American Energy & Manufacturing Competitiveness Partnership

Magnify.

Final Technical Report of the American Energy and Manufacturing Competitiveness Partnership

Award No. DE-EE0006099
Final Technical Report No. DOE-COC-0006099

Compete.

Council on Competitiveness

THE COUNCIL ON COMPETITIVENESS has developed this report with the support of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, in fulfillment of Contract No. DE-EE0006099.000.

FINAL TECHNICAL REPORT: DOE-COC-0006099

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Printed in the United States of America

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Letter from the President

On behalf of the Council on Competitiveness (Council), I am pleased to release *Magnify*, a final technical report of the pathbreaking 2013–2016 American Energy & Manufacturing Competitiveness (AEMC) Partnership progressive dialogue series and national summits between the Council and the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) to bring together America's pre-eminent leaders from industry, academia, labor, the national laboratories and government to address the grand challenges and opportunities afforded by an unprecedented and rapidly shifting national and global energy landscape.

But *Magnify* is more than a report of critical conversations and collaborations.

Magnify is a concerted call to action for the nation to build on this distinctive time in its energy history to dramatically strengthen its energy, manufacturing and economic competitiveness. The future economic productivity and prosperity of the United States is inextricably tied to our ability to fuel America's creation engine sustainably and efficiently.

America is in the early stages of a natural gas boom that is luring manufacturing investment to capitalize on stable, low-cost energy supplies. Furthermore, the United States holds aces in its research, innovation and venture capital assets that remain world-class. Wise policies and practices could unleash this potential and seize on the opportunity to make, commercialize and export new technologies and products—particularly next-generation clean energy technologies and products—at much higher rates.

Creating the conditions that foster the adoption of energy efficiency, the deployment of renewable technologies, and the deepening of clean tech manufacturing investment in the 21st century, while propelling private sector innovation and elevating energy efficiency and management to a more strategic level, has been at the core of the Council's efforts between 2013 and 2016 with EERE to bolster America's economy and job growth, environment, national security and standard of living—in essence, America's competitiveness.

The AEMC Partnership dialogues and national summits are an open exchange of ideas. The opinions and positions presented in this report are those of the Council on Competitiveness or the individuals who offered them. The opinions and positions in the report do not reflect official positions of the federal government.

Energy efficiency must be a core, first priority, but our goals will not be achieved through efficiency alone. Without plentiful, affordable and secure future supplies of advanced manufacturing technologies and energy, the United States could face a loss of jobs and entire industries, and see erosion of its innovation capacity and manufacturing base. Prices for goods and services will go up, our ability to create wealth will decline, and our very way of life may be threatened. If we allow this to happen, we will lose both the investment and the technological capacity we need for new energy solutions, goods and services.

The Council and its private sector, C-suite membership has committed to turn the tide in this nation and place emphasis on building a more energy sustainable, innovative, secure and strong manufacturing

economy. The Council is proud of our decade-long, strategic partnership with the Department of Energy Office of Energy Efficiency and Renewable Energy. This partnership has been characterized by first-of-its-kind, policy thought leadership and concrete actions co-created to elevate energy security, sustainability and advanced manufacturing to a top-tier, national imperative. In the first phase of this powerful, public-private partnership, the Council and EERE brought together hundreds of leaders from around the country in a series of progressive, regional dialogues to set forth actionable recommendations. In 2008 we released *Prioritize: A 100-Day energy Action Plan for the 44th President of the United States*, identifying six pillars integral to U.S. energy transformation and as top priorities for presidential action upon taking office. And in 2009, during a major summit, we released *Drive: A Comprehensive Roadmap to Achieve Energy Security, Sustainability and Competitiveness*, setting forth the integrated building blocks for America's energy transformation, sustainability and competitiveness in a low-carbon world.

Building on the Council's partnership with EERE—and in recognition that America's energy future is inextricably linked to our manufacturing future—the Council launched the U.S. Manufacturing Competitiveness Initiative, culminating in a 2011 Manufacturing Summit and the release of *Make*, a strategy for policymakers and all stakeholders to accelerate manufacturing competitiveness across all sectors of the economy.

