another reviewer stated that their conclusions were based on the volume of E85 sales to date and the expansion of facilities. Another person stated that there is a significant degree of marketing being undertaken to support E85. They are installing stations and they are working with a number of key stakeholders to further the fuel in the marketplace. In addition, the data presented on fueling station growth at various locations is significant. One other reviewer cited the level of Congressional support, adding that there was significant growth shown and that the retrofit seems to have the best performance goals. This person also expressed some concern over product limitations.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

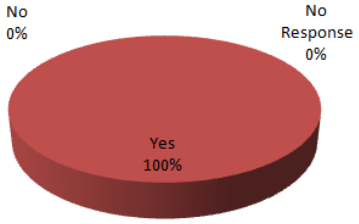
One person noted that the grant for this project is 42% with Kum & Go contributing approximately 50%, which is a significant investment by the company. As to whether the amount of resources being devoted to this project is sufficient, it is difficult to assess. Another person agreed, stating that there is not enough information to determine whether the investment in this project is pegged correctly. One reviewer stated that the break-even is 10,000 gallons. Another commented that there are never enough resources.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

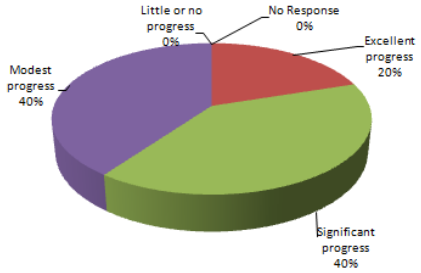
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Kum-n-Go E85 Infrastructure Project

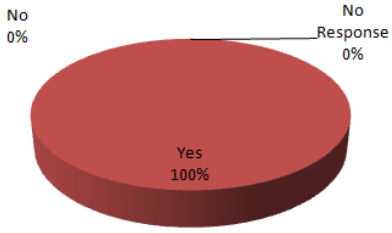
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



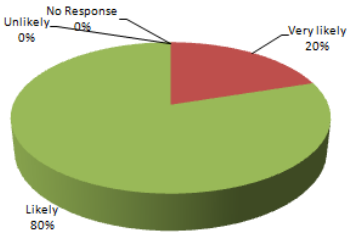
Question 3: Characterize the technical accomplishments and progress toward goals.



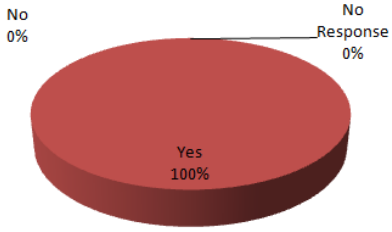
Question 2a: Are the goals of the project technically achievable?



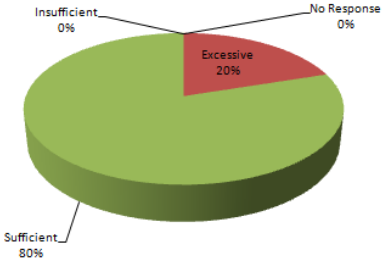
Question 4: How likely is the project team to move technologies into the marketplace?



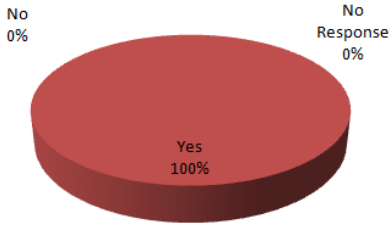
Question 2b: Have the technical barriers been identified and addressed?



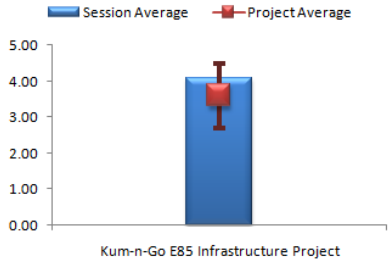
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



NBB Terminal Blending (Jill Hamilton of National Biodiesel Board)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer noted that biodiesel use displaces petroleum, while another commented that the project creates upstream supply as well as a business model for repeating the effort in additional locations. Another reviewer indicated that they have installed/modified five of six biodiesel meter blend terminals to dispense biodiesel 24 hours a day/365 days a year. The sixth entity will be doing this in 2008 after a change of location. They worked with five different vendors and were anxious to have them work with Clean Cities coalitions, since many had not done that in the past. Similarly, one reviewer cited the installation of six biodiesel blend terminals and coordination with Clean Cities. Another response simply noted that the fuel production was limited.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were generally positive here. One person commented that the initial problem in Arizona was overcome well, adding that locations are generally in areas well-suited for the use of the project. Another person stated that there was a good regional distribution of sites and also commented on the reprogramming of the original site in Arizona to Iowa.

One person felt that proper metering of terminals seems beneficial, while another reviewer felt that an upstream approach is important to the proliferation of alternative fuel options at the retail level. This person adds that creating successful terminals by leveraging federal grants not only builds fuel supply, but also establishes a repeatable model. One final reviewer commented on the 90 million gallons to be sold vs. the 31.8 million initially projected. This person noted that one of the six terminals isn't complete, and moved from Arizona to Iowa to get this project completed and meet the contract. The Florida site is already moving 28 million gallons of biodiesel; the cruise industry is its largest customer. The NYC site has biodiesel for on- and off-road applications (fleets and home heating), and has sold over 500,000 gallons of biodiesel. The Oceanside, NY has over 170,000 biodiesel gallons sold. The PA site, which opened March 2007, has sold 30,000 gallons of biodiesel. The Hartford Terminal, which opened in October, sold 30,000 gallons of biodiesel per month. The West Central site is to open in Iowa by April/May 08.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that five of six terminals are in operation and displacing almost 30 million gallons of diesel fuel, with another citing the statistic of up to 90 million gallons of distributed biofuels. One person stated that they have significantly exceeded their biodiesel distribution goals. Lastly, one person commented on the good outreach to CC coalitions, Florida yes, sales good, and goals met.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer based their conclusions on the amount of fuel already displaced, adding that terminals can go far to further educate consumers about benefits. Similarly, another person stated that the project has a 90 million gallon goal that it is on track to meet. It is establishing large-scale, quality-assured supply options and terminal business model. All of these contribute to building the

marketplace for a new fuel. One reviewer felt that they had identified the markets well and had good cost share. Similarly, another person stated that the NBB approach appears to be business-like, and they seem to have the experience and financial information on-hand to advise the industry and retailers.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

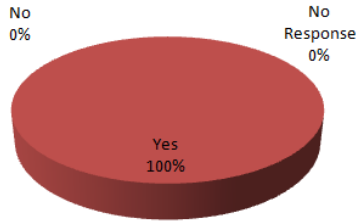
One reviewer commented that the project has successfully leveraged federal Clean Cities grants to promote other government and private investment, while another cited the 81% cost-share of this project, adding that this is significant and the DOE funding is greatly appreciated. One reviewer asked, is government investment necessary, or is there another federal role here?

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

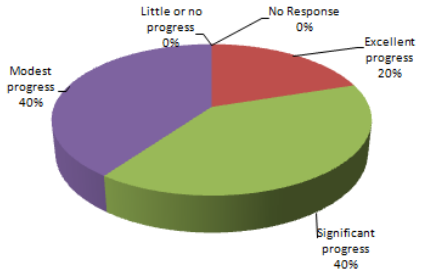
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: NBB Terminal Blending

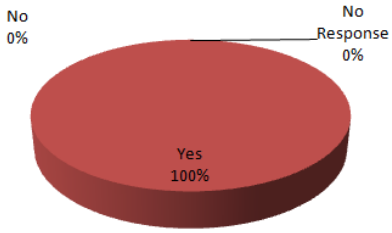
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



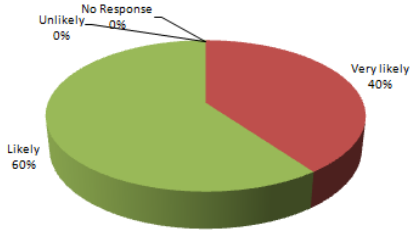
Question 3: Characterize the technical accomplishments and progress toward goals.



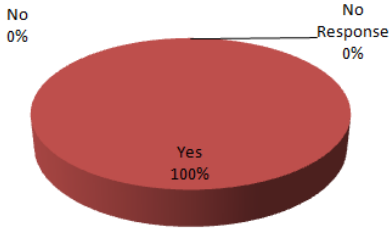
Question 2a: Are the goals of the project technically achievable?



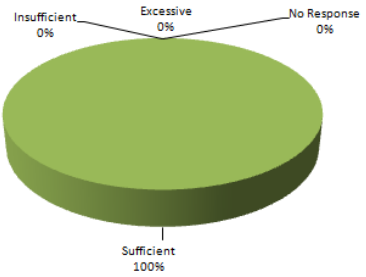
Question 4: How likely is the project team to move technologies into the marketplace?



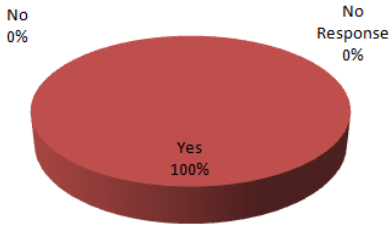
Question 2b: Have the technical barriers been identified and addressed?



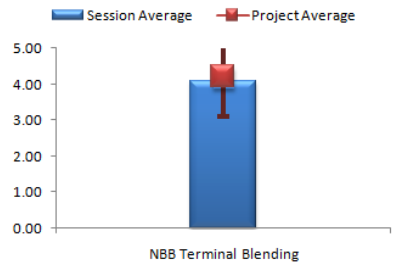
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



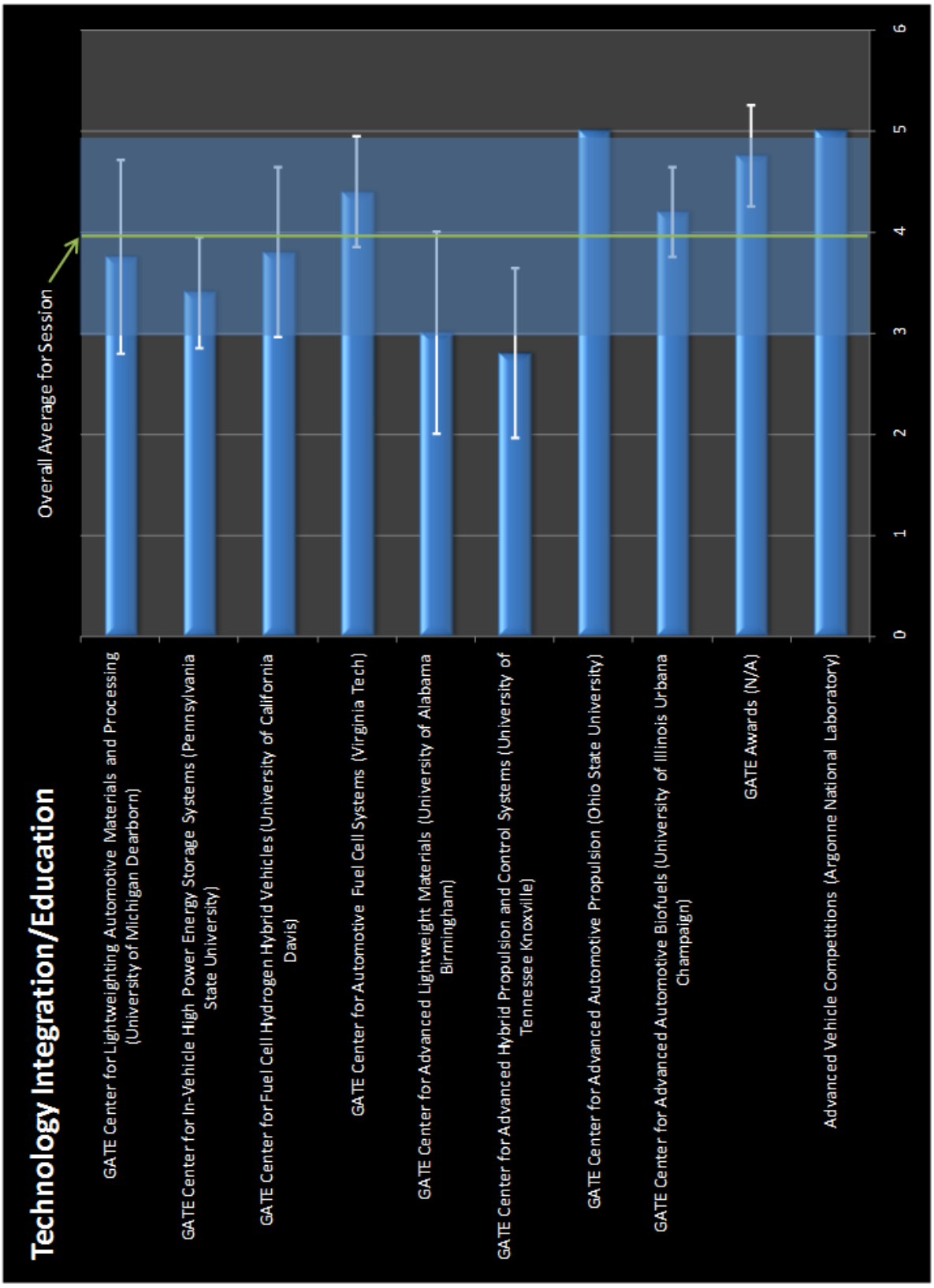
16. Technology Integration and Education

Introduction

In addition to research, the Vehicle Technologies Program supports two college-level education programs to engage some of our nation's best engineering minds in advanced transportation research. Challenge X is a three-year (2004-2007) collegiate engineering competition that offers college engineering students the opportunity to conduct hands-on research and development with leading-edge automotive propulsion, fuels, materials, and emissions control technologies. DOE established the Graduate Automotive Technology Education (GATE) Program to train a future workforce of automotive engineering professionals knowledgeable about, and experienced in, developing and commercializing advanced automotive technologies. To that end, DOE established ten GATE Centers of Excellence at nine U.S. universities that addressed fuel cells, hybrid electric vehicle drivetrains and control systems, lightweight materials, direct-injection engines, and advanced energy storage.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
16-3	Advanced Vehicle Competitions (Forrest Jehlik, Argonne National Laboratory)	5.00	0.00
16-6	GATE Awards	4.75	0.50
16-9	GATE Center for Advanced Automotive Biofuels (Chia-Fon Lee, University of Illinois Urbana Champaign)	4.20	0.45
16-12	GATE Center for Advanced Automotive Propulsion (Yann Guezennec, Ohio State University)	5.00	0.00
16-15	GATE Center for Advanced Hybrid Propulsion and Control Systems (David Irick, University of Tennessee Knoxville)	2.80	0.84
16-18	GATE Center for Advanced Lightweight Materials (Uday Vaida, University of Alabama Birmingham)	3.00	1.00
16-21	GATE Center for Automotive Fuel Cell Systems (Doug Nelson, Virginia Tech)	4.40	0.55
16-24	GATE Center for Fuel Cell Hydrogen Hybrid Vehicles (Joshua Cunningham, University of California Davis)	3.80	0.84
16-27	GATE Center for In-Vehicle High Power Energy Storage Systems (Joel Anstrom, Pennsylvania State University)	3.40	0.55
16-30	GATE Center for Lightweighting Automotive Materials and Processing (P.K. Mallick, University of Michigan Dearborn)	3.75	0.96
	Overall Session Average and Standard Deviation	**3.96**	**0.97**


Technology Integration/Education
Overall Average for Session
GATE Center for Lightweighting Automotive Materials and Processing (University of Michigan Dearborn)
GATE Center for In-Vehicle High Power Energy Storage Systems (Pennsylvania State University)
GATE Center for Fuel Cell Hydrogen Hybrid Vehicles (University of California Davis)
GATE Center for Automotive Fuel Cell Systems (Virginia Tech)
GATE Center for Advanced Lightweight Materials (University of Alabama Birmingham)
GATE Center for Advanced Hybrid Propulsion and Control Systems (University of Tennessee Knoxville)
GATE Center for Advanced Automotive Propulsion (Ohio State University)
GATE Center for Advanced Automotive Biofuels (University of Illinois Urbana Champaign)
GATE Awards (N/A)
Advanced Vehicle Competitions (Argonne National Laboratory)
0
1
2
3
4
5
6

Advanced Vehicle Competitions (Forrest Jehlik of Argonne National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive here. One reviewer noted that, in contrast to GATE (which is for graduate students), this is an excellent educational tool for undergraduate education, adding that it also offers significant technical benefits. One person commented that the hands-on experience for engineering students is vital for the training of future engineers. The program also helps validate concepts DOE has established. Another felt that these student competitions excite students to compete directly in the real-world efforts to integrate new technology into actual demonstration vehicles. One other person stated the program seeks to educate and prepare students to address transportation sustainability, energy and environment. It provides a penultimate experience with a real-world vehicle development process, and provides an excellent opportunity to students overall.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person indicated that there has been excellent oversight and management of a multi-year process, while another commented that this is an established program that has already demonstrated output. The barriers have been addressed. Similarly, one person wrote that the program follows a tried and true strategy (and has been successful for many years). One reviewer stated that the DOE Automotive Engineering Design Competition is among the best organized design competitions. The program challenges students to perform design and fabrication at a level that is comparable to major automotive manufacturers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer noted that the program demonstrated a wide variety of different powertrain configurations to solve emission and fuel economy challenges. Another stated that the competition aspect drives innovative approaches to overcoming key issues/barriers and helps to focus the technology. One response indicated that the program addresses the lack of graduating engineers who have specific and practical knowledge in areas of advanced vehicle propulsion system, adding that, to be successful, the team must be strongly multidisciplinary. Often, the DOE Vehicle Competition is the first time these students will be required to interact in a meaningful fashion with engineers and professionals from other disciplines. One final response stated that their assessment was based on the fact that student education and the promotion of advanced technology are certain outcomes.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
A reviewer commented that this program produces graduates with specific experience in advanced vehicle propulsion systems, emissions, vehicle design and integration, as well as exposure to public relations, business, economics and marketing. Another added that the training of students to enter industry or to continue their education through GATE will have significant long-term national impact. An important aspect here is that students are exposed to real-world design approaches (and disappointments), which allows them to determine their career choice in the automotive design area.

One person indicated that most concepts will at least in part be in a list of solutions to meet future regulations. Another reviewer commented that the competition focus is to move technology to a "production" feasible state.

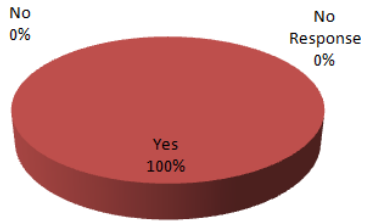
Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the money was well-spent to train students for future work and to validate technical concepts, while another added that the program offered great bang for the buck. One reviewer felt that the Advanced Vehicle Competitions (AVC) should not be funded at the expense of GATE, but stated that both GATE and the AVC merit funding increases. The payback in providing the nation with qualified automotive engineers is high. AVC should continue to seek strong industry co-sponsorship, which encourages the government-academic-industry alliance to grow new technology.

One final reviewer stated that support from DOE and other competition sponsors is at a high level. However the program goals are also highly challenging to the participating universities. The person adds, successful participation still requires substantial financial commitment from the participating universities and can sometimes present a challenge.

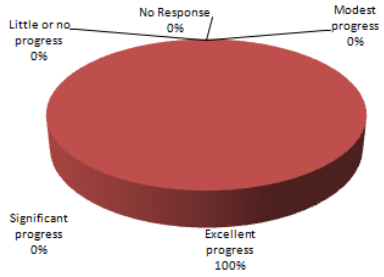
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Vehicle Competitions

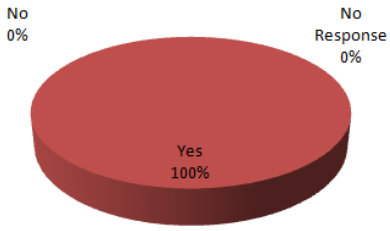
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



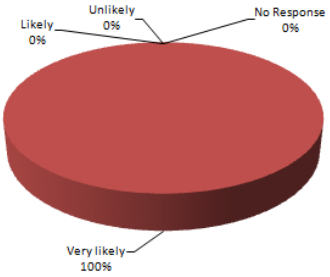
Question 3: Characterize the technical accomplishments and progress toward goals.



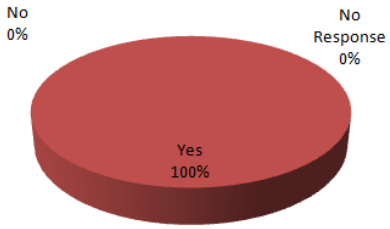
Question 2a: Are the goals of the project technically achievable?



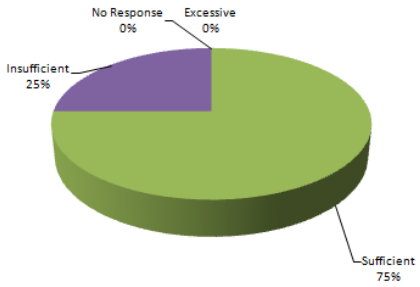
Question 4: How likely is the project team to move technologies into the marketplace?



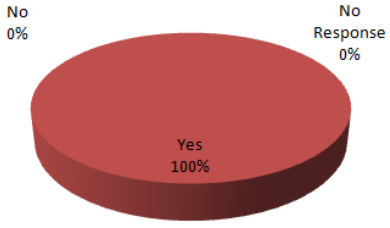
Question 2b: Have the technical barriers been identified and addressed?



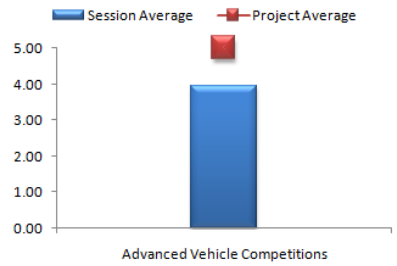
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Awards

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Reviewers provided generally positive responses here. One person stated that the project contributes to these goals indirectly through collaborative efforts with industry and academia, along with advanced course development and practical experience in advanced energy-efficient vehicle technologies. Both programs help prepare new graduates with the tools and experience to contribute immediately as new hires with OEMs and Suppliers. Another response stated the project supports Challenge X and GATE – both the educational component and the actual pre-prototype efficient vehicle design. Another reviewer added that student competitions not only stimulate technology development/integration but also prepare the next generation of engineers with the skills necessary to further this work in their future careers. One final person added that the program supports the goal to reduce petroleum consumption and reduce GHG production, and also helps address the shortage of engineers to work in the energy and environmental issues in the automotive fields.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were again generally positive. One reviewer indicated that the project was appropriate for stimulating technology development/integration and career development. Another added that the overall strategy was sound - effectiveness will be judged at the individual center level. The person added that collaboration with industry was generally very strong, but would recommend consideration of closer integration with National Laboratories, perhaps on internships. Two reviewers commented that the major goal of the project is to educate more engineers who are familiar with efficient vehicle design and who will help develop the energy sustainability issues in transportation, with one adding that the program thus has a long-term vision. The other reviewer added that the program offers excellent educational opportunities that challenge students.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer stated that the key barrier is probably funding, while another commented that the program, long-term, is essential, adding that there is a shortage of competent engineers in this area at present.

Another reviewer felt that some centers appear to have an excellent record of developing students who appear to be in-demand for key positions in industry. Some centers appear to be developing state of the art courses, while others appear to be much weaker.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Two reviewers stated the program trains new graduates and the next generation of engineers on advanced technology, with one person adding that the programs also simultaneously explore technologies that can be moved to the marketplace in the near term.

Another reviewer stated that their conclusions were based on prior experience with student competitions and their achievements. One person stated the question was not suited to this program.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Multiple reviewers stated that the program could use more funding, with one person adding that the program goals set a high benchmark, but also provide strong support. Another person stated this as "likely big bang for the buck."

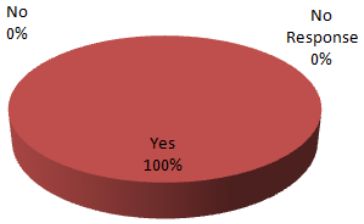
One response indicated that long-term educational output should be emphasized in the non-competitive arena. The person adds that, although in the reviews he or she checked "sufficient" for each individual school, the overall GATE funding is low when the cost of graduate education is considered. To sustain GATE, and make it significant in the eyes of educational institutions, it will require funding to be increased at the 20 to 30% level.

One final reviewer recommended additional funds that should be utilized for an internship activity where GATE Students either: (1) compete for a summer "fellowship" to work on site (for example, the summer before the students' last year) at a National Lab or Industry through a competition administered at DOE and openly competed for by students forming proposed collaborations with intended partners and/or (2) graduate student projects defined with university/National Lab/industry advisors where student spends at least one term at a National Lab and/or Industry. The reviewer also recommends eliminating duplication or redirecting the focus of some centers (e.g., there are two lightweight materials centers).

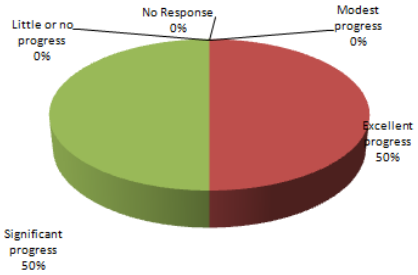
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Awards

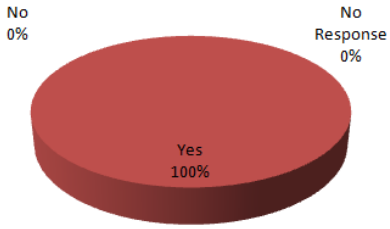
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



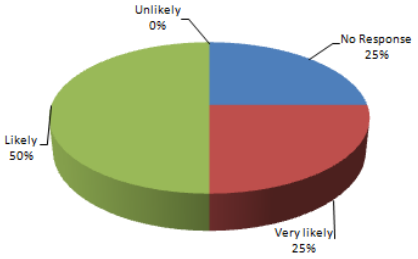
Question 3: Characterize the technical accomplishments and progress toward goals.



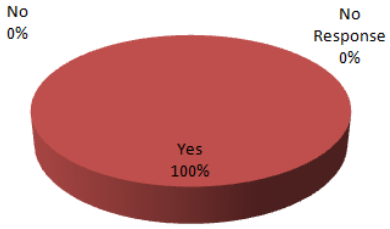
Question 2a: Are the goals of the project technically achievable?



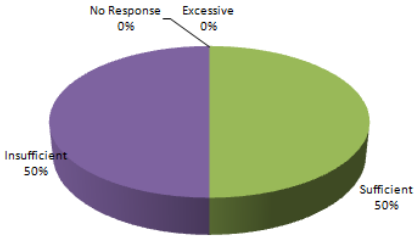
Question 4: How likely is the project team to move technologies into the marketplace?



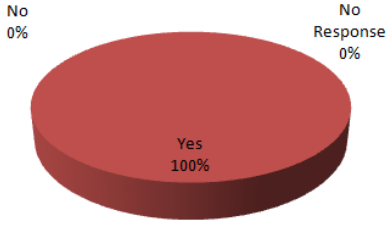
Question 2b: Have the technical barriers been identified and addressed?



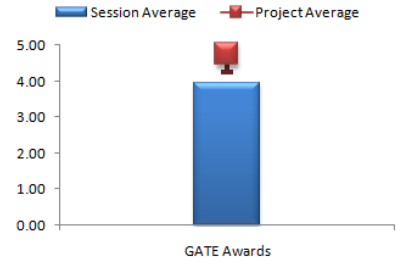
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Advanced Automotive Biofuels (Chia-Fon Lee of University of Illinois Urbana Champaign)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
All of the responding reviewers noted that advanced biofuels are clearly central to DOE objectives, specifically petroleum replacement. One reviewer noted that biofuels are an important part of DOE strategy, while another added that biofuels is a key topic and research area where there is probably a current lack of engineering expertise. One other person highlighted ignition and combustion processes, reducing GHGs, and, again, the displacement of petroleum-derived fuels.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were strongly favorable to the group's cross-fertilization between biology and fuels disciples (agricultural and mechanical engineering), with one person adding that this is essential for success and that the group importantly recognized that the combustion of biofuels is not well studied, and this area will be emphasized. Another added that this approach should help address barriers, while one person stated that this program directly addresses this agricultural and automotive industries cooperation. One final reviewer noted there was good industry support and input.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented on the good industry interface and significant publications of the group, adding that emissions was stated as a goal but not mentioned after that. Another reviewer, similarly, noted that there appears to be very strong interaction with industry, but closer ties with National Labs are strongly recommended.

Two reviewers noted that seven students have graduated from the program, with one person commenting that this was a major output, adding that the program recognizes the educational disconnect between agricultural/biological and mechanical/automotive work, and seeks to address this disconnect. The other reviewer noted that the GATE certificate in biofuels provides a focus for students and showcases their qualifications to employers. However, some courses in the certificate do address broader topics than the core focus.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
Multiple reviewers noted that the program appears to be well positioned to provide well-trained students for industry and academia, with one person adding that the research and courses on significant aspects of biofuels will provide training for students in relevant areas. Another person stated students educated in this area are likely to impact industry in the future; this is the major product, and it has a long-term benefit. There could be some immediate, applicable technology outcomes (there are some technology transfer claims). New courses will impact the student body. The Ford/Cat funded project on predicting combustion properties based on biofuel composition is valuable and will have more near-term benefit. Publication output is impressive.

One reviewer stated that it looks like good work, but without baselines and specifics of progress (against industry baselines), it is hard to measure actual progress for a number of topics. Another response commented that students are made aware of the importance of emissions and the regulatory environment that impacts fuel production and usage in the automotive industry. The program brings expertise from vehicle technologies, fuel production, combustion, agriculture, and biology. Several research programs are underway with industrial sponsors, leading to 16 archival publications and 28 conference papers. They have internships established for students to foster interaction with industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

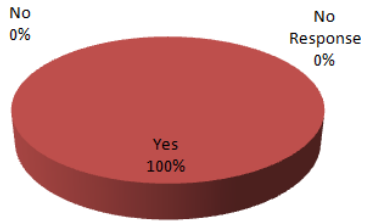
All responses noted industry support, with one person stated that the group appears to be able to partner with industrial firms to obtain additional funding. Another said that the investigators have leveraged some industry support from Ford, Caterpillar and John Deere, adding that the group has broad resources. One person stated that funding appears to be at a high level based on existing support, noting that industry support is available and that this group has broad resources. One final reviewer stated that funding was probably OK, and that industry sponsorships should help further leverage DOE funds.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

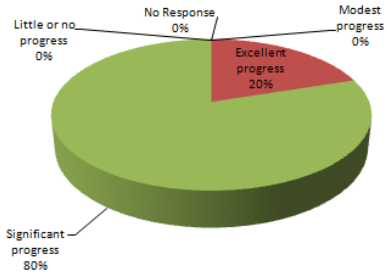
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Advanced Automotive Biofuels

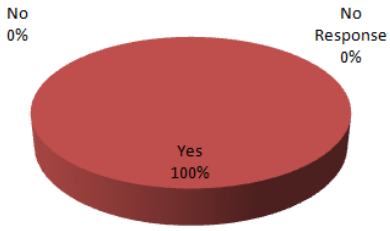
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



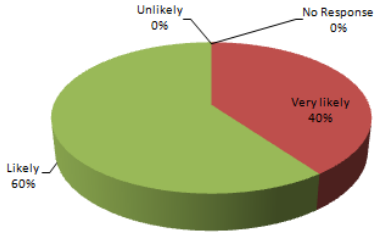
Question 3: Characterize the technical accomplishments and progress toward goals.



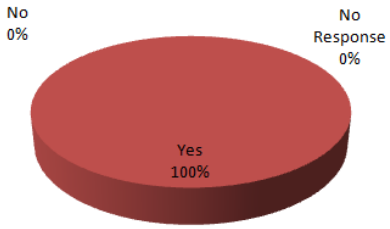
Question 2a: Are the goals of the project technically achievable?



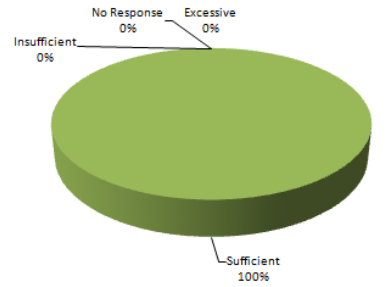
Question 4: How likely is the project team to move technologies into the marketplace?



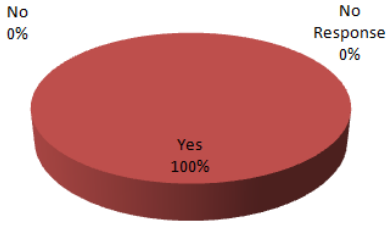
Question 2b: Have the technical barriers been identified and addressed?



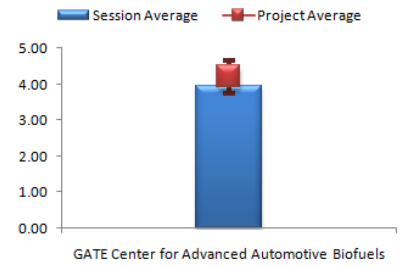
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Advanced Automotive Propulsion (Yann Guezennec of Ohio State University)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated that the scope is consistent with DOE objectives, while another noted that system integration is essential for automotive engineering optimization - so this objective does ultimately impact petroleum use reduction. One person stated that hybrid drivetrain and control systems research directly impacts potential petroleum displacement. There is also a wide focus on other key energy topics. Student/engineer training and development provides building block for future development of technologies/vehicles that meet the petroleum displacement goals. One other reviewer stated that the program addresses modeling, control and system integration of advanced automotive propulsion systems, and system integration is the overarching theme. This person added that the program focuses on advanced combustion, advanced energy storage systems and other traditional areas, but with a system integration focus.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were generally positive for this question. One person stated that there is a very strong team at OSU, and a high degree of leveraging of funding, adding that there are no clear technical barriers to identify in the area (it is more steadily developmental), but sufficiency in funding was identified as a barrier. Of course, the reviewer adds, every educational institution is hungry for more resources. Another person felt that the program appears to have very broad depth, multiple university disciplines (departments), leverage of resources, and international guest researchers and lecturers. There is unique course development! The program also offers distance learning opportunities.

Two reviewers noted that funds were highly leveraged with industry sponsors. One person added that the program laid out key barriers - funding (need funds to support longer term graduate student commitments). The program shows a good focus on getting students involved in the progression of technology development through integration/demonstration. The other felt that there is a high degree of leveraging of other funds to boost the number of graduate students graduated from the program. The multidisciplinary approach builds on core science, engineering science, advance engineering product engineering and ultimately to product engineering. Students are involved in core science, but their project is brought all the way through product engineering. Classes are taught across disciplines and the program utilizes team teaching of courses to accomplish goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Again, responses were generally positive, with one person noting that there was good placement of students within industry, and the program offers distance learning opportunities for OEMs. Another commented that OSU had "success metrics" in the presentation - they understand GATE and how it can be integrated into a larger program. Multi-department work is important. Building "real vehicles" (e.g. Bonneville fuel cell vehicle) is a great training ground, and can be used to verify/enhance teaching & modeling tools – it grows the students, but not necessarily the technology. One person highlighted the program's stress on system integration, adding that industry participation helps

develop well-rounded engineers that understand the key aspects/barriers for integration of laboratory technologies that meet the demand of the marketplace. Another noted that the synergy with automotive design competitions is a plus of the program. The program has a focus on building real vehicles, which is the best method to teach system integration.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person stated that the product is student output and education - and OSU is certainly successful. The output in distance learning is noteworthy. Secondary benefits may arise from some of the research - e.g. battery ageing work. Plug-in hybrid understanding (e.g. grid impact) is valuable for students to have a more holistic view of energy use. One reviewer stated their conclusions were based on the program's focus on integration and demonstration as well as core technology development. The person also commented on the development of actual vehicles (puts the technology to the road). One final reviewer stated that the goal is to place as many Ph.D. and Masters-level scientists into industry as possible. There are well defined metrics to assess the success of meeting this goal. The person also stated that a secondary benefit may be achieved by virtue of the research topic and projects that Ph.D. and Masters students complete.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

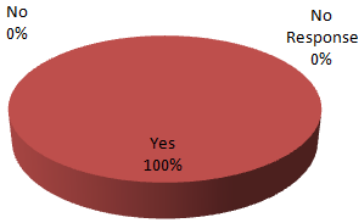
One person indicated that this is a strong program with several senior investigators – so there are resources available to them beyond DOE GATE. Challenge X synergy is a plus. "Sufficient" was checked in the interests of retaining an appropriate number of GATE schools under the constraint of a fixed overall budget. All of the GATE schools merit some increase to compensate for clear, recent rising costs. One other reviewer felt that there is a good leverage with industry sponsors, and it appears to be good program.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

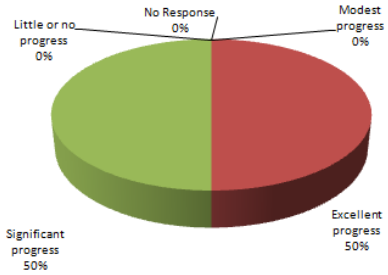
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Advanced Automotive Propulsion

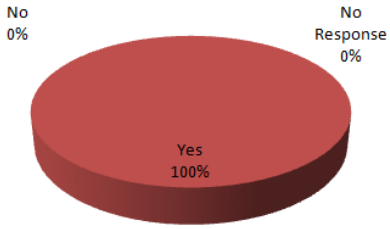
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



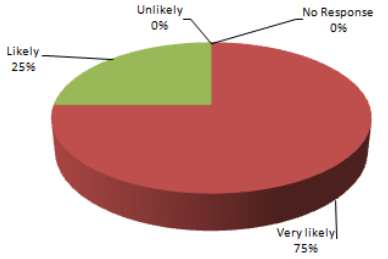
Question 3: Characterize the technical accomplishments and progress toward goals.



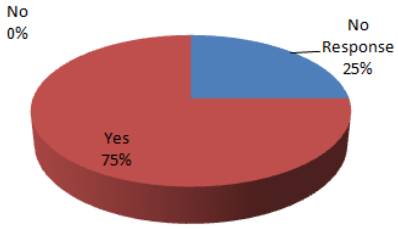
Question 2a: Are the goals of the project technically achievable?



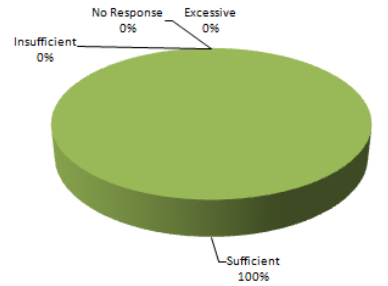
Question 4: How likely is the project team to move technologies into the marketplace?



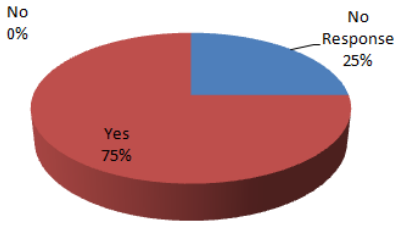
Question 2b: Have the technical barriers been identified and addressed?



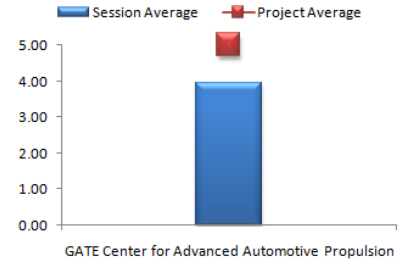
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Advanced Hybrid Propulsion and Control Systems (David Irick of University of Tennessee Knoxville)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive to this question, with one person stating the program was within scope of DOE's objectives, while another indicated that the hybrid vehicle GATE center supports efficient vehicle design. One person stated that the research and teaching topics are relevant to reduce petroleum usage, and another added that the hybrid drive and control system research is directly related to the DOE's petroleum displacement goals. One final review noted that the center focuses on hybrid systems. The focus is on hybrid drive trains and control systems, and there are four areas of focus.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Two reviewers commented that the program had a strong GATE history, with one adding that it was oriented to student training, with strong industry collaboration. The other also noted that the goal is to overcome technological barriers preventing the development and production of cost effective, high efficiency vehicles in the U.S. market. The approach is to train a future workforce of automotive engineering professionals knowledgeable about developing and commercializing advanced automotive technologies.

Other comments were less positive, with one response indicating that two of the three courses do not appear to be "special" or unique to the topic of GATE focus. Similarly, one person felt that the program seems to adequately address the necessary curriculum and program requirements – but didn't seem to feature anything unique that would set it out from the rest of the program. This person added that there is a low student count - due to uncertainty of funding – and that the program needs more sponsoring partners. One final reviewer added that the course development seems limited compared to the best in class. Courses, limited as they are, do not seem to be in demand. There appears to be modest leveraging through other organizations. Progress is negatively impacted by facility issues that necessitated relocating dynamometers to temporary locations; a permanent relocation will occur in coming months. There is significant recent growth in leveraging funding.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Multiple reviewers commented that there are a low number of students and a lack of unique courses, with one person stating that the courses are fairly generic (e.g. IC Engines), but are suited to training students for the workforce. Another commented that the activity level appears low relative to the best in class, but that it appears that the GATE designation has opened the door to projects from other funding agencies. One person noted that the investigator acknowledges that student count is low but steps are underway to recruit new qualified students. Another response stated that the program seems to be holding its own - but not grow or excelling. Projects seem to be too diverse, not integrated and focused to core program. They seem to take what they can, but don't have the prestige to pull in key sponsors and projects. This ability would greatly improve their knowledge and ability in the core program area.

One reviewer stated that the objectives are well-defined - including course development. GATE fellows are working on a biodiesel project, which is not hybrid vehicle oriented, but still meets DOE's needs to reduce petroleum consumption. To contrast, another person stated that the heavy fuel and biodiesel projects do not relate to focus.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

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Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One respondent stated that course development, leveraged funding, and the number of students are a bit limited compared to best in class. Multiple reviewers commented on this issue of leveraged funding, with one stating that the GATE center is meeting the goal of training students for the energy industry, but should seek more tightly focused co-funding if the hybrid design aspect is going to be emphasized. Another stated that not enough outside funding is being generated to adequately leverage DOE dollars.

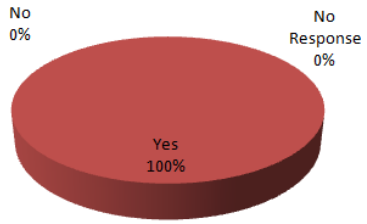
One reviewer stated that UT should develop more unique courses and also have more recognizable industry partnership contributions to course development related to GATE focus. One other person commented on the interaction with external partners for several research programs supporting the GATE program, totaling $1.7 million. This person indicated that collaborative research projects associated with GATE program could seek to be more focused, similar to earlier responses.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

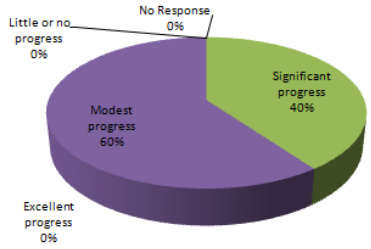
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Advanced Hybrid Propulsion and Control Systems

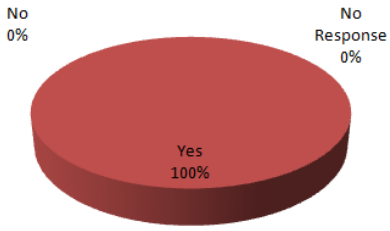
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



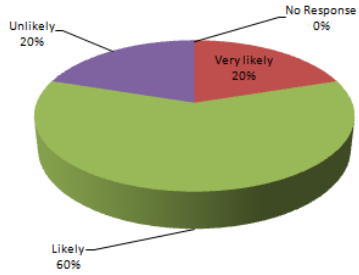
Question 3: Characterize the technical accomplishments and progress toward goals.



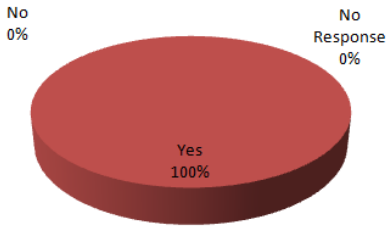
Question 2a: Are the goals of the project technically achievable?



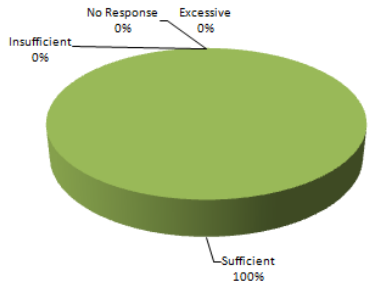
Question 4: How likely is the project team to move technologies into the marketplace?



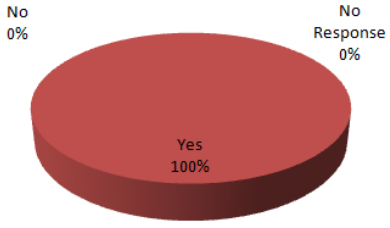
Question 2b: Have the technical barriers been identified and addressed?



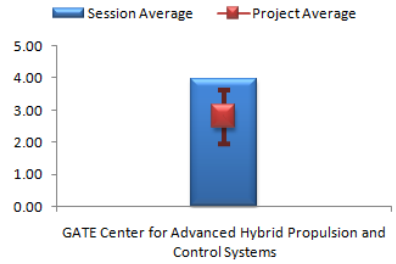
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Advanced Lightweight Materials (Uday Vaida of University of Alabama Birmingham)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person noted that the program took a multidisciplinary approach to understanding automotive research and education problems, citing the collaborations on impact modeling. This reviewer added that vehicle weight reduction emphasis is an important area. One response stated that the program seeks to develop materials which can improve the efficiency of vehicles through weight reduction using advanced composite polymers and plastic materials, and that it is successfully moving expertise into the marketplace through the graduation of students with the necessary expertise to make near-term contributions to this area of research and product development. Another added that knowledge and use of lightweight materials would help reduce petroleum usage, while one person chose to highlight the program's student training and technical development.

In contrast, one person stated that, while the benefits of the program appear mostly through training students, it was not clear that there were significant advancements of technology. The person added that the applications mentioned were not within the scope of DOE's priorities (e.g. transit buses, guardrails).

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Multiple reviewers indicated that they liked the idea to expose and create interest in high school students. Separately, one person added that the structural composites projects for guardrails and transit applications did not appear to have a significant impact on energy consumption, and also that the value of partnering with ORNL was clear but the activities were not well explained or documented. Another reviewer commented that the program had coherent objectives for the recruitment of students, that an advisory board had been established, and that they were developing relevant courses. One final reviewer stated that the deployment strategy addresses interdisciplinary cooperation to access the necessary expertise from multiple engineering disciplines, and that the program has also identified several applications/markets for technologies and materials under development. This response also noted the automotive certificate and the biomedical courses being offered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Responses to this prompt were somewhat mixed, with one reviewer noting that he or she would like to see the scope of materials and processes expanded, and another commenting that the program was still early in process. Another noted that they have worked to build industry collaborations through direct interactions with students and industry, as well as conferences and workshops. This reviewer also noted the alliances with ORNL.