During this period of time, the energy landscape has undergone profound transformation, with dramatic shifts having an impact on U.S. productivity, global investment, manufacturing operations, and job creation. The sense of urgency for a tighter linkage between clean technologies, energy and advanced manufacturing has only grown. Prior to 2009, the tone of the nation's energy conversation was centered on how to deal with long-standing energy security challenges and scarcity. Today, the tone is focused on seizing emerging energy growth opportunities to transform America's industrial base and job creation outlook—centering on energy abundance and strength.

In this context, the Council and EERE have teamed again in the American Energy & Manufacturing Competitiveness Partnership to tackle two major goals via a multi-year partnership. The AEMC Partnership identified means to:

- Increase U.S. competitiveness in the production of clean energy products—by strategically investing in technologies that leverage American competitive advantages and overcome competitive disadvantages, and
- Increase U.S. manufacturing competitiveness across the board by increasing energy productivity—by strategically investing in technologies and practices to enable U.S. manufacturers to increase their competitiveness through energy efficiency, combined heat and power, and taking advantage of low-cost domestic energy sources.

The AEMC Partnership, which launched at Oak Ridge National Laboratory in Oak Ridge, Tennessee on March 26, 2013, has engaged hundreds of leaders and energy and manufacturing competitiveness stakeholders from industry, academia, labor and government in a series of nine regional and progressive dialogues, original research, and four national summits. The nine AEMC dialogues have spanned the United States—starting in Washington, D.C. on April 11-12, 2013

and taking place in some of our nation's greatest manufacturing, research, technology and innovation hotspots:

- Dialogue 2 was co-hosted with President Lloyd Jacobs at the University of Toledo in Toledo, Ohio on June 20th.
- Dialogue 3 was co-hosted with Dr. Mark Little, Senior Vice President and Chief Technology Officer of General Electric, on August 12-13, 2013 in Niskayuna, New York at GE Global Research.
- Dialogue 4 was co-hosted with Mr. Michael Splinter, Executive Chairman of the Board of Directors, and Dr. Omkaram Nalamasu, Senior Vice President and Chief Technology Officer of Applied Materials, Inc. on October 17, 2013 in Santa Clara, California at Applied Global University.

The goals of the AEMC Partnership and its progressive dialogues have been straightforward:

- State and define key barriers, challenges, and problems in U.S. competitiveness in manufacturing of clean energy products, energy efficiency products, and advanced manufacturing products.
- Dive deeply into these problems and generate possible policies, solutions, concepts and models where the U.S. public and private sectors can work together to prioritize and solve these problems.
- Catalyze policy solutions—including concepts and models for scalable, public-private partnership pilot projects—to increase competitive manufacturing of clean energy and energy efficiency products in the United States.
- Elevate and increase awareness of the importance and benefits of competitive clean energy manufacturing in the United States, and explore other important energy and manufacturing issues impacting U.S. competitiveness.
- Understand how energy game-changers, like breakthrough technologies, impact U.S. clean energy and energy efficient manufacturing.

And perhaps most important, the Council on Competitiveness—through the progressive dialogues—has worked with its stakeholder network to generate potential public-private partnership (PPP) concepts and proposals to advance the goal of the AEMC Partnership.

Since its inception in 1986, the Council has recognized, supported and catalyzed public-private partnerships as an optimal model of investment and engagement to address large-scale, complex problems, and to develop scalable, sustainable solutions beyond the scope and capabilities of any one sector, company, university or laboratory.

Magnify outlines two PPP concepts—honed by intensive dialogues, conversations, interviews and research—that could be carried out by EERE and/or the Council to increase the competitive production of clean energy products, energy efficiency products, and advanced manufacturing in the United States. *Magnify*'s two PPP concepts aim to bridge very specific gaps in the nation's innovation ecosystem generated from the AEMC Partnership's progressive dialogues and supporting activities:

- **Clean Energy Materials Accelerator:** This PPP concept focuses on reducing the risks associated with deploying newly developed materials in commercial products and processes by creating a platform to identify and address common challenges; increasing access to existing materials qualification and characterization tools; and creating standards for advanced materials with leaders in industry, academic, government, and other organizations.