One person commented that industry collaboration is important, and is growing. Alabama appears to offer good opportunities for local industry interaction, and there is progress since the last review. However, this reviewer added, not all collaborations are geared to weight reduction or vehicle

efficiency. Another person commented that the specifics are only generally touched on, and that the program sounds promising but was the presentation was light on specific details and Q&A. There are lots of project areas, but no specific goals to measure concrete progress.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person commented that their response considered mostly the graduation of students, which they feel to be a major objective and output. The reviewer added that applied topics appear to have direct relevance to industry.

There was some disagreement regarding deploying the resultant technologies, with one person indicating that the products developed may find their way to the marketplace, and another reviewer stating that the program has identified several segments of the market that can benefit from the development and technologies. One person specifically noted their example of an application for transit buses. To contrast, another reviewer indicated that it was hard to tell the baseline of the technologies that improvements are compared to. Also, this person stated that there was not much detail on the group's ability to integrate new technologies in a high production setting (real factory).

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

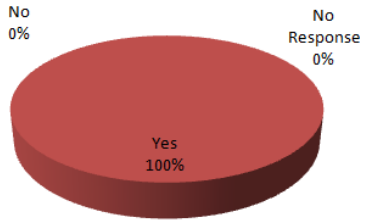
Multiple reviewers commented that the investigators are starting to leverage the available project funds to acquire additional external funding, with one person indicating that they seem to leverage DOE funds well. One of these reviewers additionally commented that the program leverages industry collaborations to directly support GATE interaction with students, while another noted that investigators might consider carefully the balance of resources between general automotive/materials engineering topics and the specific emphasis on lightweight materials. One reviewer stated that it was hard to tell how much more bang would be associated with additional funding. One final reviewer stated that, in general, the developed courses do not appear to be significantly unique or advanced to require additional resources for development.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

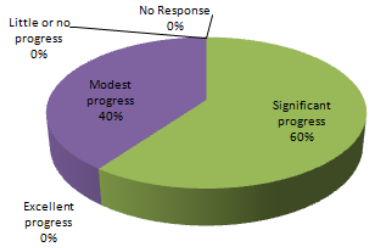
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Advanced Lightweight Materials

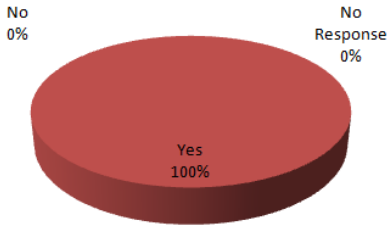
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



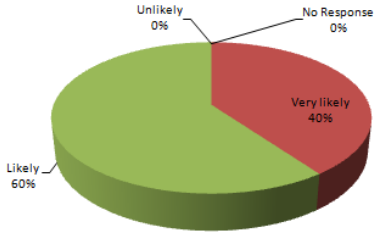
Question 3: Characterize the technical accomplishments and progress toward goals.



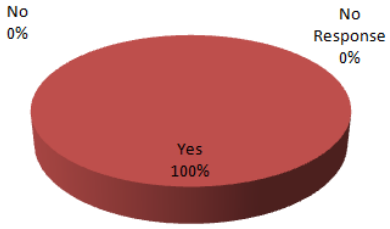
Question 2a: Are the goals of the project technically achievable?



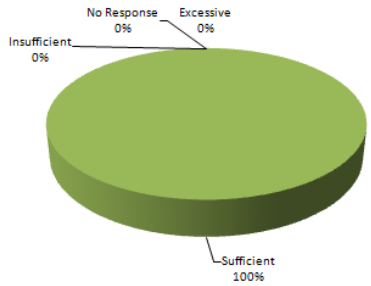
Question 4: How likely is the project team to move technologies into the marketplace?



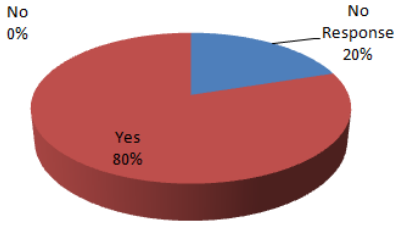
Question 2b: Have the technical barriers been identified and addressed?



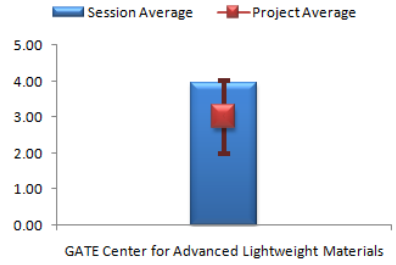
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Automotive Fuel Cell Systems (Doug Nelson of Virginia Tech)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Responses were generally positive, with multiple reviewers stating that hydrogen and fuel cells would help displace petroleum for mobility and is highly related to DOE goals. One person stated that fuel cell systems are clearly central to DOE's objectives towards petroleum displacements. Similarly one person wrote that the center emphasizes fuel cells – a long-term solution to oil displacement. One final response indicated that the program emphasizes overcoming technical barriers for hydrogen fuel cells, high efficiency vehicles in general, and also addresses hybrid vehicles. The program is focused on clean domestic fuels and energy security, with multidisciplinary learning opportunities. The program engages students in applied automotive research in fuel cell technologies for vehicles.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person stated that the group's approach utilizes university and industry leveraged resources, as well as NSF center funding – this is clearly defined and seemingly very effective. The involvement of multiple university departments appears to provide beneficial multidisciplinary approach, and there is a strong development of unique courses. Another reviewer commented that there is a need for engineers in hydrogen / fuel cell industry & research – this is identified. Graduation of engineers is primary output. This is achievable. Separately, the program has identified technology barriers in the fuel cell area.

One response stated that there was good interfacing with various different departments and areas with VT that mirrors what industry must do. Another stated that the multidisciplinary focus is important toward the achievement of goals and overcoming barriers for implementation, but felt that the group could use more government lab interaction.

One final response said that the program seeks to address the lack of engineers, and also to address energy sustainability in transportation. Also, OEMs lack some technologies and materials that are needed to bring fuel cells to market. The program takes a collaborative approach between academic departments: mechanical engineering, material science, engineering science and mechanics department. This collaboration is key to success.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
Responses were generally positive, with one person stating that this is a well thought out program with diverse expertise and leveraged externally. Another noted that curriculum development, recruitment, research, publication and information dissemination are all identified as goals and are being achieved. There is an integrated research plan. One person chose to highlight the number of students moving to automotive firms, and also on the detail of research. Another added that courses and research support improvement in membrane durability of fuel cells. Research is conducted in conjunction with industrial sponsorship. There is an integrated research plan.

In contrast, one person stated that there was no discussion of specific barriers that need to be overcome. It is hard to quantify actual progress – no baselines were provided to measure progress and or potential end goals (energy saving) potential for research gains.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer stated that their conclusions are based primarily on the program developing well-trained students. Another stated that the primary product is information output and the graduation of well-educated students – there is strong evidence of success. The course hours completed are substantial, adding that there may also be real-world impact from the research on membranes and water removal, but other projects are more learning exercises in system design. One response stated that VT is addressing via research some of the major challenges that need to be solved to make fuel cells viable for transportation. One person stated that the product of this program is graduation of students who have been exposed to the issues of energy sustainability in transportation. The program gives students the expertise to have an immediate contribution upon graduation. There may also be a real-world impact through the industrial collaboration through research projects.

One final response stated that it seems impressive but hard to quantify actual progress - no baselines to measure progress and or potential end goals (energy saving) potential for research gains. It is mostly confined to students entering workforce and publications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

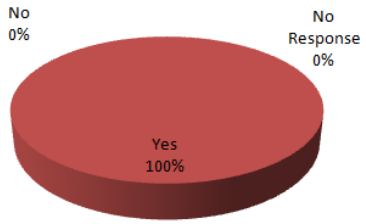
One person noted that the program is levering GATE funds and industrial research sponsorship, while another felt there was a good partnership with industry and the general automotive community. A response commented that there is synergy with other research programs, and there is some added support beyond DOE GATE. There are ambitious plans for the next year, but these are probably attainable using the expected resources. One final reviewer stated that the group seems to be making good progress with current funding, but it is hard to tell what additional "bang" will be derived by more "bucks."

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

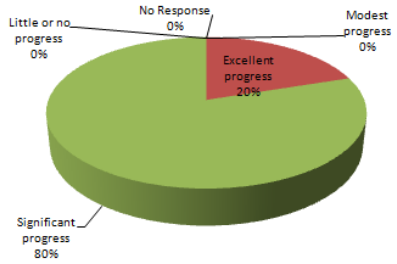
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Automotive Fuel Cell Systems

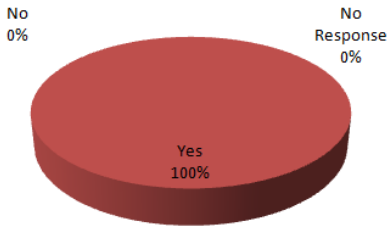
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



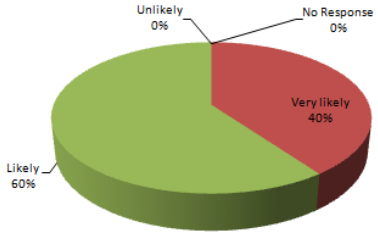
Question 3: Characterize the technical accomplishments and progress toward goals.



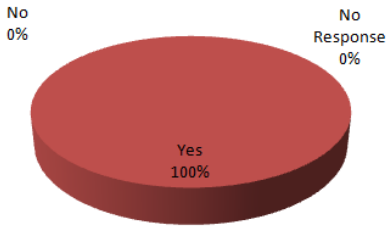
Question 2a: Are the goals of the project technically achievable?



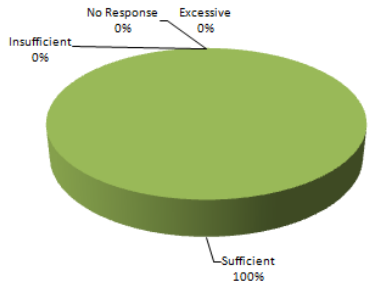
Question 4: How likely is the project team to move technologies into the marketplace?



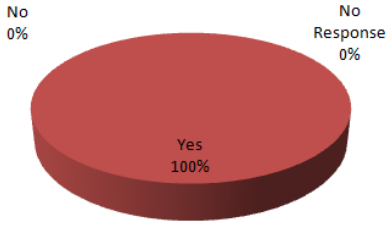
Question 2b: Have the technical barriers been identified and addressed?



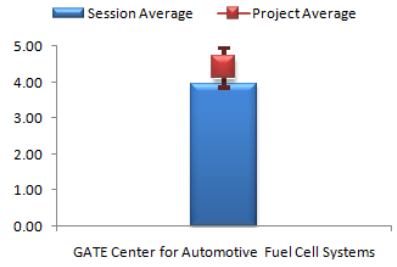
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Fuel Cell Hydrogen Hybrid Vehicles (Joshua Cunningham of University of California Davis)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated that the program was within the scope of DOE's objectives, while another added that the fuel cell and hybrid emphases both support alternative, efficient propulsion systems. Similarly, another person felt that the research areas are all directly relevant to DOE goals and to the eventual displacement of petroleum - especially inclusion of infrastructure issues. One other stated that the program's goals focus on training future engineers in the areas of fuel cell, hydrogen and hybrid vehicles. The reviewer added that the program also stresses the policy aspect.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One person stated that education is the main output, noting that the center recognizes the shortage of skilled professionals. Another added that there is an extensive list of areas for study that should prepare students for the future. One person indicated that there was a good layout and understanding of overall program goals and objectives, and a good multi-disciplinary approach. The person also noted the focus on component, system, and infrastructure (the infrastructure is a key point that other centers seem to be lacking), adding that the program needs more industry (OEM) sponsorship and interaction. One response commented that there are not currently enough students that know how to do integration of mechanical and electrical systems in hybrid vehicles, and that there is also not enough graduating students who have an understanding of policy aspects. Program is cross training for transportation leaders, as it attempts to expose students to fuel, vehicle, engine, fuel production and transportation policies.

One other person felt that the combination of two previous centers is appropriate and beneficial, and the opportunity to integrate policy context with technology appears unique and beneficial. The cooperation of multiple engineering departments and ITS offers unique breadth, and the program appears to offer unique classes although perhaps not as many as some other centers. There is good leverage with California Energy Commission. There is also beneficial consideration/coordination with PHEV/Grid interaction, and the creative competitive student selection process is cost-shared by non-GATE research grants.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that there was a good layout of research plan components but little description of actual projects and progress toward project completion. Another stated that the number of students appears to be lower than most programs.

One person stated that GATE program activities are strongly integrated with overall UC Davis activities in these research areas. This indicates a high level of integration of the GATE program into the overall UC Davis curriculum and research focus. Another noted that it is difficult to separate the GATE activities and outcomes from UC Davis broader activities. For example, STEPS alone dwarfs

GATE. This is positive because it implies high leverage, but it also makes it more difficult to quantify how the GATE funding specifically helps. There is an impressive continuity in student graduation.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One person indicated that there is a competitive process (promoting quality) for GATE scholar recruiting – and students will be the main output. The students are obliged to show that their research will satisfy the GATE objectives as part of the application. Another also stated that the product is education and that the program graduates students who have expertise not only in technologies and core science related to hydrogen and fuel cell vehicles, but also transportation policy implications. The high level of integration of the GATE activities with broader UC Davis programs and curriculum enhances the likelihood of achieving this goal. The reviewer adds that there is a competitive application process to be a GATE student, and students are required to develop an integrated research plan.

One other person stated that there is a broad range of focus areas - but felt that there was little specific information on the ability to move research into the marketplace.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

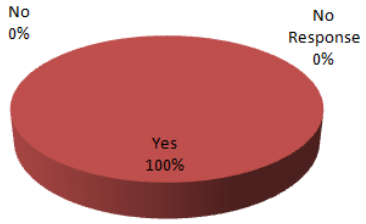
One person stated that the partnerships developed aid this effort greatly, while another felt that the program needs more industry sponsorship to leverage DOE funds. One person felt that the program was leveraging existing programs and laboratories at UC Davis, as well as external partners. One final person commented that UC Davis is a giant in the advanced transportation research area. The presentation showcased UC Davis broadly. However, this reviewer has no doubt that the GATE funding is facilitating some adventurous research (including economic issues), and there is good evidence of course development.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

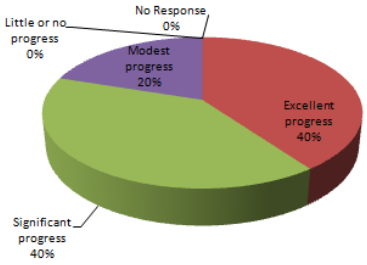
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Fuel Cell Hydrogen Hybrid Vehicles

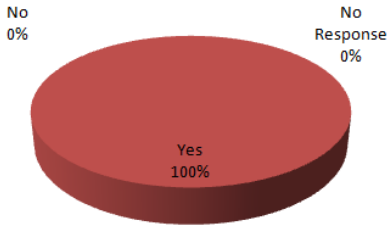
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



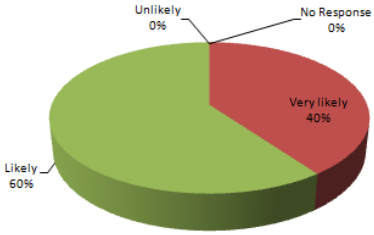
Question 3: Characterize the technical accomplishments and progress toward goals.



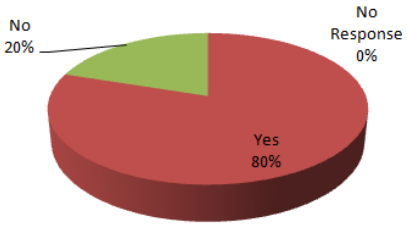
Question 2a: Are the goals of the project technically achievable?



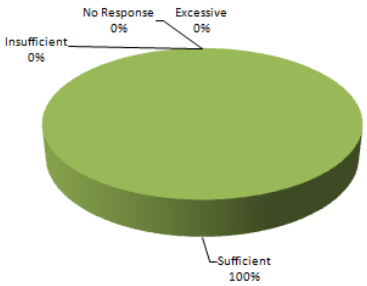
Question 4: How likely is the project team to move technologies into the marketplace?



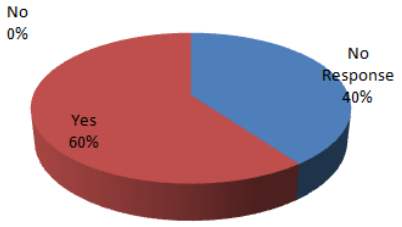
Question 2b: Have the technical barriers been identified and addressed?



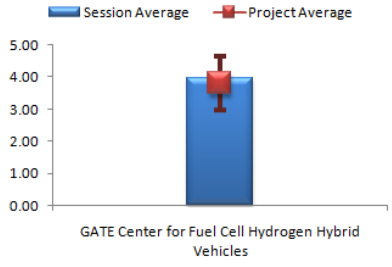
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for In-Vehicle High Power Energy Storage Systems (Joel Anstrom of Pennsylvania State University)

Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person stated that the scope aligns with DOE objectives, while another commented that energy storage systems are directly applicable technologies toward the ultimate goal of petroleum displacement. Similarly, one response indicated that the energy storage emphasis addresses a critical area in hybrid vehicle design, which in turn addresses vehicle efficiency. Another stated that energy storage is important aspect of hybrids and fuel cell vehicles. One final reviewer noted the focus on a graduate curriculum for high power in-vehicle storage for hybrid electric and fuel cell vehicles: batteries, capacitors, flywheels. The program is developing an integrated systems approach to energy storage.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that there is a strong group of faculty members, with an established structure, and there is also an established GATE curriculum. Another stated that the unique curriculum (energy storage) was a positive, but that not much national lab interaction and industry sponsorship is visible. One person stated that they were not sure why diesel combustion and emissions was part of PSU's GATE program.

A reviewer stated that the inclusion of flywheels for energy storage is unique, and that hardware in the loop appears to be unique. The program's course development seems a bit limited compared to the best in class, but the exchange program with a university in Spain is beneficial. The program stepped up recruiting efforts to get back on track in the number of students. This is the only Energy Storage center, but leadership in the technology is not clear. One reviewer stated that their approach builds on the synergy of electrochemical, composites manufacturing and the Center for Dielectric Studies. They have added power electronics, diesel combustion and emissions, and Hybrid and Hydrogen Vehicle Research Center. There is a strong team of faculty with an established organization. There is a well established and defined GATE curriculum that focuses on energy storage. The reviewer also noted that all "GATE Fellows" must follow the GATE Curriculum and develop a research theme in energy storage. Other students can take the GATE Curriculum, but without having a restriction on their research topic.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person noted that GATE Fellows have research specifically in energy storage, but other GATE students can take GATE courses – this provides two pathways for student education. Another felt that the number of students is adequate and the courses appear to be new or different than they were without GATE. Another person commented that the program seems to address student development – but was concerned that there was not much discussion of specific technical projects and progress. One final reviewer stated that the synergy with the DOE Advanced Vehicle Competitions is a positive feature.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Multiple reviewers were interested in the support and placement of students, with one person stating that they based their conclusions on placing well-trained students. Another noted that 18 GATE fellows have been funded, adding that the research topics are important and relevant to vehicle design. There is good publication output, but it is not clear how much the GATE fellows are exposed to industry. One other reviewer stated that the output is students who are specifically educated to address energy storage for HEV and fuel cell vehicles. The person adds that the well structured GATE curriculum enhances the success in achieving this goal. There is a long list of industry research relationships, as well as outreach to local festivals and industry conferences and workshops. The program plans to expand interaction with local industry in the involvement/sponsorship of GATE program. Overall, the emphasis is on students.

One person stated that publications and partnerships with industry and other government agencies make the GATE involvement valuable and useful in training. One person felt that there was not much presented that deals with the direct movement of technologies to the marketplace (other than FutureTruck competition vehicles).

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that PSU / PTI understand how to leverage GATE funds. There are related programs that fund additional students. GATE and Challenge X offer synergy. Another agreed that the program leverages other federal, state and industrial funding. The program has a strong record of support from industry sponsors to support curriculum with software licenses. One response stated that the number of courses is not too large, but the partnerships with domestic and overseas organizations provide very valuable experience.

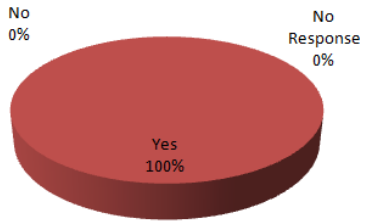
One final reviewer indicated that there was no specific indication of how much leverage there was from outside and industry sources (other than "good"); listed names, but no idea of how much funding is provided from each sponsor. The person added that this funding seems to be more "in-kind" and product and product support sponsorship, and that the program overall seems to be student-limited (availability) not funding.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

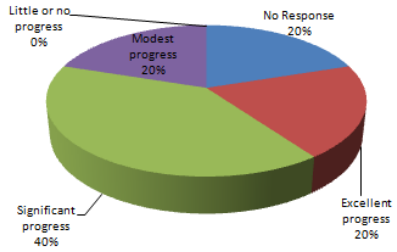
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for In-Vehicle High Power Energy Storage Systems

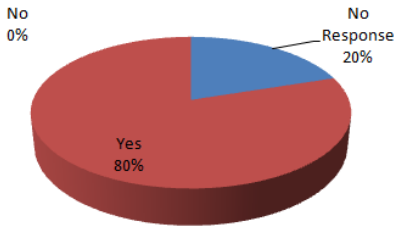
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



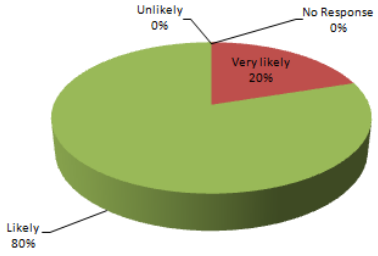
Question 3: Characterize the technical accomplishments and progress toward goals.



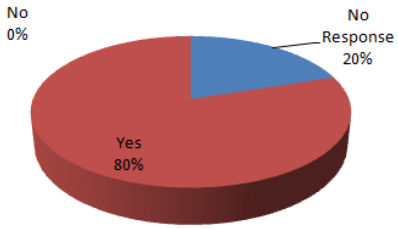
Question 2a: Are the goals of the project technically achievable?



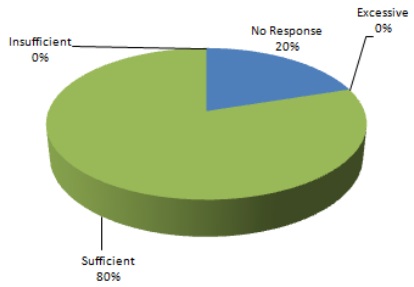
Question 4: How likely is the project team to move technologies into the marketplace?



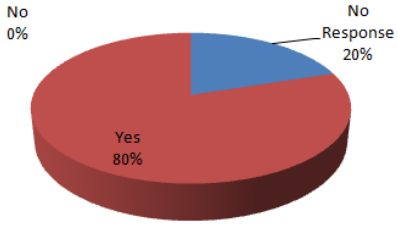
Question 2b: Have the technical barriers been identified and addressed?



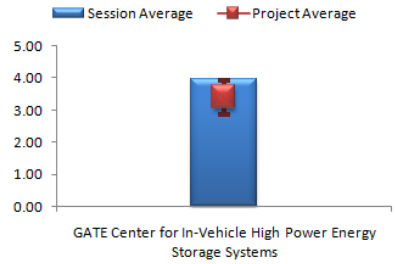
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



GATE Center for Lightweighting Automotive Materials and Processing (P.K. Mallick of University of Michigan Dearborn)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
Comments here were generally positive and focused on improved fuel economy. One response noted that the lightweight vehicle emphasis supports improved fuel economy, while another wrote that CLAMP is directly related to reducing fuel consumption on new vehicles. One reviewer stated that improvements to lightweight materials directly relate to the DOE petroleum displacement goals. This person added that, while not as glamorous as other technologies, it facilitates efficiency improvements for all vehicles (regardless of drive train). Similarly, one final respondent commented that the program focuses on lightweight automotive materials and processing to improve vehicle efficiency. Their goal is to create a university/industry/government education and research center, with an emphasis on training graduates and transferring technology to industry.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses were again generally positive here. One reviewer stated that their products are research/information and qualified student output, adding that the courses and research topics are well suited to the objectives, and the thrust into fuel cell materials is novel. Another person commented that the program is somewhat unique with respect to advanced materials and the educational process.

One person noted that the presentation directly addressed how they were going to address key barriers to increase energy efficiency through the use of advanced materials for weight reduction. This person added that inclusion of manufacturability is a key benefit, as it is not just finding high-strength materials, but also about how to economically manufacture vehicles using these materials that is important. Another added that there appears to be a good focus of curriculum and graduate research related to lightweight materials for vehicles. This person added that the program may benefit from some courses focusing on the implications of lightweight design of vehicles to include safety implications as well as manufacturing processes.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One reviewer commented that courses and projects directly relate to GATE focus, and UM-D is also involving industry speakers in programs. Another stated that one positive of the program is that it seems to have a large number of students and their research appears to be directly meeting the advanced material needs of industry.

One other reviewer felt that there appears to be a good grounding in the coursework, and even in the materials area, but indicated that UM-D may want to be clearer about the focus on the specific issues related to lightweight design. (This person adds that this is a generic GATE concern, not limited to UM-D – which courses should be in the core curriculum, and which should be GATE supported? If the core is not supportive enough of the topic area, the GATE resources may not be directed at the topic area closely enough.)

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Multiple responses commented on the fact that UM-D is graduating students, with one adding that this is the main objective, so there is already measurable output. Papers have also been published. Another stated that training of advanced materials engineers will be a vital component to meeting new CO_2 reduction regulations. Similarly, one reviewer stated that the output is the transfer of knowledge/information to industry and qualified graduates in the field of lightweight automotive materials. The program also seeks to enhance continuing education of practicing engineers through seminars and colloquia. They have developed a database on material properties, processing and test methods that has been made available to industry through web-based resources, along with conducting regular seminars and symposia. Another person stated that a positive of the program is that it has already demonstrated results in the transfer of advanced materials knowledge to industry.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

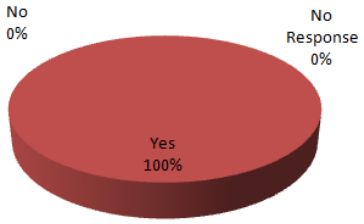
Responses to this prompt were generally positive. One person stated that UM-D appears to be using GATE funds directly on GATE focus courses and research. Another felt that the program is succeeding at the present funding level, adding that faculty are seeking external funding in the materials / GATE area. Similarly, one person stated that the program has good industry support that leverages DOE funding. One final reviewer noted that there are multiple proposals in development to augment the GATE research areas.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

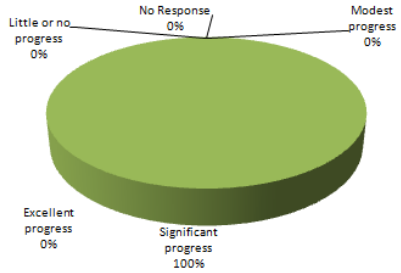
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: GATE Center for Lightweighting Automotive Materials and Processing

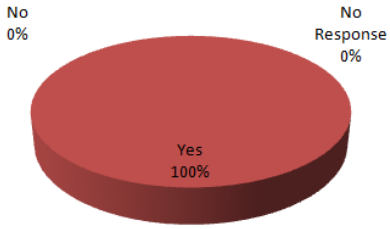
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



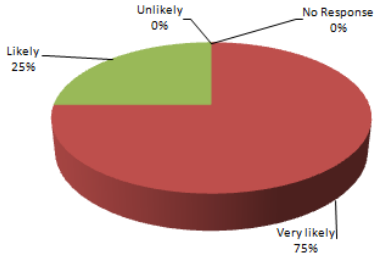
Question 3: Characterize the technical accomplishments and progress toward goals.



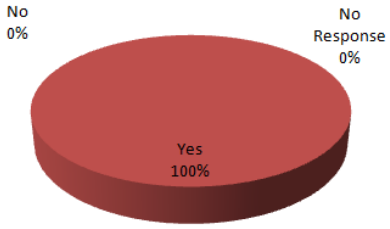
Question 2a: Are the goals of the project technically achievable?



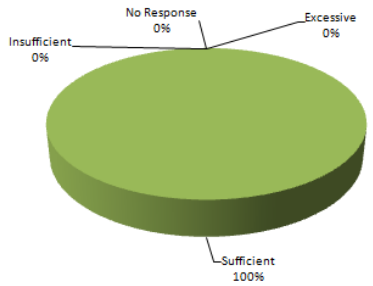
Question 4: How likely is the project team to move technologies into the marketplace?



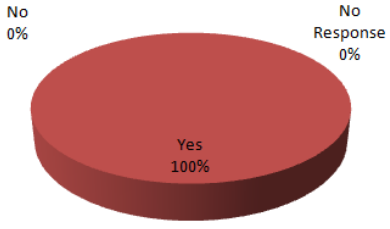
Question 2b: Have the technical barriers been identified and addressed?



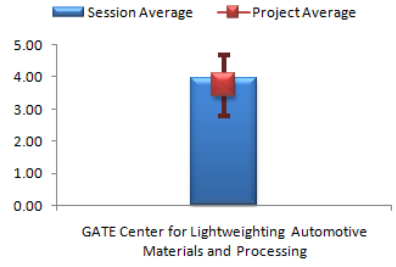
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



17. Acronyms

Acronym	Definition
A/SP	Auto/Steel Partnership
A/T	Aftertreatment
ACES	Advanced Collaborative Emissions Study
ACM	Acicular Mullite DPF material (Dow)
AEM	Advanced Electrolyte Model
AFDC	Alternative Fuels Data Center
AHSS	Advanced High Strength Steel
ALA	American Lung Association
ALM	Automotive Lightweight Materials
ANL	Argonne National Laboratory
ANLCC	Argonne National Laboratory Composite Cathode
APBF	Advanced Petroleum-Based Fuels
APEEM	Advanced Power Electronics and Electric Machines Program
APS	Advanced Photon Source
APU	Auxiliary Power Unit
ARC	Accelerating Rate Calorimetry
ARL	Army Research Laboratory
ASI	Area Specific Impedance
ASTM	American Society for Testing and Materials
ATD	DOE Advanced Technology Development Program
AVC	Advanced Vehicle Competitions
BATT	Batteries for Advanced Transportation Technologies
BD	Biodiesel
BES	DOE Basic Energy Sciences
BNL	Brookhaven National Laboratory
BSFC	Brake specific fuel consumption
BTE	Brake thermal efficiency
BYU	Brigham Young University
CA	Crank Angle
CAE	Computer Aided Engineering
CAFÉ	Corporate Average Fuel Economy
CALCE	Center for Advanced Life Cycle Engineering
CF	Carbon Fiber
CFD	Computational fluid dynamics
CIA	Central Intelligence Agency
CLAMP	Center for Lightweighting Automotive Materials and Processing
CLEERS	Cross-Cut Lean Exhaust Emission Reduction Simulation
CNG	Compressed Natural Gas
CNT	Carbon Nanotubes

Acronym	Definition
CO2	Carbon Dioxide
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CSI	Current Source Inverter
CTE	Thermal stressing mismatch
CVD	Chemical Vapor Deposition
CVT	Continuously Variable Transmission
DARPA	Defense Advanced Research Projects Agency
DDC	Detroit Diesel Corporation
DEER	Diesel Engine-Efficiency and Emissions Research Conference
DERC	Diesel Emissions Reduction Consortium
DLFT	Direct Compounded Long Fiber Thermoplastics
DOC	Diesel oxidation catalyst
DOD	Department of Defense
DoD	Depth of Discharge
DOE	Department of Energy
DOT	Department of Transportation
DPF	Diesel particulate filter
DRIFTS	Diffuse Reflectance Infrared Fourier Transform Spectroscopic
DSC	Differential Scanning Calorimetry
E85	85 percent ethanol blend with gasoline
EBS	Ethanol Boosting System
ECUT	Energy Conversion and Utilization Techniques
EERE	Energy Efficiency and Renewable Energy
EGR	Exhaust Gas Recirculation
EIA	Energy Information Administration
EISA	Energy Independence and Security Act of 2007
EMC	Electromagnetic Compatibility
EOI	End of Injection
EPA	Environmental Protection Agency
EPAct	Energy Policy Act
EPRI	Electric Power Research Institute
ERC	Engine Research Center at University of Wisconsin
EV	Electric Vehicle
EV/CS	Electric Vehicle Charge Sustaining
EXAFS	Extended X-ray Absorption Fine Structure
FACE	Fuels for Advanced Combustion Engines
FCV	Fuel cell vehicle
FE	DOE Office of Fossil Energy
FEA	Finite Element Analysis

Acronym	Definition
FEERC	Fuels, Engines, and Emissions Research Center
FFV	Flexible fuel vehicle
FIE	Fuel Injection Equipment
FMEA	Failure Mode and Effects Analysis
FTE	Full time employee equivalent
FTIR	Fourier Transform Infrared Spectroscopy
FTP	Federal Test Procedure
FY	Fiscal Year
GATE	Graduate Automotive Technology Education
GDI	Gasoline Direct Injection
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse gases
GITT	Galvanostatic intermittent titration technique
GPC	Generalized Predictive Control
GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation
GTL	Gas-to-liquids
HCCI	Homogeneous Charge Compression Ignition
HD	Heavy-duty
HDD	Heavy-duty diesel
HE	High Energy
HECC	High Efficiency Clean Combustion
HEI	Health Effects Institute
HEV	Hybrid Electric Vehicle
HF	Hydrogen Fluoride
HIL	Hardware in the Loop
HI-MAC	High Integrity Magnesium Automotive Castings
HSS	High Strength Steel
HTML	High Temperature Materials Laboratory
HTRI	Heat Transfer Research, Inc.
HV	Heavy vehicle
HWCVD	Hot Wire Chemical Vapor Deposition
IARC	International Agency for Research on Cancer
IC	Internal Combustion
ICE	Internal Combustion Engine
IEA	International Energy Agency
IMAPS	International Microelectronics and Packaging Society
IMEP	Indicated Mean Effective Pressure
INL	Idaho National Laboratory
IP	Intellectual Property
IPR	Intellectual Property Rights
IQT	Ignition Quality Tester

Acronym	Definition
IRS	Internal Revenue Service
ISO	International Organization for Standardization
ITEC	International Truck and Engine Company
ITS	Intelligent Transportation Systems
IVC	Intake Valve Closing
JARI	Japan Automobile Research Institute
JFET	Junction Gate Field Effect Transistor
JPL	Jet Propulsion Laboratory
kg	Kilogram
KIVA	Internal combustion engine simulation code (Los Alamos)
LANL	Los Alamos National Laboratory
LAST	Thermoelectrics material
LBNL	Lawrence Berkeley National Laboratory
LCCF	Low Cost Carbon Fiber
LD	Light-duty
LDRD	Laboratory Directed Research and Development
LDV	Light-Duty Vehicles
LES	Large Eddy Simulation
LFT	Long fiber thermoplastics
LIBOB	Lithium bis(oxalato)borate)
LIVC	Late Intake Valve Closing
LNT	Lean NOx Trap
LPPM	Low pressure permanent mold
LTC	Low Temperature Combustion
MAS NMR	Magic Angle Spinning Nuclear Magnetic Resonance
MATT	Mobile Automotive Technology Testbed
MCMB	Mesocarbon Microbeads
MFERD	Magnesium Front End Research and Development
MMBPD	Million barrels per day
MMV	Multi-Material Vehicle
MOSFET	Metal oxide semiconductor field effect transistor
MOU	Memorandum of Understanding
MSAT	Mobile Source Air Toxics
MSU	Michigan State University
NASA	National Aeronautics and Space Administration
NBB	National Biodiesel Board
NCA	Battery cathode material
NDA	Non Disclosure Agreement
NDE	Non-Destructive Evaluation
NE	DOE Office of Nuclear Energy

Acronym	Definition
NEMS	National Energy Modeling System
NETL	National Energy Technology Laboratory
NEV	Neighborhood Electric Vehicle
NGV	Natural Gas Vehicle
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NL	National Laboratory
NMC	Lithiated nickel-manganese-cobalt oxide
NMR	Nuclear Magnetic Resonance
NPBF	Non-Petroleum Based Fuels
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
NSLS	National Synchrotron Light Source
NTRC	National Transportation Research Center
OBD2	Onboard Diagnostics
OCV	Open Circuit Voltage
OEM	Original Equipment Manufacturer
OER	DOE Office of Electricity Reliability
OMAC	Graphite battery material
ONAMI	Thermoelectrics presentation
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
OSC	Oxygen Storage Capacity
OSU	Ohio State University
OVT	Vehicle Technologies Program
PAH	Polycyclic Aromatic Hydrocarbons
PAH	Polycyclic aromatic hydrocarbons
PAN	Polyacryloitrile
PCB	Polychlorinated Biphenyls
PCCI	Premixed Charge Compression Ignition
PEM	Power Electronics Module
PEO	Poly ethylene oxide
PHEV	Plug-In Hybrid Electric Vehicle
PI	Principal Investigator
PLIF	Planar Laser-Induced Fluorescence
PM	Particulate Matter
PM	Powder Metal
PM	Program Manager
PMEP	Pumping Mean Effective Pressure
PMLA	Piezoceramic multilayer actuators
PNGV	Partnership for a New Generation of Vehicles

Acronym	Definition
POM	Polycyclic Organic Matter
PPM	Parts per million
PSAT	Powertrain Systems Analysis Toolkit
PSU	Pennsylvania State University
PTI	Pennsylvania Transportation Institute
PVDF	Polyvinylidene Fluoride
R&D	Research and Development
RD3	Research, Development, Demonstration, and Deployment
RFP	Request for Proposals
RFS	Renewable Fuels Standard
RI	Resonance Inspection
RME	Rapeseed Methyl Ester (biodiesel)
ROI	Return on Investment
RON	Research Octane Number
RSW	Resistance Spot Weld
SAE	Society of Automotive Engineers
SBIR	Small Business Innovation Research
SC	DOE Office of Science
SCC	Stress corrosion cracking
SCR	Selective Catalytic Reduction
SEI	Solid electrolyte interface
SI	Spark ignition
SMC	Sheet Molding Compound
SMG	Surface modified graphite
SNL	Sandia National Laboratories
SOC	Start of Combustion
SOC	State of Charge
SOI	Start of Injection
SRNL	Savannah River National Laboratory
SSEC	Solid State Energy Conversion
STEM	Scanning Transmission Electron Microscopy
STTR	Small Business Technology Transfer
SUV	Sport Utility Vehicle
TAP	Temporal Analysis of Products
TC	Turbocharger
TE	Thermoelectrics
TEG	Thermoelectric Generator
TIM	Thermal Interface Material
TRIP	Transformation Induced Plasticity
TRXRD	Time-resolved X-Ray Diffraction

Acronym	Definition
TS	Thermal Stratification
TVLT	Time varying linear transform
UC	University of California
UH	University of Houston
UHC	Unburned Hydrocarbons
ULC	Ultra large casting
ULSD	Ultra-low sulfur diesel
USABC	US Advanced Battery Consortium
USAMP	U.S. Automotive Materials Partnership
UT	University of Tennessee
UW	University of Wisconsin
V	Volts
V2G	Vehicle to Grid
VCR	Variable Compression Ratio
VMT	Vehicle Miles Traveled
VO	Vegetable Oil
VT	Vehicle Technologies Program
VVA	Variable Valve Actuation
W	Watt
WGS	Water Gas Shift
WHR	Waste Heat Recovery
WSB	Water soluble binder
XAS	X-ray Absorption Spectroscopy
XPS	X-ray Photoelectron Spectroscopy
ZT	Thermoelectrics figure of merit (measure of efficiency)

18. Cross-Reference of Project Investigators, Projects, and Organizations

Cross-Reference, Sorted by Project Investigator

Page Principal Investigator (Organization) – Project Title / Session

2-12 Abraham, Daniel (Argonne National Laboratory) -- ANL Diagnostics / Applied Battery Research

2-70 Abraham, Daniel (Argonne National Laboratory) -- SEI Studies at ANL / Applied Battery Research

7-24 Aceves, Salvador (Lawrence Livermore National Laboratory) -- HCCI Engine Research and Modeling / Combustion Research

10-28 Aceves, Salvador (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

5-34 Adams, Don (Oak Ridge National Laboratory) -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

10-31 Adhvaryu, Atanu (Caterpillar) -- Multi-Component Nanoparticle-Based Lubricant Additive / Fuels Technologies

10-14 Agarwal, Apoory (Ford Motor Company) -- E85 Optimized Engine Application / Fuels Technologies

14-12 Ajayi, Oyelayo (Argonne National Laboratory) -- Boundary Layer Lubrication / Vehicle Systems and Simulation

3-15 Alamgir, Mohamed (Compact Power) -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

10-9 Alexander, Colleen (National Renewable Energy Laboratory) -- APBF Impacts on Advanced Combustion Engines / Fuels Technologies

12-15 Allard, Larry (Oak Ridge National Laboratory) -- Catalysts via First Principles / Propulsion Materials

12-17 Allard, Larry (Oak Ridge National Laboratory) -- Characterization of Catalyst Microstructures and Deactivation Mechanism / Propulsion Materials

2-44 Amine, Khalil (Argonne National Laboratory) -- Low-Cost Components: Development of Advanced High-Power and High-Energy Battery Materials / Applied Battery Research

2-58 Amine, Khalil (Argonne National Laboratory) -- Material-Level and Component Abuse Studies / Applied Battery Research

5-34 Anderson, Iver (Ames National Laboratory) -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

3-21 Andrew, Mike (Johnson Controls-SAFT) -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

8-47 Andrews, Eric (Cummins Inc.) -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

16-18 Andrews, J. Barry (University of Alabama Birmingham) -- GATE Center for Advanced Lightweight Materials / Technology Integration/Education

16-27 Anstrom, Joel (Pennsylvania State University) -- GATE Center for In-Vehicle High Power Energy Storage Systems / Technology Integration/Education

12-70 Armstrong, B.L. (Oak Ridge National Laboratory) -- Power Electronics Materials Compatibility / Propulsion Materials

7-72 Assanis, Dennis (University of Michigan) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

12-70 Ayers, C.W. (Oak Ridge National Laboratory) -- Power Electronics Materials Compatibility / Propulsion Materials

5-34 Ayers, Curt (Oak Ridge National Laboratory) -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

7-72 Babajimopolous, Aris (University of Michigan) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

13-3 Bailey, Brent (Health Effects Institute) -- Collaborative Emissions Study (ACES) / Health Impacts

5-22 Balachandran, Uthamalingam (Argonne National Laboratory) -- High-Temperature Capacitor R&D / Advanced Power Electronics

9-41 Balakotaiah, Vemuri (University of Houston) -- Kinetic and Performance Studies of the Regeneration Phase of Model PT/RH/Ba NOx Traps / Emission Control/Aftertreatment

4-8 Balsara, Nitash (Lawrence Berkeley National Laboratory) -- Block Copolymer Electrolytes for High-Energy Density Lithium Batteries / Exploratory Battery Research

3-28 Barnes, Jim (U.S. Navy) -- Interagency Agreement with Navy-Technology Assessment (NSWC) / Battery Development, Testing, Simulation, Analysis

10-39 Barone, Teresa (Oak Ridge National Laboratory) -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

13-6 Barone, Teresa (Oak Ridge National Laboratory) -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

4-25 Basak, Pratyay (Lawrence Berkeley National Laboratory) -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

2-28 Basco, J. (Argonne National Laboratory) -- Gen 3 Cell Testing / Applied Battery Research

2-34 Basco, J. (Argonne National Laboratory) -- Life Validation Testing Protocol Development / Applied Battery Research

3-41 Basco, J. (Argonne National Laboratory) -- Testing USABC Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

2-31 Battaglia, Vince (Lawrence Berkeley National Laboratory) -- Life Validation Testing Protocol Development / Applied Battery Research

4-17 Battaglia, Vince (Lawrence Berkeley National Laboratory) -- Electrode Construction and Testing / Exploratory Battery Research

12-55 Battiste, R. (Oak Ridge National Laboratory) -- Materials for HCCI Engines / Propulsion Materials

4-25 Beer, Leanne (Lawrence Berkeley National Laboratory) -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

6-7 Bell, Lon (BSST LLC - Amerigon) -- Direct Energy Conversion from Waste Heat Recovery / Solid State Energy Conversion

3-34 Belt, Jeff (Idaho National Laboratory) -- Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

4-54 Benhammou, Dan (National Renewable Energy Laboratory) -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

11-43 Berger, Libby (General Motors Corporation) -- Focal Project 4 – Floor Pan / Lightweight Materials

15-6 Bergeron, Paul (National Renewable Energy Laboratory) -- Clean Cities-Core Program and Tools / Deployment

15-15 Bergeron, Paul (National Renewable Energy Laboratory) -- EPAct Data Collection and Management / Deployment

7-48 Bergin, Mike (University of Wisconsin) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

12-32 Blau, Peter (Oak Ridge National Laboratory) -- Friction and Wear Reduction in Diesel Engine Valve Trains / Propulsion Materials

12-60 Blau, Peter (Oak Ridge National Laboratory) -- Materials for High-Pressure Fuel Injection Systems / Propulsion Materials

2-28 Bloom, Ira (Argonne National Laboratory) -- Gen 3 Cell Testing / Applied Battery Research

2-34 Bloom, Ira (Argonne National Laboratory) -- Life Validation Testing Protocol Development / Applied Battery Research

3-41 Bloom, Ira (Argonne National Laboratory) -- Testing USABC Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

14-32 Bocci, Dan (Argonne National Laboratory) -- HEV Cold Temperature Impact Testing / Vehicle Systems and Simulation

14-32 Bohn, Ted (Argonne National Laboratory) -- HEV Cold Temperature Impact Testing / Vehicle Systems and Simulation

14-65 Bohn, Ted (Argonne National Laboratory) -- Thru-the-Road PHEV and Ultracapacitor Integration / Vehicle Systems and Simulation

4-48 Borodin, Oleg (University of Utah) -- Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces / Exploratory Battery Research

11-21 Botkin, Mark (General Motors Corporation) -- Crash Energy Management / Lightweight Materials

7-7 Briggs, Tom (Oak Ridge National Laboratory) -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

10-28 Buchholz, Bruce (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

10-6 Bunting, Bruce (Oak Ridge National Laboratory) -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-23 Bunting, Bruce (Oak Ridge National Laboratory) -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-37 Bunting, Bruce (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

12-55 Bunting, Bruce (Oak Ridge National Laboratory) -- Materials for HCCI Engines / Propulsion Materials

5-32 Burress, Tim (Oak Ridge National Laboratory) -- Technology Benchmarking / Advanced Power Electronics

14-4 Carlson, Barney (Argonne National Laboratory) -- Advanced Powertrain Research Facility Benchmarking / Vehicle Systems and Simulation

14-32 Carlson, Barney (Argonne National Laboratory) -- HEV Cold Temperature Impact Testing / Vehicle Systems and Simulation

11-18 Carpenter, Joe (U.S. Department of Energy) -- Cost Modeling / Lightweight Materials

7-39 Caton, Jerry (Texas A&M University) -- Improved Engine Design Concepts Using the Second Law of Thermodynamics / Combustion Research

4-62 Ceder, Gerbrand (Massachusetts Institute of Technology) -- Olivine and Layered Materials (Characterization, Rate Performance, and Stability) / Exploratory Battery Research

7-68 Chakravarthy, V. Kalyana (Oak Ridge National Laboratory) -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

11-36 Chao, Y.J. (University of South Carolina) -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

14-20 Chen, G. (Argonne National Laboratory) -- Erosion of Advanced Radiator Materials / Vehicle Systems and Simulation

14-38 Chen, G. (Argonne National Laboratory) -- Nano Fluids for Thermal Control Applications / Vehicle Systems and Simulation

9-50 Chen, Hai-Ying (Johnson Matthey) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

7-72 Chen, Jyh-Yuan (University of California Berkeley) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

12-30 Chen, Yong-Ching (Cummins Inc.) -- Fatigue Enhancements by Shock Peening (Cummins) / Propulsion Materials

7-72 Cheng, Wai (Massachusetts Institute of Technology) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-7 Cho, Kukwon (Oak Ridge National Laboratory) -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

10-37 Cho, Kukwon (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

9-16 Choi, Jae-Soon (Oak Ridge National Laboratory) -- CLEERS NOx Adsorber Kinetics and the Multi-Lab Diesel Emissions Reduction Activities / Emission Control/Aftertreatment

9-61 Choi, Jae-Soon (Oak Ridge National Laboratory) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

9-67 Choi, Jae-Soon (Oak Ridge National Laboratory) -- Pre-Competitive R&D on NOx Adsorber Mechanisms / Emission Control/Aftertreatment

2-28 Christopherson, Jon (Idaho National Laboratory) -- Gen 3 Cell Testing / Applied Battery Research

2-37 Christopherson, Jon (Idaho National Laboratory) -- Life Validation Testing Protocol Development / Applied Battery Research

3-11 Chu, Andy (A123Systems) -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

7-75 Ciatti, Steve (Argonne National Laboratory) -- Visualization of In-Cylinder Combustion R&D / Combustion Research

10-34 Clark, Wendy (National Renewable Energy Laboratory) -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

7-48 Colban, Will (Sandia National Laboratories) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-65 Confer, Keith (Delphi) -- Spark-Assisted HCCI Control / Combustion Research

10-11 Confer, Keith (Delphi) -- E85 Optimized Engine / Fuels Technologies

14-20 Cookson, D. (Argonne National Laboratory) -- Erosion of Advanced Radiator Materials / Vehicle Systems and Simulation

14-38 Cookson, D. (Argonne National Laboratory) -- Nano Fluids for Thermal Control Applications / Vehicle Systems and Simulation

13-3 Costantini, M. (Health Effects Institute) -- Collaborative Emissions Study (ACES) / Health Impacts

11-55 Cox, B. (Chrysler LLC) -- High-Integrity Magnesium Automotive Castings (HI-MAC) / Lightweight Materials

4-58 Creager, Stephen (Clemson University) -- New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization / Exploratory Battery Research

9-37 Crocker, Mark (University of Kentucky) -- Investigation of Aging Mechanisms in Lean NOx Traps / Emission Control/Aftertreatment

4-21 Crowther, Owen (Columbia University) -- In Situ Observations of Lithium Dendrite Growth / Exploratory Battery Research

16-24 Cunningham, Joshua (University of California Davis) -- GATE Center for Fuel Cell Hydrogen Hybrid Vehicles / Technology Integration/Education

9-61 Cunningham, M (Cummins Inc.) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

9-50 Currier, Neal (Cummins Inc.) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-61 Currier, Neal (Cummins Inc.) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

11-14 Daniels, Ed (Argonne National Laboratory) -- Compatibilization/Compounding Evaluation of Recovered Polymers / Lightweight Materials

11-24 Daniels, Ed (Argonne National Laboratory) -- Develop a Web-Based Information System / Lightweight Materials

11-30 Daniels, Ed (Argonne National Laboratory) -- Development of Technology for Removal of PCBs / Lightweight Materials

11-113 Daniels, Ed (Argonne National Laboratory) -- Post-Shred Materials Recovery Technology Development and Demonstration / Lightweight Materials

11-39 Dasch, Cam (General Motors Corporation) -- Enhanced Resonance Inspection for Light-Metal Castings / Lightweight Materials

11-106 Dasch, Cam (General Motors Corporation) -- NDE Inspection of Adhesive bonds in Metal-Metal Joints / Lightweight Materials

10-28 Davisson, Lee (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

7-65 Daw, Stuart (Oak Ridge National Laboratory) -- Spark-Assisted HCCI Control / Combustion Research

7-68 Daw, Stuart (Oak Ridge National Laboratory) -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

9-28 Daw, Stuart (Oak Ridge National Laboratory) -- Coordination of Cross-Cut Lean Exhaust Emission Reduction Simulation (CLEERS) Project / Emission Control/Aftertreatment

10-39 Daw, Stuart (Oak Ridge National Laboratory) -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

14-17 Daw, Stuart (Oak Ridge National Laboratory) -- Emissions Aftertreatment and Engine Cold-Starting Modeling / Vehicle Systems and Simulation

7-11 Dec, John (Sandia National Laboratories) -- Advanced HCCI Engine Combustion Fundamentals / Combustion Research

2-21 Dees, Dennis (Argonne National Laboratory) -- Gen 3 Cell Model / Applied Battery Research

2-55 Dees, Dennis (Argonne National Laboratory) -- Low-Temperature Performance: Performance Modeling / Applied Battery Research

2-66 Dees, Dennis (Argonne National Laboratory) -- Plug-in Hybrid Electric Vehicle R&D on High-Energy Materials / Applied Battery Research

4-58 DesMarteau, D (Clemson University) -- New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization / Exploratory Battery Research

7-72 Dibble, Robert (University of California Berkeley) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

4-54 Dillon, Anne (National Renewable Energy Laboratory) -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

11-129 Dinda, Subi (Automotive Materials & Mfg Tech) -- Results of FY 2007 Automotive Lightweighting Materials Deep-Dive Peer Review / Lightweight Materials

5-22 Dirk, Shawn (Sandia National Laboratories) -- High-Temperature Capacitor R&D / Advanced Power Electronics

4-66 Doeff, Marca (Lawrence Berkeley National Laboratory) -- Olivines and Substituted Layered Materials / Exploratory Battery Research

4-32 Dudney, Nancy (Oak Ridge National Laboratory) -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

14-32 Duoba, Michael (Argonne National Laboratory) -- HEV Cold Temperature Impact Testing / Vehicle Systems and Simulation

14-56 Duoba, Michael (Argonne National Laboratory) -- PHEV Test Procedures / Vehicle Systems and Simulation

8-28 Durrett, Russ (General Motors Corporation) -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

10-6 Eaton, Scott (Oak Ridge National Laboratory) -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-23 Eaton, Scott (Oak Ridge National Laboratory) -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-37 Eaton, Scott (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

7-24 Edman, Jonas (Lawrence Livermore National Laboratory) -- HCCI Engine Research and Modeling / Combustion Research

7-72 Edwards, Chris (Stanford University) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-7 Edwards, Dean (Oak Ridge National Laboratory) -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

7-65 Edwards, Dean (Oak Ridge National Laboratory) -- Spark-Assisted HCCI Control / Combustion Research

10-17 Edwards, Dean (Oak Ridge National Laboratory) -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-37 Edwards, Dean (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

10-20 Egolfopolous, Fokion (University of Southern California) -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

7-48 Ekoto, Isaac (Sandia National Laboratories) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-20 El-Hannouny, Essam (Argonne National Laboratory) -- Fuel Spray Research Using Advanced Photon Source / Combustion Research

16-21 Ellis, Mike (Virginia Tech) -- GATE Center for Automotive Fuel Cell Systems / Technology Integration/Education

5-27 El-Refaie, Ayman (General Electric) -- Scalable, Low-Cost, High-Performance IPM Motor / Advanced Power Electronics

12-82 Erdemir, Ali (Argonne National Laboratory) -- Super Hard Coating Systems / Propulsion Materials

16-24 Erickson, Paul (University of California Davis) -- GATE Center for Fuel Cell Hydrogen Hybrid Vehicles / Technology Integration/Education

7-54 Farrell, P. (University of Wisconsin) -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

11-11 Feng, Zhili (Oak Ridge National Laboratory) -- Characterization of Thermomechanical Behavior of TRIP Steels / Lightweight Materials

11-36 Feng, Zhili (Oak Ridge National Laboratory) -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

12-27 Fenske, George (Argonne National Laboratory) -- Fabrication of Small Diesel Fuel Injector Orifices / Propulsion Materials

14-47 Fenske, George (Argonne National Laboratory) -- Parasitic Energy Losses / Vehicle Systems and Simulation

7-72 Filipi, Zoran (University of Michigan) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-65 Finney, Charles E.A. (Oak Ridge National Laboratory) -- Spark-Assisted HCCI Control / Combustion Research

7-24 Flowers, Dan (Lawrence Livermore National Laboratory) -- HCCI Engine Research and Modeling / Combustion Research

10-28 Flowers, Dan (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

10-23 Foster, Adam (University of Tennessee) -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

7-54 Foster, David (University of Wisconsin) -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

14-41 Francfort, Jim (Idaho National Laboratory) -- Non-PHEV Evaluations and Data Collection / Vehicle Systems and Simulation

14-54 Francfort, Jim (Idaho National Laboratory) -- PHEV Evaluation and Data Collection / Vehicle Systems and Simulation

8-31 Frazier, Tim (Cummins Inc.) -- Light-Duty Efficient Clean Combustion / High Efficiency Clean Combustion

9-34 Gallant, Tom (Pacific Northwest National Laboratory) -- Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive) / Emission Control/Aftertreatment

10-51 Gallant, Tom (Pacific Northwest National Laboratory) -- Unconventional Hydrocarbon Fuels / Fuels Technologies

12-10 Gallego, Nidia (Oak Ridge National Laboratory) -- Carbon Foam Thermal Management / Propulsion Materials

8-47 Garimella, Phanindra (Cummins Inc.) -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

7-72 Gerdes, Chris (Stanford University) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

2-8 Gering, Kevin (Idaho National Laboratory) -- Advanced Chemistry: Electrolyte Modeling / Applied Battery Research

2-73 Gering, Kevin (Idaho National Laboratory) -- Statistical DOE at INL / Applied Battery Research

7-54 Ghandhi, J. (University of Wisconsin) -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

4-54 Gillaspie, Dane (National Renewable Energy Laboratory) -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

12-68 Glass, Robert (Lawrence Livermore National Laboratory) -- NOx Sensor Development / Propulsion Materials

8-28 Gonzalez, Manuel (General Motors Corporation) -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

5-13 Goodarzi, Abas (US Hybrid Corporation) -- Bi-Directional DC-DC Converter / Advanced Power Electronics

4-77 Goodenough, J. (University of Texas at Austin) -- Performance Enhancement of Cathodes with Conductive Polymers / Exploratory Battery Research

11-46 Grant, Glenn (Pacific Northwest National Laboratory) -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

12-57 Grant, Glenn (Pacific Northwest National Laboratory) -- Materials for HECC/HCCI Engine Components (Caterpillar) / Propulsion Materials

7-68 Graves, Ron (Oak Ridge National Laboratory) -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

10-34 Graves, Ron (Oak Ridge National Laboratory) -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

12-25 Graves, Ron (Oak Ridge National Laboratory) -- Evaluation of Combustion characteristics and Materials via ACERT Engine (Caterpillar) / Propulsion Materials

7-68 Green Jr., Johney B. (Oak Ridge National Laboratory) -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

7-65 Green, Jr., Johney B. (Oak Ridge National Laboratory) -- Spark-Assisted HCCI Control / Combustion Research

13-3 Greenbaum, Dan (Health Effects Institute) -- Collaborative Emissions Study (ACES) / Health Impacts

4-62 Grey, Clare (Stony Brook University) -- Olivine and Layered Materials (Characterization, Rate Performance, and Stability) / Exploratory Battery Research

12-87 Gruen, Dieter (Argonne National Laboratory) -- Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials / Propulsion Materials

16-12 Guezennec, Yann (Ohio State University) -- GATE Center for Advanced Automotive Propulsion / Technology Integration/Education

8-51 Gutterman, Jeff (Delphi Automotive Systems) -- Variable Valve Actuation / High Efficiency Clean Combustion

3-8 Habab, Ahsan (USABC) -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

8-43 Habibzadeh, Bahman (Mack Trucks Inc.) -- Narrow-Band Engine and a CVT to Optimize Performance / High Efficiency Clean Combustion

7-7 Hale, Richard (Oak Ridge National Laboratory) -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

8-47 Hall, Matt (University of Texas at Austin) -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

15-21 Hamilton, Jill (National Biodiesel Board) -- NBB Terminal Blending / Deployment

10-37 Han, Manbae (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

16-9 Hansen, Alan (University of Illinois Urbana Champaign) -- GATE Center for Advanced Automotive Biofuels / Technology Integration/Education

7-14 Hanson, Ron (Stanford University) -- Automotive HCCI Engine Research / Combustion Research

4-100 Harb, J.N. (Brigham Young University) -- The Impact of Electrode Structure on the Processes that Limit Cathode Performance / Exploratory Battery Research

9-41 Harold, Mike (University of Houston) -- Kinetic and Performance Studies of the Regeneration Phase of Model PT/RH/Ba NOx Traps / Emission Control/Aftertreatment

8-28 He, Xin (General Motors Corporation) -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

11-49 Heimbuch, Roger (Auto Steel Partnership) -- Future Generation Passenger Compartment Validation / Lightweight Materials

11-52 Heimbuch, Roger (Auto Steel Partnership) -- High Strength Stamping / Lightweight Materials

11-81 Heimbuch, Roger (Auto Steel Partnership) -- Lightweight Rear Chassis Structures / Lightweight Materials

11-131 Heimbuch, Roger (Auto Steel Partnership) -- Sheet Steel Joining / Lightweight Materials

11-137 Heimbuch, Roger (Auto Steel Partnership) -- Tribology / Lightweight Materials

6-11 Hendricks, Terry (Pacific Northwest National Laboratory) -- Thermoelectric Analytical Support / Solid State Energy Conversion

2-24 Henriksen, Gary (Argonne National Laboratory) -- Gen 3 Cell Status / Applied Battery Research

2-63 Henriksen, Gary (Argonne National Laboratory) -- Overview: Applied Battery Research / Applied Battery Research

7-17 Herbinet, Olivier (Lawrence Livermore National Laboratory) -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Herbinet, Olivier (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

9-34 Herling, Darrell (Pacific Northwest National Laboratory) -- Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive) / Emission Control/Aftertreatment

9-64 Herling, Darrell (Pacific Northwest National Laboratory) -- PNNL CLEERS Activities – Overview / Emission Control/Aftertreatment

9-50 Hess, Howard (Johnson Matthey) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

7-24 Hessel, Randy (University of Wisconsin) -- HCCI Engine Research and Modeling / Combustion Research

11-103 Holbery, Jim (Pacific Northwest National Laboratory) -- Natural Fiber Composite Retting, Preform Manufacturing, and Molding / Lightweight Materials

12-37 Holbery, Jim (Pacific Northwest National Laboratory) -- Hydrogen Compatible Materials / Propulsion Materials

11-46 Hovanski, Yuri (Pacific Northwest National Laboratory) -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

12-40 Hsu, Stephen (National Energy Technology Laboratory) -- IEA Annex on Materials For Transportation / Propulsion Materials

8-7 Huang, Jim (Westport Innovations) -- Development of a Robust Accelerometer- Based Start of Combustion-Sensing System / High Efficiency Clean Combustion

4-77 Huang, Y-H (University of Texas at Austin) -- Performance Enhancement of Cathodes with Conductive Polymers / Exploratory Battery Research

9-25 Huff, Shean (Oak Ridge National Laboratory) -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

10-17 Huff, Shean (Oak Ridge National Laboratory) -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-34 Huff, Shean (Oak Ridge National Laboratory) -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

7-11 Hwang, Wontae (Sandia National Laboratories) -- Advanced HCCI Engine Combustion Fundamentals / Combustion Research

7-72 Im, Hong (University of Michigan) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

16-15 Irick, David (University of Tennessee Knoxville) -- GATE Center for Advanced Hybrid Propulsion and Control Systems / Technology Integration/Education

2-48 Jansen, Andrew (Argonne National Laboratory) -- Low-Cost Components: Screening of Advanced Battery Materials / Applied Battery Research

2-51 Jansen, Andrew (Argonne National Laboratory) -- Low-Temperature Performance Characterization / Applied Battery Research

11-43 Jaranson, John (Ford Motor Company) -- Focal Project 4 – Floor Pan / Lightweight Materials

16-3 Jehlik, Forrest (Argonne National Laboratory) -- Advanced Vehicle Competitions / Technology Integration/Education

12-49 Jensen, Jeff (Caterpillar Inc.) -- Lightweight Valve Train Materials (Titanium) / Propulsion Materials

11-24 Jody, Sam (Argonne National Laboratory) -- Develop a Web-Based Information System / Lightweight Materials

11-30 Jody, Sam (Argonne National Laboratory) -- Development of Technology for Removal of PCBs / Lightweight Materials

6-7 John LaGrandeur (BSST LLC - Amerigon) -- Direct Energy Conversion from Waste Heat Recovery / Solid State Energy Conversion

5-27 Johnson, Frank (General Electric) -- Scalable, Low-Cost, High-Performance IPM Motor / Advanced Power Electronics

11-39 Jones, Martin H. (Ford Motor Company) -- Enhanced Resonance Inspection for Light-Metal Castings / Lightweight Materials

7-57 Kaiser, Sebastian (Sandia National Laboratories) -- Sandia Hydrogen Combustion Research / Combustion Research

9-61 Kamasamudram, K. (Cummins Inc.) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

14-52 Karbowski, Dominik (Argonne National Laboratory) -- PHEV Control Impact and Optimization / Vehicle Systems and Simulation

9-25 Kass, Mike (Oak Ridge National Laboratory) -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

7-20 Kastengren, Alan (Argonne National Laboratory) -- Fuel Spray Research Using Advanced Photon Source / Combustion Research

5-10 Kelly, Ken (National Renewable Energy Laboratory) -- Advanced Thermal Interface Materials, Characterization & Dev. of Advanced Heat Transfer Technologies / Advanced Power Electronics

4-32 Kercher, Andrew (Oak Ridge National Laboratory) -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

4-25 Kerr, John (Lawrence Berkeley National Laboratory) -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

4-32 Kiggans, Jim (Oak Ridge National Laboratory) -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

14-23 Killian, Mike (Eaton Corporation) -- Friction & Wear / Vehicle Systems and Simulation

7-24 Killingsworth, Nick (Lawrence Livermore National Laboratory) -- HCCI Engine Research and Modeling / Combustion Research

10-28 Killingsworth, Nick (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

9-50 Kim, Do Heui (Pacific Northwest National Laboratory) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

7-48 Kim, Duksang (Kookmin University) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

4-54 Kim, Yong-Hyun (National Renewable Energy Laboratory) -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

9-4 King, Dave (Pacific Northwest National Laboratory) -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

12-77 Kircher, Andrew (Oak Ridge National Laboratory) -- Solder Joints of Power Electronics / Propulsion Materials

12-20 Klepser, Cheryl (Cummins Inc.) -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

10-34 Knoll, Keith (National Renewable Energy Laboratory) -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

7-42 Kong, Song-Charng (Iowa State University) -- KIVA Modeling to Support Diesel Combustion Research / Combustion Research

2-18 Kostecki, Robert (Lawrence Berkeley National Laboratory) -- Diagnostics at LBNL / Applied Battery Research

4-4 Kostecki, Robert (Lawrence Berkeley National Laboratory) -- 3-D Nanostructured Carbon-Tin Composite Anodes / Exploratory Battery Research

13-6 Kranendonk, Laura (Oak Ridge National Laboratory) -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

8-19 Kruiswyk, Rick (Caterpillar Inc.) -- Engine System Approach to Exhaust Energy Recovery / High Efficiency Clean Combustion

11-120 Kunc, V. (Oak Ridge National Laboratory) -- Predictive Modeling of Polymer Composites / Lightweight Materials

14-50 Kwon, J. (Argonne National Laboratory) -- PHEV Component Sizing / Vehicle Systems and Simulation

16-9 Kyritsis, Dimitrios (University of Illinois Urbana Champaign) -- GATE Center for Advanced Automotive Biofuels / Technology Integration/Education

5-29 Lai, Jason (Virginia Tech) -- Soft Switching Inverter for Reducing Switching and Power Losses / Advanced Power Electronics

10-39 Lance, Michael (Oak Ridge National Laboratory) -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

12-20 Lara-Curzio, Edgar (Oak Ridge National Laboratory) -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

12-35 Lara-Curzio, Edgar (Oak Ridge National Laboratory) -- High-Temperature Materials Laboratory / Propulsion Materials

9-21 Larson, Richard (Sandia National Laboratories) -- CLEERS: Benchmark Kinetics for NOx Adsorbers and Catalyzed DPF / Emission Control/Aftertreatment

11-83 Lavender, Curt (Pacific Northwest National Laboratory) -- Low Cost Titanium / Lightweight Materials

7-72 Lavoie, George (University of Michigan) -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

10-34 Lawson, Doug (National Renewable Energy Laboratory) -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

13-9 Lawson, Doug (National Renewable Energy Laboratory) -- Health Impacts Research / Health Impacts

16-9 Lee, Chia-Fon (University of Illinois Urbana Champaign) -- GATE Center for Advanced Automotive Biofuels / Technology Integration/Education

9-7 Lee, Kyeong (Argonne National Laboratory) -- Advanced Diesel Particulate Filter (DPF) Research / Emission Control/Aftertreatment

4-54 Lee, Se-Hee (University of Colorado, Boulder) -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

10-6 Lewis, Sam (Oak Ridge National Laboratory) -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-37 Lewis, Sam (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

10-39 Lewis, Sam (Oak Ridge National Laboratory) -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

13-6 Lewis, Sam (Oak Ridge National Laboratory) -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

9-50 Li, Junhui (Cummins Inc.) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-4 Li, Liyu (Pacific Northwest National Laboratory) -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

12-49 Lin, H.T. (Oak Ridge National Laboratory) -- Lightweight Valve Train Materials (Titanium) / Propulsion Materials

12-63 Lin, H.T. (Oak Ridge National Laboratory) -- Mechanical Reliability of Piezo-Stack Actuators / Propulsion Materials

2-48 Liu, Jun (Argonne National Laboratory) -- Low-Cost Components: Screening of Advanced Battery Materials / Applied Battery Research

11-100 Logan, Steve (Chrysler LLC) -- Multi-Material Vehicle / Lightweight Materials

14-29 Lohse-Busch, Henning (Argonne National Laboratory) -- Hardware-in-the-Loop Mobile Advanced Technology Testbed / Vehicle Systems and Simulation

7-20 Longman, Doug (Argonne National Laboratory) -- Fuel Spray Research Using Advanced Photon Source / Combustion Research

11-90 Luo, Alan (General Motors Corporation) -- Magnesium Front-End R&D / Lightweight Materials

11-140 Maj, Michael (Ford Motor Company) -- Ultra-Large Casting Demonstrations / Lightweight Materials

9-4 Male, Jonathan (Pacific Northwest National Laboratory) -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

9-70 Male, Jonathan (Pacific Northwest National Laboratory) -- Urea SCR Fundamentals / Emission Control/Aftertreatment

16-30 Mallick, P.K. (University of Michigan Dearborn) -- GATE Center for Lightweighting Automotive Materials and Processing / Technology Integration/Education

4-89 Manthiram, Arumugam (University of Texas at Austin) -- Stabilized Spinels and Nano Olivines / Exploratory Battery Research

14-62 Markel, Tony (National Renewable Energy Laboratory) -- Thermoelectric Analysis, Integrated Vehicle Thermal Management Systems Analysis/Modeling / Vehicle Systems and Simulation

5-15 Marlino, Laura (Oak Ridge National Laboratory) -- Current Source Inverter / Advanced Power Electronics

5-34 Marlino, Laura (Oak Ridge National Laboratory) -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

5-37 Marlino, Laura (Oak Ridge National Laboratory) -- Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs / Advanced Power Electronics

12-68 Martin, Peter (Lawrence Livermore National Laboratory) -- NOx Sensor Development / Propulsion Materials

8-47 Matthews, Ron (University of Texas at Austin) -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

12-5 Maziasz, Phil (Oak Ridge National Laboratory) -- Austenitic Stainless Steel Alloys of Exhaust Components / Propulsion Materials

12-52 Maziasz, Phil (Oak Ridge National Laboratory) -- Materials for Advanced Engine Valve Train / Propulsion Materials

5-13 Mazumder, Sudip (University of Illinois Chicago) -- Bi-Directional DC-DC Converter / Advanced Power Electronics

11-33 McCarty, Eric (Chrysler LLC) -- Die-Face Engineering Project for Advanced Sheet-Forming Materials / Lightweight Materials

11-55 McCarty, Eric (Chrysler LLC) -- High-Integrity Magnesium Automotive Castings (HI-MAC) / Lightweight Materials

11-62 McCarty, Eric (Chrysler LLC) -- Improved Automotive Suspension Components Cast with B206 Alloy / Lightweight Materials

11-86 McCarty, Eric (Chrysler LLC) -- Magnesium Front-End Design and Demonstration / Lightweight Materials

11-90 McCarty, Eric (Chrysler LLC) -- Magnesium Front-End R&D / Lightweight Materials

11-94 McCarty, Eric (Chrysler LLC) -- Magnesium Powertrain Cast Components / Lightweight Materials

11-100 McCarty, Eric (Chrysler LLC) -- Multi-Material Vehicle / Lightweight Materials

11-117 McCarty, Eric (Chrysler LLC) -- Powder Metal Performance Modeling of Automotive Components / Lightweight Materials

11-140 McCarty, Eric (Chrysler LLC) -- Ultra-Large Casting Demonstrations / Lightweight Materials

11-143 McCarty, Eric (Chrysler LLC) -- Warm-Forming Magnesium Sheet / Lightweight Materials

10-42 McCormick, Robert (National Renewable Energy Laboratory) -- NPBF Quality, Stability, Performance, and Emission Impacts of Biodiesel Blends / Fuels Technologies

5-34 McKeever, John (Oak Ridge National Laboratory) -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

2-18 McLarnon, Frank (Lawrence Berkeley National Laboratory) -- Diagnostics at LBNL / Applied Battery Research

10-20 Meeks, Ellen (Reaction Design) -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

11-33 Mehta, Manish (TRC/NCMS) -- Die-Face Engineering Project for Advanced Sheet-Forming Materials / Lightweight Materials

8-35 Mendler, Charles (Envera LLC) -- Low-Cost, Fast Response Actuator / High Efficiency Clean Combustion

8-11 Milam, David (Caterpillar, Inc) -- Development of Enabling Technologies for High-Efficiency, Low-Emissions HCCI Engines / High Efficiency Clean Combustion

7-48 Miles, Paul (Sandia National Laboratories) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-61 Miles, Paul (Sandia National Laboratories) -- Small Bore Advanced Combustion Engine R&D / Combustion Research

15-3 Milewski, Kay (National Energy Technology Laboratory) -- Clean Cities Coalition Regional Support / Deployment

10-20 Modak, Abhijit (Reaction Design) -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

11-106 Moore, David (Sandia National Laboratories) -- NDE Inspection of Adhesive bonds in Metal-Metal Joints / Lightweight Materials

12-15 Moses-DeBusk, M. (Oak Ridge National Laboratory) -- Catalysts via First Principles / Propulsion Materials

10-25 Mueller, Chuck (Sandia National Laboratories) -- Fuel Effects on Advanced Combustion / Fuels Technologies

9-50 Muntean, George (Pacific Northwest National Laboratory) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

12-55 Muralidharan, G. (Oak Ridge National Laboratory) -- Materials for HCCI Engines / Propulsion Materials

12-77 Muralidharan, G. (Oak Ridge National Laboratory) -- Solder Joints of Power Electronics / Propulsion Materials

3-34 Murphy, Tim (Idaho National Laboratory) -- Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

3-38 Murphy, Tim (Idaho National Laboratory) -- Testing USABC (PHEV Battery Development) Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

7-27 Musculus, Mark (Sandia National Laboratories) -- Heavy-Duty Combustion Modeling / Combustion Research

7-30 Musculus, Mark (Sandia National Laboratories) -- Heavy-Duty, Low-Temperature, and Diesel Combustion Research / Combustion Research

16-6 N/A (N/A) -- GATE Awards / Technology Integration/Education

10-20 Naik, Chitral (Reaction Design) -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

12-15 Narula, C.K. (Oak Ridge National Laboratory) -- Catalysts via First Principles / Propulsion Materials

8-22 Nelson, Chris (Cummins Inc.) -- Exhaust Energy Recovery / High Efficiency Clean Combustion

16-21 Nelson, Doug (Virginia Tech) -- GATE Center for Automotive Fuel Cell Systems / Technology Integration/Education

4-14 Newman, John (University of California at Berkeley) -- Design of PHEVs and Electrolyte Properties / Exploratory Battery Research

4-36 Newman, John (Lawrence Berkeley National Laboratory) -- Kinetics of Lithium Insertion into Silicon Anodes / Exploratory Battery Research

11-120 Nguyen, B.N. (Pacific Northwest National Laboratory) -- Predictive Modeling of Polymer Composites / Lightweight Materials

10-23 Nguyen, Ke (University of Tennessee) -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

11-97 Nyberg, Eric (Pacific Northwest National Laboratory) -- Magnesium Research and Technology Development / Lightweight Materials

7-45 Oefelein, Joe (Sandia National Laboratories) -- LES Applied To LTC/Diesel/Hydrogen Combustion / Combustion Research

8-39 Ojeda, Willy (Navistar Inc.) -- Low-Temperature Combustion Demonstrator for High-Efficiency Clean Combustion / High Efficiency Clean Combustion

11-21 Olszewski, Gerry (Chrysler LLC) -- Crash Energy Management / Lightweight Materials

11-43 Olszewski, Gerry (Chrysler LLC) -- Focal Project 4 – Floor Pan / Lightweight Materials

11-59 Olszewski, Gerry (Chrysler LLC) -- High-Volume Processing of Composites / Lightweight Materials

11-110 Olszewski, Gerry (Chrysler LLC) -- P4 Preform / Lightweight Materials

5-19 Olszewski, Mitch (Oak Ridge National Laboratory) -- Direct-Cooled Power Electronics Substrate / Advanced Power Electronics

5-32 Olszewski, Mitch (Oak Ridge National Laboratory) -- Technology Benchmarking / Advanced Power Electronics

3-18 Ota, Naoki (Enerdel) -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

10-23 Ottinger, Nathan (University of Tennessee) -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

5-4 Ozpineci, Burak (Oak Ridge National Laboratory) -- Active Filter Approach to the Reduction of the DC Link Capacitor / Advanced Power Electronics

5-6 Ozpineci, Burak (Oak Ridge National Laboratory) -- Advanced Converter Systems for High-Temperature HEV Environments / Advanced Power Electronics

5-39 Ozpineci, Burak (Oak Ridge National Laboratory) -- Wide Bandgap Materials / Advanced Power Electronics

12-77 Ozpineci, Burak (Oak Ridge National Laboratory) -- Solder Joints of Power Electronics / Propulsion Materials

14-25 Pagerit, Sylvain (Argonne National Laboratory) -- GM Cooperative Research and Development Agreement / Vehicle Systems and Simulation

14-27 Pagerit, Sylvain (Argonne National Laboratory) -- Government Performance and Results Act and Multipath / Vehicle Systems and Simulation

14-50 Pagerit, Sylvain (Argonne National Laboratory) -- PHEV Component Sizing / Vehicle Systems and Simulation

14-52 Pagerit, Sylvain (Argonne National Laboratory) -- PHEV Control Impact and Optimization / Vehicle Systems and Simulation

4-32 Park, Sea Hoon (Oak Ridge National Laboratory) -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

7-48 Park, Sung Wook (University of Wisconsin) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

9-25 Parks, Jim (Oak Ridge National Laboratory) -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

9-45 Parks, Jim (Oak Ridge National Laboratory) -- Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation / Emission Control/Aftertreatment

9-61 Parks, Jim (Oak Ridge National Laboratory) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

13-6 Parks, Jim (Oak Ridge National Laboratory) -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

9-61 Partridge, Bill (Oak Ridge National Laboratory) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

8-28 Patton, Ken (General Motors Corporation) -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

12-70 Pawel, S.J. (Oak Ridge National Laboratory) -- Power Electronics Materials Compatibility / Propulsion Materials

12-30 Paxton, Dean (Pacific Northwest National Laboratory) -- Fatigue Enhancements by Shock Peening (Cummins) / Propulsion Materials

9-10 Peden, Charles (Pacific Northwest National Laboratory) -- Characterization of Aging Mechanisms in Advanced Catalysts for SCR of NOx with Urea / Emission Control/Aftertreatment

9-13 Peden, Charles (Pacific Northwest National Laboratory) -- CLEERS Diesel Soot Filter Characterization / Emission Control/Aftertreatment

9-32 Peden, Charles (Pacific Northwest National Laboratory) -- Degradation Mechanisms in Advanced Catalysts for Urea SCR (CRADA with General Motors) / Emission Control/Aftertreatment

9-50 Peden, Charles (Pacific Northwest National Laboratory) -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-53 Peden, Charles (Pacific Northwest National Laboratory) -- NOx Adsorber Fundamentals / Emission Control/Aftertreatment

3-25 Pesaran, Ahmad (National Renewable Energy Laboratory) -- IEA/HEV Implementing Agreement / Battery Development, Testing, Simulation, Analysis

3-45 Pesaran, Ahmad (National Renewable Energy Laboratory) -- Thermal Management Modeling / Battery Development, Testing, Simulation, Analysis

3-49 Pesaran, Ahmad (National Renewable Energy Laboratory) -- Thermal Management Studies / Battery Development, Testing, Simulation, Analysis

4-54 Pesaran, Ahmad (National Renewable Energy Laboratory) -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

12-47 Phillips, Nate (Oak Ridge National Laboratory) -- Life Prediction for Diesel Engine Components / Propulsion Materials

12-49 Phillips, Nate (Caterpillar Inc.) -- Lightweight Valve Train Materials (Titanium) / Propulsion Materials

12-52 Phillips, Nate (Caterpillar Inc.) -- Materials for Advanced Engine Valve Train / Propulsion Materials

12-66 Phillips, Nate (Oak Ridge National Laboratory) -- Non-Destructive Evaluation of Diesel Components / Propulsion Materials

7-51 Pickett, Lyle (Sandia National Laboratories) -- Low-Temperature Diesel Combustion Cross-Cut Research / Combustion Research

7-24 Piggott, Tom (Lawrence Livermore National Laboratory) -- HCCI Engine Research and Modeling / Combustion Research

7-68 Pihl, Josh (Oak Ridge National Laboratory) -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

9-57 Pihl, Josh (Oak Ridge National Laboratory) -- NOx Adsorber R&D (CRADA between ORNL and International Truck and Engine Company) / Emission Control/Aftertreatment

7-17 Pitz, Bill (Lawrence Livermore National Laboratory) -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Pitz, Bill (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

12-5 Pollard, Michael (Caterpillar Inc.) -- Austenitic Stainless Steel Alloys of Exhaust Components / Propulsion Materials

12-60 Pollard, Michael (Caterpillar Inc.) -- Materials for High-Pressure Fuel Injection Systems / Propulsion Materials

11-14 Pomykala, Joe (Argonne National Laboratory) -- Compatibilization/Compounding Evaluation of Recovered Polymers / Lightweight Materials

11-113 Pomykala, Joe (Argonne National Laboratory) -- Post-Shred Materials Recovery Technology Development and Demonstration / Lightweight Materials

7-20 Powell, Christopher (Argonne National Laboratory) -- Fuel Spray Research Using Advanced Photon Source / Combustion Research

2-34 Prezas, P. (Argonne National Laboratory) -- Life Validation Testing Protocol Development / Applied Battery Research

3-41 Prezas, P. (Argonne National Laboratory) -- Testing USABC Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

9-25 Prikhodko, Vitaly (Oak Ridge National Laboratory) -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

14-15 Proc, Ken (National Renewable Energy Laboratory) -- Cool Cab Truck Thermal Load Reduction / Vehicle Systems and Simulation

10-20 Puduppakkam, Karthik (Reaction Design) -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

7-7 Qualls, A. Lou (Oak Ridge National Laboratory) -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

7-68 Qualls, A. Lou (Oak Ridge National Laboratory) -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

7-48 Ra, Youngchul (University of Wisconsin) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

9-4 Rappe, Ken (Pacific Northwest National Laboratory) -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

10-4 Ratcliff, Matt (National Renewable Energy Laboratory) -- Advanced Fuel and Lubricant Impacts on Emerging and Existing Diesel Engines / Fuels Technologies

10-9 Ratcliff, Matt (National Renewable Energy Laboratory) -- APBF Impacts on Advanced Combustion Engines / Fuels Technologies

7-48 Reitz, Rolf (University of Wisconsin) -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-54 Reitz, Rolf (University of Wisconsin) -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

4-81 Richardson, Thomas (Lawrence Berkeley National Laboratory) -- Phase Behavior and Solid State Chemistry in Olivines / Exploratory Battery Research

2-18 Richardson, Tom (Lawrence Berkeley National Laboratory) -- Diagnostics at LBNL / Applied Battery Research

10-20 Roby, Stephen (Chevron) -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

5-8 Rogers, Susan (U.S. Department of Energy) -- Advanced Power Electronics and Electric Motors R&D / Advanced Power Electronics

2-4 Roth, Pete (Sandia National Laboratories) -- Abuse Tolerance Improvement / Applied Battery Research

3-4 Roth, Pete (Sandia National Laboratories) -- Abuse Testing of High-Power Batteries / Battery Development, Testing, Simulation, Analysis

14-25 Rousseau, Aymeric (Argonne National Laboratory) -- GM Cooperative Research and Development Agreement / Vehicle Systems and Simulation

14-27 Rousseau, Aymeric (Argonne National Laboratory) -- Government Performance and Results Act and Multipath / Vehicle Systems and Simulation

14-50 Rousseau, Aymeric (Argonne National Laboratory) -- PHEV Component Sizing / Vehicle Systems and Simulation

14-52 Rousseau, Aymeric (Argonne National Laboratory) -- PHEV Control Impact and Optimization / Vehicle Systems and Simulation

12-44 Routbort, Jules (Argonne National Laboratory) -- Joining of Advanced Materials by Plasticity / Propulsion Materials

12-75 Routbort, Jules (Argonne National Laboratory) -- Residual Stress / Propulsion Materials

12-87 Routbort, Jules (Argonne National Laboratory) -- Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials / Propulsion Materials

14-20 Routbort, Jules (Argonne National Laboratory) -- Erosion of Advanced Radiator Materials / Vehicle Systems and Simulation

14-38 Routbort, Jules (Argonne National Laboratory) -- Nano Fluids for Thermal Control Applications / Vehicle Systems and Simulation

9-61 Ruth, M. (Cummins Inc.) -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

7-54 Rutland, Chris (University of Wisconsin) -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

14-7 Salari, Kambiz (Lawrence Livermore National Laboratory) -- Aerodynamic Drag Reduction / Vehicle Systems and Simulation

5-27 Salasoo, Lembit (General Electric) -- Scalable, Low-Cost, High-Performance IPM Motor / Advanced Power Electronics

7-54 Sanders, S. (University of Wisconsin) -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

11-46 Santella, Mike (Oak Ridge National Laboratory) -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

3-31 Santini, Dan (Argonne National Laboratory) -- Requirements and Targets Validation / Battery Development, Testing, Simulation, Analysis

4-44 Sastry, Ann Marie (University of Michigan) -- Microscale Electrode Design Using Coupled Kinetic, Thermal, and Mechanical Modeling / Exploratory Battery Research

6-14 Schock, Harold (Michigan State University) -- Thermoelectric Conversion of Waste Heat to Electricity / Solid State Energy Conversion

8-4 Schram, Tim (Ford Motor Company) -- Advanced Boost System Development for Diesel HCCI Application / High Efficiency Clean Combustion

15-9 Seiff, Hank (Clean Vehicle Education Foundation') -- CNG Cylinder Safety Program / Deployment

4-36 Sethuraman, Vijay (Lawrence Berkeley National Laboratory) -- Kinetics of Lithium Insertion into Silicon Anodes / Exploratory Battery Research

4-70 Shao-Horn, Y (Massachusetts Institute of Technology) -- Origin of Surface Instability of Lithium Positive Electrode Materials upon Cycling / Exploratory Battery Research

14-25 Sharer, Phil (Argonne National Laboratory) -- GM Cooperative Research and Development Agreement / Vehicle Systems and Simulation

14-50 Sharer, Phil (Argonne National Laboratory) -- PHEV Component Sizing / Vehicle Systems and Simulation

14-52 Sharer, Phil (Argonne National Laboratory) -- PHEV Control Impact and Optimization / Vehicle Systems and Simulation

14-9 Shidore, Neeraj (Argonne National Laboratory) -- Battery Hardware-in-the-Loop / Vehicle Systems and Simulation

4-25 Shin, Joon Ho (Lawrence Berkeley National Laboratory) -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

12-20 Shyam, Amit (Oak Ridge National Laboratory) -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

12-55 Sikka, V.K. (Oak Ridge National Laboratory) -- Materials for HCCI Engines / Propulsion Materials

7-17 Silke, Emma (Lawrence Livermore National Laboratory) -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Silke, Emma (Lawrence Livermore National Laboratory) -- LLNL APBF / Fuels Technologies

15-12 Simms, Stacey (Colorado Governor's Energy Office) -- Colorado E85 Infrastructure Project / Deployment

11-36 Simunovic, Srdjan (Oak Ridge National Laboratory) -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

11-134 Simunovic, Srdjan (Oak Ridge National Laboratory) -- Strain-Rate Characterization/Strain-Rate Characterization Technology Development / Lightweight Materials

12-85 Singh, David (Oak Ridge National Laboratory) -- Thermoelectrics Materials by Design, Computational Theory and Structure / Propulsion Materials

12-44 Singh, Dileep (Argonne National Laboratory) -- Joining of Advanced Materials by Plasticity / Propulsion Materials

12-75 Singh, Dileep (Argonne National Laboratory) -- Residual Stress / Propulsion Materials

12-87 Singh, Dileep (Argonne National Laboratory) -- Thermoelectrics Materials by Design, Diamond-Based Thermoelectric materials / Propulsion Materials

14-20 Singh, Dileep (Argonne National Laboratory) -- Erosion of Advanced Radiator Materials / Vehicle Systems and Simulation

14-38 Singh, Dileep (Argonne National Laboratory) -- Nano Fluids for Thermal Control Applications / Vehicle Systems and Simulation

7-11 Sjoberg, Magnus (Sandia National Laboratories) -- Advanced HCCI Engine Combustion Fundamentals / Combustion Research

11-36 Sklad, Phil (Oak Ridge National Laboratory) -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

11-46 Sklad, Phil (Oak Ridge National Laboratory) -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

11-134 Sklad, Phil (Oak Ridge National Laboratory) -- Strain-Rate Characterization/Strain-Rate Characterization Technology Development / Lightweight Materials

10-6 Sluder, Scott (Oak Ridge National Laboratory) -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-37 Sluder, Scott (Oak Ridge National Laboratory) -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

10-39 Sluder, Scott (Oak Ridge National Laboratory) -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

4-48 Smith, Grant (University of Utah) -- Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces / Exploratory Battery Research

5-25 Smith, Greg (General Motors Corporation) -- Integrated Traction Drive System / Advanced Power Electronics

11-11 Smith, Mark (Pacific Northwest National Laboratory) -- Characterization of Thermomechanical Behavior of TRIP Steels / Lightweight Materials

11-83 Smith, Mark (Pacific Northwest National Laboratory) -- Low Cost Titanium / Lightweight Materials

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11-59 Chrysler LLC (Olszewski, Gerry -- High-Volume Processing of Composites / Lightweight Materials

11-110 Chrysler LLC (Olszewski, Gerry -- P4 Preform / Lightweight Materials

15-9 Clean Vehicle Education Foundation' (Seiff, Hank -- CNG Cylinder Safety Program / Deployment

4-58 Clemson University (Creager, Stephen -- New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization / Exploratory Battery Research

4-58 Clemson University (DesMarteau, D -- New Lithium-based Ionic Liquid Electrolytes that Resist Salt Concentration Polarization / Exploratory Battery Research

15-12 Colorado Governor's Energy Office (Simms, Stacey -- Colorado E85 Infrastructure Project / Deployment

4-21 Columbia University (Crowther, Owen -- In Situ Observations of Lithium Dendrite Growth / Exploratory Battery Research

4-21 Columbia University (West, Alan -- In Situ Observations of Lithium Dendrite Growth / Exploratory Battery Research

3-15 Compact Power (Alamgir, Mohamed -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

8-47 Cummins Inc. (Andrews, Eric -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

12-30 Cummins Inc. (Chen, Yong-Ching -- Fatigue Enhancements by Shock Peening (Cummins) / Propulsion Materials

9-61 Cummins Inc. (Cunningham, M -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

9-50 Cummins Inc. (Currier, Neal -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-61 Cummins Inc. (Currier, Neal -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

8-31 Cummins Inc. (Frazier, Tim -- Light-Duty Efficient Clean Combustion / High Efficiency Clean Combustion

8-47 Cummins Inc. (Garimella, Phanindra -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

9-61 Cummins Inc. (Kamasamudram, K. -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

12-20 Cummins Inc. (Klepser, Cheryl -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

9-50 Cummins Inc. (Li, Junhui -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

8-22 Cummins Inc. (Nelson, Chris -- Exhaust Energy Recovery / High Efficiency Clean Combustion

9-61 Cummins Inc. (Ruth, M. -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

9-50 Cummins Inc. (Stafford, Randy -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

12-20 Cummins Inc. (Stafford, Randy -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

9-50 Cummins Inc. (Stang, John -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

8-15 Cummins Inc. (Stanton, Don -- Enabling High-Efficiency Clean Combustion (HECC) / High Efficiency Clean Combustion

9-61 Cummins Inc. (Whitacre, Shawn -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

9-50 Cummins Inc. (Yezerets, Alex -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-61 Cummins Inc. (Yezerets, Alex -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

12-20 Cummins Inc. (Yezerets, Alex -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

12-20 Cummins Inc. (Yonushonis, Tom -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

7-65 Delphi (Confer, Keith -- Spark-Assisted HCCI Control / Combustion Research

10-11 Delphi (Confer, Keith -- E85 Optimized Engine / Fuels Technologies

8-51 Delphi Automotive Systems (Gutterman, Jeff -- Variable Valve Actuation / High Efficiency Clean Combustion

5-17 Delphi Automotive Systems (Taylor, Ralph -- Development, Test, and Demonstration of an Inverter / Advanced Power Electronics

8-25 Detroit Diesel Corporation (Zhang, Houshun -- Heavy Truck Engine Development and HECC / High Efficiency Clean Combustion

14-23 Eaton Corporation (Killian, Mike -- Friction & Wear / Vehicle Systems and Simulation

3-18 Enerdel (Ota, Naoki -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

8-35 Envera LLC (Mendler, Charles -- Low-Cost, Fast Response Actuator / High Efficiency Clean Combustion

10-14 Ford Motor Company (Agarwal, Apoory -- E85 Optimized Engine Application / Fuels Technologies

11-43 Ford Motor Company (Jaranson, John -- Focal Project 4 – Floor Pan / Lightweight Materials

11-39 Ford Motor Company (Jones, Martin H. -- Enhanced Resonance Inspection for Light-Metal Castings / Lightweight Materials

11-140 Ford Motor Company (Maj, Michael -- Ultra-Large Casting Demonstrations / Lightweight Materials

8-4 Ford Motor Company (Schram, Tim -- Advanced Boost System Development for Diesel HCCI Application / High Efficiency Clean Combustion

10-14 Ford Motor Company (Stein, R. -- E85 Optimized Engine Application / Fuels Technologies

8-4 Ford Motor Company (Sun, Harold -- Advanced Boost System Development for Diesel HCCI Application / High Efficiency Clean Combustion

5-27 General Electric (El-Refaie, Ayman -- Scalable, Low-Cost, High-Performance IPM Motor / Advanced Power Electronics

5-27 General Electric (Johnson, Frank -- Scalable, Low-Cost, High-Performance IPM Motor / Advanced Power Electronics

5-27 General Electric (Salasoo, Lembit -- Scalable, Low-Cost, High-Performance IPM Motor / Advanced Power Electronics

10-53 General Motors (Wu, Ko-Jen -- Use of EGR to Optimize Fuel Economy & Minimize Emissions in Engines Operating on E85 / Fuels Technologies

11-43 General Motors Corporation (Berger, Libby -- Focal Project 4 – Floor Pan / Lightweight Materials

11-21 General Motors Corporation (Botkin, Mark -- Crash Energy Management / Lightweight Materials

11-39 General Motors Corporation (Dasch, Cam -- Enhanced Resonance Inspection for Light-Metal Castings / Lightweight Materials

11-106 General Motors Corporation (Dasch, Cam -- NDE Inspection of Adhesive bonds in Metal-Metal Joints / Lightweight Materials

8-28 General Motors Corporation (Durrett, Russ -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

8-28 General Motors Corporation (Gonzalez, Manuel -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

8-28 General Motors Corporation (He, Xin -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

11-90 General Motors Corporation (Luo, Alan -- Magnesium Front-End R&D / Lightweight Materials

8-28 General Motors Corporation (Patton, Ken -- HECC Engine Designs for Spark-Ignition and Compression-Ignition Engines / High Efficiency Clean Combustion

5-25 General Motors Corporation (Smith, Greg -- Integrated Traction Drive System / Advanced Power Electronics

11-33 General Motors Corporation (Stoughton, Tom -- Die-Face Engineering Project for Advanced Sheet-Forming Materials / Lightweight Materials

6-3 General Motors Corporation (Yang, Jihui -- Development of Thermoelectric Technology for Automotive Waste Heat Recovery / Solid State Energy Conversion

13-3 Health Effects Institute (Bailey, Brent -- Collaborative Emissions Study (ACES) / Health Impacts

13-3 Health Effects Institute (Costantini, M. -- Collaborative Emissions Study (ACES) / Health Impacts

13-3 Health Effects Institute (Greenbaum, Dan -- Collaborative Emissions Study (ACES) / Health Impacts

13-3 Health Effects Institute (Tennant, Chris -- Collaborative Emissions Study (ACES) / Health Impacts

13-3 Health Effects Institute (Warren, J. -- Collaborative Emissions Study (ACES) / Health Impacts

4-40 Hydro-Quebec (Zaghib, K -- Low-Cost Graphite and Olivine-Based Materials for Li-Ion Batteries / Exploratory Battery Research

3-34 Idaho National Laboratory (Belt, Jeff -- Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

2-28 Idaho National Laboratory (Christopherson, Jon -- Gen 3 Cell Testing / Applied Battery Research

2-37 Idaho National Laboratory (Christopherson, Jon -- Life Validation Testing Protocol Development / Applied Battery Research

14-41 Idaho National Laboratory (Francfort, Jim -- Non-PHEV Evaluations and Data Collection / Vehicle Systems and Simulation

14-54 Idaho National Laboratory (Francfort, Jim -- PHEV Evaluation and Data Collection / Vehicle Systems and Simulation

2-8 Idaho National Laboratory (Gering, Kevin -- Advanced Chemistry: Electrolyte Modeling / Applied Battery Research

2-73 Idaho National Laboratory (Gering, Kevin -- Statistical DOE at INL / Applied Battery Research

3-34 Idaho National Laboratory (Murphy, Tim -- Testing USABC (High-Power Energy Storage) Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

3-38 Idaho National Laboratory (Murphy, Tim -- Testing USABC (PHEV Battery Development) Deliverables/Benchmarking / Battery Development, Testing, Simulation, Analysis

7-42 Iowa State University (Kong, Song-Charng -- KIVA Modeling to Support Diesel Combustion Research / Combustion Research

7-42 Iowa State University (Xue, Qingluan -- KIVA Modeling to Support Diesel Combustion Research / Combustion Research

3-21 Johnson Controls-SAFT (Andrew, Mike -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

9-50 Johnson Matthey (Chen, Hai-Ying -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-50 Johnson Matthey (Hess, Howard -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

7-48 Kookmin University (Kim, Duksang -- Light-Duty Combustion Modeling (UWI) / Combustion Research

15-18 Kum-n-Go (Steely, Ben -- Kum-n-Go E85 Infrastructure Project / Deployment

4-8 Lawrence Berkeley National Laboratory (Balsara, Nitash -- Block Copolymer Electrolytes for High-Energy Density Lithium Batteries / Exploratory Battery Research

4-25 Lawrence Berkeley National Laboratory (Basak, Pratyay -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

2-31 Lawrence Berkeley National Laboratory (Battaglia, Vince -- Life Validation Testing Protocol Development / Applied Battery Research

4-17 Lawrence Berkeley National Laboratory (Battaglia, Vince -- Electrode Construction and Testing / Exploratory Battery Research

4-25 Lawrence Berkeley National Laboratory (Beer, Leanne -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

4-66 Lawrence Berkeley National Laboratory (Doeff, Marca -- Olivines and Substituted Layered Materials / Exploratory Battery Research

4-25 Lawrence Berkeley National Laboratory (Kerr, John -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

2-18 Lawrence Berkeley National Laboratory (Kostecki, Robert -- Diagnostics at LBNL / Applied Battery Research

4-4 Lawrence Berkeley National Laboratory (Kostecki, Robert -- 3-D Nanostructured Carbon-Tin Composite Anodes / Exploratory Battery Research

2-18 Lawrence Berkeley National Laboratory (McLarnon, Frank -- Diagnostics at LBNL / Applied Battery Research

4-36 Lawrence Berkeley National Laboratory (Newman, John -- Kinetics of Lithium Insertion into Silicon Anodes / Exploratory Battery Research

4-81 Lawrence Berkeley National Laboratory (Richardson, Thomas -- Phase Behavior and Solid State Chemistry in Olivines / Exploratory Battery Research

2-18 Lawrence Berkeley National Laboratory (Richardson, Tom -- Diagnostics at LBNL / Applied Battery Research

4-36 Lawrence Berkeley National Laboratory (Sethuraman, Vijay -- Kinetics of Lithium Insertion into Silicon Anodes / Exploratory Battery Research

4-25 Lawrence Berkeley National Laboratory (Shin, Joon Ho -- Interfacial Behavior of Electrolytes / Exploratory Battery Research

4-36 Lawrence Berkeley National Laboratory (Srinivasan, Venkat -- Kinetics of Lithium Insertion into Silicon Anodes / Exploratory Battery Research

4-74 Lawrence Berkeley National Laboratory (Srinivasan, Venkat -- Overview: Batteries for Advanced Transportation Technologies (BATT) Program / Exploratory Battery Research

4-93 Lawrence Berkeley National Laboratory (Srinivasan, Venkat -- Summary and Future Plans / Exploratory Battery Research

7-24 Lawrence Livermore National Laboratory (Aceves, Salvador -- HCCI Engine Research and Modeling / Combustion Research

10-28 Lawrence Livermore National Laboratory (Aceves, Salvador -- LLNL APBF / Fuels Technologies

10-28 Lawrence Livermore National Laboratory (Buchholz, Bruce -- LLNL APBF / Fuels Technologies

10-28 Lawrence Livermore National Laboratory (Davisson, Lee -- LLNL APBF / Fuels Technologies

7-24 Lawrence Livermore National Laboratory (Edman, Jonas -- HCCI Engine Research and Modeling / Combustion Research

7-24 Lawrence Livermore National Laboratory (Flowers, Dan -- HCCI Engine Research and Modeling / Combustion Research

10-28 Lawrence Livermore National Laboratory (Flowers, Dan -- LLNL APBF / Fuels Technologies

12-68 Lawrence Livermore National Laboratory (Glass, Robert -- NOx Sensor Development / Propulsion Materials

7-17 Lawrence Livermore National Laboratory (Herbinet, Olivier -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Lawrence Livermore National Laboratory (Herbinet, Olivier -- LLNL APBF / Fuels Technologies

7-24 Lawrence Livermore National Laboratory (Killingsworth, Nick -- HCCI Engine Research and Modeling / Combustion Research

10-28 Lawrence Livermore National Laboratory (Killingsworth, Nick -- LLNL APBF / Fuels Technologies

12-68 Lawrence Livermore National Laboratory (Martin, Peter -- NOx Sensor Development / Propulsion Materials

7-24 Lawrence Livermore National Laboratory (Piggott, Tom -- HCCI Engine Research and Modeling / Combustion Research

7-17 Lawrence Livermore National Laboratory (Pitz, Bill -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Lawrence Livermore National Laboratory (Pitz, Bill -- LLNL APBF / Fuels Technologies

14-7 Lawrence Livermore National Laboratory (Salari, Kambiz -- Aerodynamic Drag Reduction / Vehicle Systems and Simulation

7-17 Lawrence Livermore National Laboratory (Silke, Emma -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Lawrence Livermore National Laboratory (Silke, Emma -- LLNL APBF / Fuels Technologies

7-17 Lawrence Livermore National Laboratory (Westbrook, Charles -- Chemical Kinetic Research on HCCI and Diesel Fuels / Combustion Research

10-28 Lawrence Livermore National Laboratory (Westbrook, Charles -- LLNL APBF / Fuels Technologies

12-68 Lawrence Livermore National Laboratory (Woo, Leta -- NOx Sensor Development / Propulsion Materials

7-42 Los Alamos National Laboratory (Torres, David -- KIVA Modeling to Support Diesel Combustion Research / Combustion Research

8-43 Mack Trucks Inc. (Habibzadeh, Bahman -- Narrow-Band Engine and a CVT to Optimize Performance / High Efficiency Clean Combustion

10-45 Mahle (Woodrow, Bruce -- Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) / Fuels Technologies

4-62 Massachusetts Institute of Technology (Ceder, Gerbrand -- Olivine and Layered Materials (Characterization, Rate Performance, and Stability) / Exploratory Battery Research

7-72 Massachusetts Institute of Technology (Cheng, Wai -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

4-70 Massachusetts Institute of Technology (Shao-Horn, Y -- Origin of Surface Instability of Lithium Positive Electrode Materials upon Cycling / Exploratory Battery Research

6-14 Michigan State University (Schock, Harold -- Thermoelectric Conversion of Waste Heat to Electricity / Solid State Energy Conversion

16-6 N/A (N/A -- GATE Awards / Technology Integration/Education

15-21 National Biodiesel Board (Hamilton, Jill -- NBB Terminal Blending / Deployment

12-40 National Energy Technology Laboratory (Hsu, Stephen -- IEA Annex on Materials For Transportation / Propulsion Materials

15-3 National Energy Technology Laboratory (Milewski, Kay -- Clean Cities Coalition Regional Support / Deployment

12-42 National Energy Technology Laboratory (Yocum, Aaron -- Integrated Surface Engineering for Improving Energy Efficiency / Propulsion Materials

10-9 National Renewable Energy Laboratory (Alexander, Colleen -- APBF Impacts on Advanced Combustion Engines / Fuels Technologies

4-54 National Renewable Energy Laboratory (Benhammou, Dan -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

15-6 National Renewable Energy Laboratory (Bergeron, Paul -- Clean Cities-Core Program and Tools / Deployment

15-15 National Renewable Energy Laboratory (Bergeron, Paul -- EPAct Data Collection and Management / Deployment

10-34 National Renewable Energy Laboratory (Clark, Wendy -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

4-54 National Renewable Energy Laboratory (Dillon, Anne -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

4-54 National Renewable Energy Laboratory (Gillaspie, Dane -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

5-10 National Renewable Energy Laboratory (Kelly, Ken -- Advanced Thermal Interface Materials, Characterization & Dev. of Advanced Heat Transfer Technologies / Advanced Power Electronics

4-54 National Renewable Energy Laboratory (Kim, Yong-Hyun -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

10-34 National Renewable Energy Laboratory (Knoll, Keith -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

10-34 National Renewable Energy Laboratory (Lawson, Doug -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

13-9 National Renewable Energy Laboratory (Lawson, Doug -- Health Impacts Research / Health Impacts

14-62 National Renewable Energy Laboratory (Markel, Tony -- Thermoelectric Analysis, Integrated Vehicle Thermal Management Systems Analysis/Modeling / Vehicle Systems and Simulation

10-42 National Renewable Energy Laboratory (McCormick, Robert -- NPBF Quality, Stability, Performance, and Emission Impacts of Biodiesel Blends / Fuels Technologies

3-25 National Renewable Energy Laboratory (Pesaran, Ahmad -- IEA/HEV Implementing Agreement / Battery Development, Testing, Simulation, Analysis

3-45 National Renewable Energy Laboratory (Pesaran, Ahmad -- Thermal Management Modeling / Battery Development, Testing, Simulation, Analysis

3-49 National Renewable Energy Laboratory (Pesaran, Ahmad -- Thermal Management Studies / Battery Development, Testing, Simulation, Analysis

4-54 National Renewable Energy Laboratory (Pesaran, Ahmad -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

14-15 National Renewable Energy Laboratory (Proc, Ken -- Cool Cab Truck Thermal Load Reduction / Vehicle Systems and Simulation

10-4 National Renewable Energy Laboratory (Ratcliff, Matt -- Advanced Fuel and Lubricant Impacts on Emerging and Existing Diesel Engines / Fuels Technologies

10-9 National Renewable Energy Laboratory (Ratcliff, Matt -- APBF Impacts on Advanced Combustion Engines / Fuels Technologies

4-54 National Renewable Energy Laboratory (Sullivan, Patrick -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

10-9 National Renewable Energy Laboratory (Taylor, Joshua -- APBF Impacts on Advanced Combustion Engines / Fuels Technologies

14-35 National Renewable Energy Laboratory (Walcowicz, Kevin -- Medium-Duty/Heavy-Duty Advanced Technology Evaluations / Vehicle Systems and Simulation

4-54 National Renewable Energy Laboratory (Whitney, Erin -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

8-39 Navistar Inc. (Ojeda, Willy -- Low-Temperature Combustion Demonstrator for High-Efficiency Clean Combustion / High Efficiency Clean Combustion

5-34 Oak Ridge National Laboratory (Adams, Don -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

12-15 Oak Ridge National Laboratory (Allard, Larry -- Catalysts via First Principles / Propulsion Materials

12-17 Oak Ridge National Laboratory (Allard, Larry -- Characterization of Catalyst Microstructures and Deactivation Mechanism / Propulsion Materials

12-70 Oak Ridge National Laboratory (Armstrong, B.L. -- Power Electronics Materials Compatibility / Propulsion Materials

12-70 Oak Ridge National Laboratory (Ayers, C.W. -- Power Electronics Materials Compatibility / Propulsion Materials

5-34 Oak Ridge National Laboratory (Ayers, Curt -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

10-39 Oak Ridge National Laboratory (Barone, Teresa -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

13-6 Oak Ridge National Laboratory (Barone, Teresa -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

12-55 Oak Ridge National Laboratory (Battiste, R. -- Materials for HCCI Engines / Propulsion Materials

12-32 Oak Ridge National Laboratory (Blau, Peter -- Friction and Wear Reduction in Diesel Engine Valve Trains / Propulsion Materials

12-60 Oak Ridge National Laboratory (Blau, Peter -- Materials for High-Pressure Fuel Injection Systems / Propulsion Materials

7-7 Oak Ridge National Laboratory (Briggs, Tom -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

10-6 Oak Ridge National Laboratory (Bunting, Bruce -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-23 Oak Ridge National Laboratory (Bunting, Bruce -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-37 Oak Ridge National Laboratory (Bunting, Bruce -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

12-55 Oak Ridge National Laboratory (Bunting, Bruce -- Materials for HCCI Engines / Propulsion Materials

5-32 Oak Ridge National Laboratory (Burress, Tim -- Technology Benchmarking / Advanced Power Electronics

7-68 Oak Ridge National Laboratory (Chakravarthy, V. Kalyana -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

7-7 Oak Ridge National Laboratory (Cho, Kukwon -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

10-37 Oak Ridge National Laboratory (Cho, Kukwon -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

9-16 Oak Ridge National Laboratory (Choi, Jae-Soon -- CLEERS NOx Adsorber Kinetics and the Multi-Lab Diesel Emissions Reduction Activities / Emission Control/Aftertreatment

9-61 Oak Ridge National Laboratory (Choi, Jae-Soon -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

9-67 Oak Ridge National Laboratory (Choi, Jae-Soon -- Pre-Competitive R&D on NOx Adsorber Mechanisms / Emission Control/Aftertreatment

7-65 Oak Ridge National Laboratory (Daw, Stuart -- Spark-Assisted HCCI Control / Combustion Research

7-68 Oak Ridge National Laboratory (Daw, Stuart -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

9-28 Oak Ridge National Laboratory (Daw, Stuart -- Coordination of Cross-Cut Lean Exhaust Emission Reduction Simulation (CLEERS) Project / Emission Control/Aftertreatment

10-39 Oak Ridge National Laboratory (Daw, Stuart -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

14-17 Oak Ridge National Laboratory (Daw, Stuart -- Emissions Aftertreatment and Engine Cold-Starting Modeling / Vehicle Systems and Simulation

4-32 Oak Ridge National Laboratory (Dudney, Nancy -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

10-6 Oak Ridge National Laboratory (Eaton, Scott -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-23 Oak Ridge National Laboratory (Eaton, Scott -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-37 Oak Ridge National Laboratory (Eaton, Scott -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

7-7 Oak Ridge National Laboratory (Edwards, Dean -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

7-65 Oak Ridge National Laboratory (Edwards, Dean -- Spark-Assisted HCCI Control / Combustion Research

10-17 Oak Ridge National Laboratory (Edwards, Dean -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-37 Oak Ridge National Laboratory (Edwards, Dean -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

11-11 Oak Ridge National Laboratory (Feng, Zhili -- Characterization of Thermomechanical Behavior of TRIP Steels / Lightweight Materials

11-36 Oak Ridge National Laboratory (Feng, Zhili -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

7-65 Oak Ridge National Laboratory (Finney, Charles E.A. -- Spark-Assisted HCCI Control / Combustion Research

12-10 Oak Ridge National Laboratory (Gallego, Nidia -- Carbon Foam Thermal Management / Propulsion Materials

7-68 Oak Ridge National Laboratory (Graves, Ron -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

10-34 Oak Ridge National Laboratory (Graves, Ron -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

12-25 Oak Ridge National Laboratory (Graves, Ron -- Evaluation of Combustion characteristics and Materials via ACERT Engine (Caterpillar) / Propulsion Materials

7-68 Oak Ridge National Laboratory (Green Jr., Johney B. -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

7-65 Oak Ridge National Laboratory (Green, Jr., Johney B. -- Spark-Assisted HCCI Control / Combustion Research

7-7 Oak Ridge National Laboratory (Hale, Richard -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

10-37 Oak Ridge National Laboratory (Han, Manbae -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

9-25 Oak Ridge National Laboratory (Huff, Shean -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

10-17 Oak Ridge National Laboratory (Huff, Shean -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-34 Oak Ridge National Laboratory (Huff, Shean -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

9-25 Oak Ridge National Laboratory (Kass, Mike -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

4-32 Oak Ridge National Laboratory (Kercher, Andrew -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

4-32 Oak Ridge National Laboratory (Kiggans, Jim -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

12-77 Oak Ridge National Laboratory (Kircher, Andrew -- Solder Joints of Power Electronics / Propulsion Materials

13-6 Oak Ridge National Laboratory (Kranendonk, Laura -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

11-120 Oak Ridge National Laboratory (Kunc, V. -- Predictive Modeling of Polymer Composites / Lightweight Materials

10-39 Oak Ridge National Laboratory (Lance, Michael -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

12-20 Oak Ridge National Laboratory (Lara-Curzio, Edgar -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

12-35 Oak Ridge National Laboratory (Lara-Curzio, Edgar -- High-Temperature Materials Laboratory / Propulsion Materials

10-6 Oak Ridge National Laboratory (Lewis, Sam -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-37 Oak Ridge National Laboratory (Lewis, Sam -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

10-39 Oak Ridge National Laboratory (Lewis, Sam -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

13-6 Oak Ridge National Laboratory (Lewis, Sam -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

12-49 Oak Ridge National Laboratory (Lin, H.T. -- Lightweight Valve Train Materials (Titanium) / Propulsion Materials

12-63 Oak Ridge National Laboratory (Lin, H.T. -- Mechanical Reliability of Piezo-Stack Actuators / Propulsion Materials

5-15 Oak Ridge National Laboratory (Marlino, Laura -- Current Source Inverter / Advanced Power Electronics

5-34 Oak Ridge National Laboratory (Marlino, Laura -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

5-37 Oak Ridge National Laboratory (Marlino, Laura -- Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs / Advanced Power Electronics

12-5 Oak Ridge National Laboratory (Maziasz, Phil -- Austenitic Stainless Steel Alloys of Exhaust Components / Propulsion Materials

12-52 Oak Ridge National Laboratory (Maziasz, Phil -- Materials for Advanced Engine Valve Train / Propulsion Materials

5-34 Oak Ridge National Laboratory (McKeever, John -- Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors / Advanced Power Electronics

12-15 Oak Ridge National Laboratory (Moses-DeBusk, M. -- Catalysts via First Principles / Propulsion Materials

12-55 Oak Ridge National Laboratory (Muralidharan, G. -- Materials for HCCI Engines / Propulsion Materials

12-77 Oak Ridge National Laboratory (Muralidharan, G. -- Solder Joints of Power Electronics / Propulsion Materials

12-15 Oak Ridge National Laboratory (Narula, C.K. -- Catalysts via First Principles / Propulsion Materials

5-19 Oak Ridge National Laboratory (Olszewski, Mitch -- Direct-Cooled Power Electronics Substrate / Advanced Power Electronics

5-32 Oak Ridge National Laboratory (Olszewski, Mitch -- Technology Benchmarking / Advanced Power Electronics

5-4 Oak Ridge National Laboratory (Ozpineci, Burak -- Active Filter Approach to the Reduction of the DC Link Capacitor / Advanced Power Electronics

5-6 Oak Ridge National Laboratory (Ozpineci, Burak -- Advanced Converter Systems for High-Temperature HEV Environments / Advanced Power Electronics

5-39 Oak Ridge National Laboratory (Ozpineci, Burak -- Wide Bandgap Materials / Advanced Power Electronics

12-77 Oak Ridge National Laboratory (Ozpineci, Burak -- Solder Joints of Power Electronics / Propulsion Materials

4-32 Oak Ridge National Laboratory (Park, Sea Hoon -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

9-25 Oak Ridge National Laboratory (Parks, Jim -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

9-45 Oak Ridge National Laboratory (Parks, Jim -- Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation / Emission Control/Aftertreatment

9-61 Oak Ridge National Laboratory (Parks, Jim -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

13-6 Oak Ridge National Laboratory (Parks, Jim -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

9-61 Oak Ridge National Laboratory (Partridge, Bill -- NOx Aftertreatment CRADA with Cummins / Emission Control/Aftertreatment

12-70 Oak Ridge National Laboratory (Pawel, S.J. -- Power Electronics Materials Compatibility / Propulsion Materials

12-47 Oak Ridge National Laboratory (Phillips, Nate -- Life Prediction for Diesel Engine Components / Propulsion Materials

12-66 Oak Ridge National Laboratory (Phillips, Nate -- Non-Destructive Evaluation of Diesel Components / Propulsion Materials

7-68 Oak Ridge National Laboratory (Pihl, Josh -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

9-57 Oak Ridge National Laboratory (Pihl, Josh -- NOx Adsorber R&D (CRADA between ORNL and International Truck and Engine Company) / Emission Control/Aftertreatment

9-25 Oak Ridge National Laboratory (Prikhodko, Vitaly -- Controlling NOx from Multi-Mode Lean DI Engines / Emission Control/Aftertreatment

7-7 Oak Ridge National Laboratory (Qualls, A. Lou -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

7-68 Oak Ridge National Laboratory (Qualls, A. Lou -- Stretch Efficiency -- Thermodynamic Analysis of New Combustion Regimes / Combustion Research

11-46 Oak Ridge National Laboratory (Santella, Mike -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

12-20 Oak Ridge National Laboratory (Shyam, Amit -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

12-55 Oak Ridge National Laboratory (Sikka, V.K. -- Materials for HCCI Engines / Propulsion Materials

11-36 Oak Ridge National Laboratory (Simunovic, Srdjan -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

11-134 Oak Ridge National Laboratory (Simunovic, Srdjan -- Strain-Rate Characterization/Strain-Rate Characterization Technology Development / Lightweight Materials

12-85 Oak Ridge National Laboratory (Singh, David -- Thermoelectrics Materials by Design, Computational Theory and Structure / Propulsion Materials

11-36 Oak Ridge National Laboratory (Sklad, Phil -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

11-46 Oak Ridge National Laboratory (Sklad, Phil -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

11-134 Oak Ridge National Laboratory (Sklad, Phil -- Strain-Rate Characterization/Strain-Rate Characterization Technology Development / Lightweight Materials

10-6 Oak Ridge National Laboratory (Sluder, Scott -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-37 Oak Ridge National Laboratory (Sluder, Scott -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

10-39 Oak Ridge National Laboratory (Sluder, Scott -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

14-59 Oak Ridge National Laboratory (Smith, Richard -- PHEV Value Proposition Study / Vehicle Systems and Simulation

11-134 Oak Ridge National Laboratory (Starbuck J. Michael -- Strain-Rate Characterization/Strain-Rate Characterization Technology Development / Lightweight Materials

12-10 Oak Ridge National Laboratory (Stinton, David -- Carbon Foam Thermal Management / Propulsion Materials

10-6 Oak Ridge National Laboratory (Storey, John -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-37 Oak Ridge National Laboratory (Storey, John -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

10-39 Oak Ridge National Laboratory (Storey, John -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

13-6 Oak Ridge National Laboratory (Storey, John -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

10-39 Oak Ridge National Laboratory (Strzelec, Andrea -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

12-49 Oak Ridge National Laboratory (Sun J.G. -- Lightweight Valve Train Materials (Titanium) / Propulsion Materials

10-6 Oak Ridge National Laboratory (Szybist, Jim -- APBF Fuel Effects on Advanced Combustion Regimes / Fuels Technologies

10-17 Oak Ridge National Laboratory (Szybist, Jim -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-37 Oak Ridge National Laboratory (Szybist, Jim -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

13-6 Oak Ridge National Laboratory (Szybist, Jim -- Health Impacts – Unregulated Emissions from Emerging Technologies / Health Impacts

10-34 Oak Ridge National Laboratory (Theiss, Tim -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

10-17 Oak Ridge National Laboratory (Thomas, John -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-34 Oak Ridge National Laboratory (Thomas, John -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

4-32 Oak Ridge National Laboratory (Tiegs, Terry -- Investigation of Metallic Lithium Anode and Graphite Current Collector for Advanced Batteries / Exploratory Battery Research

5-6 Oak Ridge National Laboratory (Tolbert, Leon -- Advanced Converter Systems for High-Temperature HEV Environments / Advanced Power Electronics

9-57 Oak Ridge National Laboratory (Toops, Todd -- NOx Adsorber R&D (CRADA between ORNL and International Truck and Engine Company) / Emission Control/Aftertreatment

10-23 Oak Ridge National Laboratory (Toops, Todd -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-39 Oak Ridge National Laboratory (Toops, Todd -- NPBF Effects and Enhancements on Engine Emission Control Technologies / Fuels Technologies

7-4 Oak Ridge National Laboratory (Wagner, Robert -- Achieving High-Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines / Combustion Research

7-7 Oak Ridge National Laboratory (Wagner, Robert -- Achieving/Demonstrating FreedomCAR/ACEC Efficiency Goal / Combustion Research

7-65 Oak Ridge National Laboratory (Wagner, Robert -- Spark-Assisted HCCI Control / Combustion Research

10-17 Oak Ridge National Laboratory (Wagner, Robert -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-37 Oak Ridge National Laboratory (Wagner, Robert -- NPBF Characteristics Effects on Advanced Combustion Engines / Fuels Technologies

12-63 Oak Ridge National Laboratory (Wang, Hong -- Mechanical Reliability of Piezo-Stack Actuators / Propulsion Materials

12-92 Oak Ridge National Laboratory (Wang, Hsin -- Thermoelectrics Materials by Design, Mechanical Reliability / Propulsion Materials

11-5 Oak Ridge National Laboratory (Warren, David -- Advanced Oxidation of Carbon-Fiber Precursors / Lightweight Materials

11-8 Oak Ridge National Laboratory (Warren, David -- Advanced Stabilization of Carbon-Fiber Precursors / Lightweight Materials

11-27 Oak Ridge National Laboratory (Warren, David -- Development of Next Generation P4 / Lightweight Materials

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11-68 Oak Ridge National Laboratory (Warren, David -- LCCF – Commercialization of Textile Precursor Company X / Lightweight Materials

11-71 Oak Ridge National Laboratory (Warren, David -- LCCF – FISIPE VA-PAN Development / Lightweight Materials

11-74 Oak Ridge National Laboratory (Warren, David -- LCCF – Precursor and Fiber Evaluation / Lightweight Materials

11-77 Oak Ridge National Laboratory (Warren, David -- LCCF Precursors / Lightweight Materials

12-13 Oak Ridge National Laboratory (Watkins, Thomas -- Catalyst Characterization / Propulsion Materials

12-20 Oak Ridge National Laboratory (Watkins, Thomas -- Durability of Diesel Engine Particulate Filters / Propulsion Materials

12-22 Oak Ridge National Laboratory (Wereszczak, Andrew -- Environmental Effects on Power Electronics / Propulsion Materials

12-63 Oak Ridge National Laboratory (Wereszczak, Andrew -- Mechanical Reliability of Piezo-Stack Actuators / Propulsion Materials

12-92 Oak Ridge National Laboratory (Wereszczak, Andrew -- Thermoelectrics Materials by Design, Mechanical Reliability / Propulsion Materials

10-17 Oak Ridge National Laboratory (West, Brian -- Enhanced Ethanol Engine and Vehicle Efficiency / Fuels Technologies

10-34 Oak Ridge National Laboratory (West, Brian -- Non-Petroleum Based Fuels Intermediate Ethanol Blends / Fuels Technologies

5-19 Oak Ridge National Laboratory (Wiles, Randy -- Direct-Cooled Power Electronics Substrate / Advanced Power Electronics

12-70 Oak Ridge National Laboratory (Wilson, D.F. -- Power Electronics Materials Compatibility / Propulsion Materials

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9-34 Pacific Northwest National Laboratory (Gallant, Tom -- Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive) / Emission Control/Aftertreatment

10-51 Pacific Northwest National Laboratory (Gallant, Tom -- Unconventional Hydrocarbon Fuels / Fuels Technologies

11-46 Pacific Northwest National Laboratory (Grant, Glenn -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

12-57 Pacific Northwest National Laboratory (Grant, Glenn -- Materials for HECC/HCCI Engine Components (Caterpillar) / Propulsion Materials

6-11 Pacific Northwest National Laboratory (Hendricks, Terry -- Thermoelectric Analytical Support / Solid State Energy Conversion

9-34 Pacific Northwest National Laboratory (Herling, Darrell -- Diesel Soot Filter Characterization and Modeling for Advanced Substrates (CRADA with DOW Automotive) / Emission Control/Aftertreatment

9-64 Pacific Northwest National Laboratory (Herling, Darrell -- PNNL CLEERS Activities – Overview / Emission Control/Aftertreatment

11-103 Pacific Northwest National Laboratory (Holbery, Jim -- Natural Fiber Composite Retting, Preform Manufacturing, and Molding / Lightweight Materials

12-37 Pacific Northwest National Laboratory (Holbery, Jim -- Hydrogen Compatible Materials / Propulsion Materials

11-46 Pacific Northwest National Laboratory (Hovanski, Yuri -- Friction Stir-Spot Welding of AHSS / Lightweight Materials

9-50 Pacific Northwest National Laboratory (Kim, Do Heui -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-4 Pacific Northwest National Laboratory (King, Dave -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

11-83 Pacific Northwest National Laboratory (Lavender, Curt -- Low Cost Titanium / Lightweight Materials

9-4 Pacific Northwest National Laboratory (Li, Liyu -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

9-4 Pacific Northwest National Laboratory (Male, Jonathan -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

9-70 Pacific Northwest National Laboratory (Male, Jonathan -- Urea SCR Fundamentals / Emission Control/Aftertreatment

9-50 Pacific Northwest National Laboratory (Muntean, George -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

11-120 Pacific Northwest National Laboratory (Nguyen, B.N. -- Predictive Modeling of Polymer Composites / Lightweight Materials

11-97 Pacific Northwest National Laboratory (Nyberg, Eric -- Magnesium Research and Technology Development / Lightweight Materials

12-30 Pacific Northwest National Laboratory (Paxton, Dean -- Fatigue Enhancements by Shock Peening (Cummins) / Propulsion Materials

9-10 Pacific Northwest National Laboratory (Peden, Charles -- Characterization of Aging Mechanisms in Advanced Catalysts for SCR of NOx with Urea / Emission Control/Aftertreatment

9-13 Pacific Northwest National Laboratory (Peden, Charles -- CLEERS Diesel Soot Filter Characterization / Emission Control/Aftertreatment

9-32 Pacific Northwest National Laboratory (Peden, Charles -- Degradation Mechanisms in Advanced Catalysts for Urea SCR (CRADA with General Motors) / Emission Control/Aftertreatment

9-50 Pacific Northwest National Laboratory (Peden, Charles -- Mechanism of Sulfur Poisoning of NOx Adsorber Materials (CRADA with Cummins) / Emission Control/Aftertreatment

9-53 Pacific Northwest National Laboratory (Peden, Charles -- NOx Adsorber Fundamentals / Emission Control/Aftertreatment

9-4 Pacific Northwest National Laboratory (Rappe, Ken -- Advanced Combustion Engine Low-Temperature CO and HC Oxidation (CRADA with Caterpillar) / Emission Control/Aftertreatment

11-11 Pacific Northwest National Laboratory (Smith, Mark -- Characterization of Thermomechanical Behavior of TRIP Steels / Lightweight Materials

11-83 Pacific Northwest National Laboratory (Smith, Mark -- Low Cost Titanium / Lightweight Materials

11-97 Pacific Northwest National Laboratory (Smith, Mark -- Magnesium Research and Technology Development / Lightweight Materials

11-103 Pacific Northwest National Laboratory (Smith, Mark -- Natural Fiber Composite Retting, Preform Manufacturing, and Molding / Lightweight Materials

11-120 Pacific Northwest National Laboratory (Smith, Mark -- Predictive Modeling of Polymer Composites / Lightweight Materials

11-123 Pacific Northwest National Laboratory (Smith, Mark -- Predictive Modeling of Polymer Composites / Lightweight Materials

12-8 Pacific Northwest National Laboratory (Smith, Mark -- Bonding of Materials Using Reactive Nanofoils / Propulsion Materials

11-11 Pacific Northwest National Laboratory (Sun, Xin -- Characterization of Thermomechanical Behavior of TRIP Steels / Lightweight Materials

11-39 Pacific Northwest National Laboratory (Sun, Xin -- Enhanced Resonance Inspection for Light-Metal Castings / Lightweight Materials

12-8 Pacific Northwest National Laboratory (Sun, Xin -- Bonding of Materials Using Reactive Nanofoils / Propulsion Materials

16-27 Pennsylvania State University (Anstrom, Joel -- GATE Center for In-Vehicle High Power Energy Storage Systems / Technology Integration/Education

10-20 Reaction Design (Meeks, Ellen -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-20 Reaction Design (Modak, Abhijit -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-20 Reaction Design (Naik, Chitral -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-20 Reaction Design (Puduppakkam, Karthik -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-20 Reaction Design (Westbrook, Charlie -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-48 Robert Bosch, LLC (Yilmaz, Hakan -- Optimally Controlled Flexible Fuel Powertrain System (E85 Optimized) / Fuels Technologies

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7-11 Sandia National Laboratories (Dec, John -- Advanced HCCI Engine Combustion Fundamentals / Combustion Research

5-22 Sandia National Laboratories (Dirk, Shawn -- High-Temperature Capacitor R&D / Advanced Power Electronics

7-48 Sandia National Laboratories (Ekoto, Isaac -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-11 Sandia National Laboratories (Hwang, Wontae -- Advanced HCCI Engine Combustion Fundamentals / Combustion Research

7-57 Sandia National Laboratories (Kaiser, Sebastian -- Sandia Hydrogen Combustion Research / Combustion Research

9-21 Sandia National Laboratories (Larson, Richard -- CLEERS: Benchmark Kinetics for NOx Adsorbers and Catalyzed DPF / Emission Control/Aftertreatment

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7-61 Sandia National Laboratories (Miles, Paul -- Small Bore Advanced Combustion Engine R&D / Combustion Research

11-106 Sandia National Laboratories (Moore, David -- NDE Inspection of Adhesive bonds in Metal-Metal Joints / Lightweight Materials

10-25 Sandia National Laboratories (Mueller, Chuck -- Fuel Effects on Advanced Combustion / Fuels Technologies

7-27 Sandia National Laboratories (Musculus, Mark -- Heavy-Duty Combustion Modeling / Combustion Research

7-30 Sandia National Laboratories (Musculus, Mark -- Heavy-Duty, Low-Temperature, and Diesel Combustion Research / Combustion Research

7-45 Sandia National Laboratories (Oefelein, Joe -- LES Applied To LTC/Diesel/Hydrogen Combustion / Combustion Research

7-51 Sandia National Laboratories (Pickett, Lyle -- Low-Temperature Diesel Combustion Cross-Cut Research / Combustion Research

2-4 Sandia National Laboratories (Roth, Pete -- Abuse Tolerance Improvement / Applied Battery Research

3-4 Sandia National Laboratories (Roth, Pete -- Abuse Testing of High-Power Batteries / Battery Development, Testing, Simulation, Analysis

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7-14 Sandia National Laboratories (Steeper, Richard -- Automotive HCCI Engine Research / Combustion Research

2-41 Sandia National Laboratories (Thomas, Ed -- Life Validation Testing Protocol Development / Applied Battery Research

7-33 Sandia National Laboratories (Van Blarigan, Peter -- Hydrogen Free-Piston Engine / Combustion Research

7-72 Stanford University (Edwards, Chris -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-72 Stanford University (Gerdes, Chris -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-14 Stanford University (Hanson, Ron -- Automotive HCCI Engine Research / Combustion Research

4-51 State University of New York-Binghamton (Whittingham, S -- Nano-Structured Materials as Anodes / Exploratory Battery Research

4-96 State University of New York-Binghamton (Whittingham, S -- Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides / Exploratory Battery Research

4-62 Stony Brook University (Grey, Clare -- Olivine and Layered Materials (Characterization, Rate Performance, and Stability) / Exploratory Battery Research

7-39 Texas A&M University (Caton, Jerry -- Improved Engine Design Concepts Using the Second Law of Thermodynamics / Combustion Research

12-10 ThermalCentric (Straatman, Tony -- Carbon Foam Thermal Management / Propulsion Materials

12-10 ThermalCentric (Thompson, Brian -- Carbon Foam Thermal Management / Propulsion Materials

12-10 ThermalCentric (Yu, Qijun -- Carbon Foam Thermal Management / Propulsion Materials

11-33 TRC/NCMS (Mehta, Manish -- Die-Face Engineering Project for Advanced Sheet-Forming Materials / Lightweight Materials

11-18 U.S. Department of Energy (Carpenter, Joe -- Cost Modeling / Lightweight Materials

5-8 U.S. Department of Energy (Rogers, Susan -- Advanced Power Electronics and Electric Motors R&D / Advanced Power Electronics

3-28 U.S. Navy (Barnes, Jim -- Interagency Agreement with Navy-Technology Assessment (NSWC) / Battery Development, Testing, Simulation, Analysis

16-18 University of Alabama Birmingham (Andrews, J. Barry -- GATE Center for Advanced Lightweight Materials / Technology Integration/Education

16-18 University of Alabama Birmingham (Vaida, Uday -- GATE Center for Advanced Lightweight Materials / Technology Integration/Education

4-14 University of California at Berkeley (Newman, John -- Design of PHEVs and Electrolyte Properties / Exploratory Battery Research

7-72 University of California Berkeley (Chen, Jyh-Yuan -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-72 University of California Berkeley (Dibble, Robert -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

16-24 University of California Davis (Cunningham, Joshua -- GATE Center for Fuel Cell Hydrogen Hybrid Vehicles / Technology Integration/Education

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16-24 University of California Davis (Sperling, Dan -- GATE Center for Fuel Cell Hydrogen Hybrid Vehicles / Technology Integration/Education

4-54 University of Colorado, Boulder (Lee, Se-Hee -- Nano-Structured Metal Oxide Films / Exploratory Battery Research

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9-41 University of Houston (Harold, Mike -- Kinetic and Performance Studies of the Regeneration Phase of Model PT/RH/Ba NOx Traps / Emission Control/Aftertreatment

5-13 University of Illinois Chicago (Mazumder, Sudip -- Bi-Directional DC-DC Converter / Advanced Power Electronics

16-9 University of Illinois Urbana Champaign (Hansen, Alan -- GATE Center for Advanced Automotive Biofuels / Technology Integration/Education

16-9 University of Illinois Urbana Champaign (Kyritsis, Dimitrios -- GATE Center for Advanced Automotive Biofuels / Technology Integration/Education

16-9 University of Illinois Urbana Champaign (Lee, Chia-Fon -- GATE Center for Advanced Automotive Biofuels / Technology Integration/Education

9-37 University of Kentucky (Crocker, Mark -- Investigation of Aging Mechanisms in Lean NOx Traps / Emission Control/Aftertreatment

7-72 University of Michigan (Assanis, Dennis -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-72 University of Michigan (Babajimopolous, Aris -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

7-72 University of Michigan (Filipi, Zoran -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

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7-72 University of Michigan (Lavoie, George -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

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7-72 University of Michigan (Wooldridge, Margaret -- University Consortium on Low-Temperature Combustion for High-Efficiency, Ultra Low Emission Engines / Combustion Research

16-30 University of Michigan Dearborn (Mallick, P.K. -- GATE Center for Lightweighting Automotive Materials and Processing / Technology Integration/Education

7-57 University of New Hampshire (White, Christopher -- Sandia Hydrogen Combustion Research / Combustion Research

11-36 University of South Carolina (Chao, Y.J. -- Dynamic Characterization of Spot Welds in AHSS / Lightweight Materials

10-20 University of Southern California (Egolfopolous, Fokion -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-20 University of Southern California (Tsotsis, Theo -- Experimental and Modeling Studies of the Characteristics of Liquid Biofuels for Enhanced Combustion / Fuels Technologies

10-23 University of Tennessee (Foster, Adam -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-23 University of Tennessee (Nguyen, Ke -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-23 University of Tennessee (Ottinger, Nathan -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

10-23 University of Tennessee (Youngquist, Adam -- Fuel & Lubricant Effects on Advanced Emission Ctls, Aging Mechanisms, & Rapid Aging Protocols / Fuels Technologies

16-15 University of Tennessee Knoxville (Irick, David -- GATE Center for Advanced Hybrid Propulsion and Control Systems / Technology Integration/Education

4-77 University of Texas at Austin (Goodenough, J. -- Performance Enhancement of Cathodes with Conductive Polymers / Exploratory Battery Research

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8-47 University of Texas at Austin (Matthews, Ron -- On-Board Engine Exhaust Particulate Matter Sensor / High Efficiency Clean Combustion

4-48 University of Utah (Borodin, Oleg -- Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces / Exploratory Battery Research

4-48 University of Utah (Smith, Grant -- Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte-Electrode Interfaces / Exploratory Battery Research

7-48 University of Wisconsin (Bergin, Mike -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-54 University of Wisconsin (Farrell, P. -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

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7-54 University of Wisconsin (Ghandhi, J. -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

7-24 University of Wisconsin (Hessel, Randy -- HCCI Engine Research and Modeling / Combustion Research

7-48 University of Wisconsin (Park, Sung Wook -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-48 University of Wisconsin (Ra, Youngchul -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-48 University of Wisconsin (Reitz, Rolf -- Light-Duty Combustion Modeling (UWI) / Combustion Research

7-54 University of Wisconsin (Reitz, Rolf -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

7-54 University of Wisconsin (Rutland, Chris -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

7-54 University of Wisconsin (Sanders, S. -- Optimizing Low-Temperature Diesel Combustion / Combustion Research

5-13 US Hybrid Corporation (Goodarzi, Abas -- Bi-Directional DC-DC Converter / Advanced Power Electronics

3-8 USABC (Habab, Ahsan -- High-Power Electrochemical Storage Devices and Plug-in Hybrid Electric Vehicle Battery Development / Battery Development, Testing, Simulation, Analysis

16-21 Virginia Tech (Ellis, Mike -- GATE Center for Automotive Fuel Cell Systems / Technology Integration/Education

5-29 Virginia Tech (Lai, Jason -- Soft Switching Inverter for Reducing Switching and Power Losses / Advanced Power Electronics

16-21 Virginia Tech (Nelson, Doug -- GATE Center for Automotive Fuel Cell Systems / Technology Integration/Education

8-7 Westport Innovations (Huang, Jim -- Development of a Robust Accelerometer- Based Start of Combustion-Sensing System / High Efficiency Clean Combustion

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