  Why accelerate materials production? As the AEMC Partnership Dialogue and supporting research from the public and private sectors have documented, countries that lead in making next-generation materials will gain significant competitive advantage by unleashing a new wave of manufacturing innovation. Advanced materials can drive significant enhancements in energy products (more efficient solar cells; larger, lighter, and stronger wind turbines; longer-range car batteries)—while also increasing the competitiveness of all manufacturing sectors

- **Manufacturing and Energy Technology Accelerator:** This PPP concept is a new, physical and virtual collaborative resource platform designed to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—to facilitate the transition of cutting-edge clean energy technologies into products, processes, or services that are manufactured in the United States.

  Why should public and private sector leaders in innovation partner to co-create a scale-up platform? The United States is already a mecca for the world's greatest minds in science and technology—drawn to our shores by world-class universities and opportunities to work with global leaders in innovation. Unfortunately, when it comes time to bring their ideas to market, technologists and entrepreneurs often choose, or are forced, to locate manufacturing overseas. The United States must regain its position in the world as a national scale-up platform for next-generation technologies, and this PPP can help build the industrial ecosystem that makes this possible. When coupled with the U.S. ideas engine, the Manufacturing & Energy Technology Accelerator will create lasting, competitive asymmetries for the United States.

A thorough explanation of these PPP concepts and the rationale behind these recommendations is provided in Part 3 of *Magnify*.

I extend special thanks to my partner—the Honorable David. T. Danielson, former Assistant Secretary of EERE—for his vision and leadership during the development and execution of this partnership. And the PPP concepts in *Magnify* directly address five, key decision-criteria the former Assistant Secretary has articulated as critical to measure the success of any public-private partnership in which EERE might engage:

- This PPP is confronting, addressing and helping to solve a high-impact problem.
- EERE funding will make a large difference relative to what the private sector (and other funding entities) is already doing.

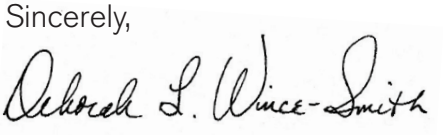
- This PPP concept focuses on a broad problem the Department of Energy is trying to solve and is open to new ideas, new approaches, and new performers.
- EERE funding and participation will result in enduring economic benefit to the United States.
- EERE funding and participation will represent a proper, high-impact role of government versus something best left to the private sector to do on its own.

Magnify is an important step on this critical journey to define key barriers, challenges and problems in the manufacturing of clean energy products and energy efficient products—and further honing concepts for scalable, public-private partnerships—to increase the competitive manufacturing of clean energy and energy efficient products, and the energy productivity throughout the U.S. manufacturing sector. The rest of the world is waking up to the opportunities associated with a strategic focus on manufacturing and energy competitiveness. Global competition is on the rise, and the stakes are high for the United States to act now, to act decisively, and to leverage inherent strengths to ensure a more prosperous, competitive future for decades to come.

I would like to recognize the generosity of our dialogue co-hosts and the many Council members, friends and colleagues who have contributed to the success of the AEMC Partnership dialogue series. And I commend the hard work of a dedicated and innovative Council on Competitiveness team, led by our Executive Vice President Chad Evans.

The Council on Competitiveness and I look forward to continuing to engage leaders in industry, academia, the national laboratories, and government as we build on the successes of the AEMC Partnership to co-create and compete for advantage in an era of global turbulence, transition and transformation.

Sincerely,



The Honorable Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

PART ONE

Executive Summary of the 2013 AEMC Partnership

Executive Summary

The AEMC Partnership is a 3-year effort by the Council on Competitiveness (Council) and the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) to bring together national leaders to address a rapidly shifting national and global energy and manufacturing landscape.

The United States is at a critical junction. As President Obama called out in his second Inaugural Address, "It's time to double-down on a clean energy industry that never has been more promising."[1] The Council and EERE have seized on this moment, and in 2013 conceived of and convened an ambitious agenda of original, groundbreaking research, regional dialogues and national summits to address these issues. Collectively, the Council and EERE have worked through these activities to uncover strategies and actions that can be taken now to enable America to bolster dramatically its energy, manufacturing and economic competitiveness for the coming decades and beyond. This is a new partnership formed under EERE's Clean Energy Manufacturing Initiative, (CEMI),[2] a strategic integration of and commitment to manufacturing efforts focusing on American competitiveness in clean energy manufacturing. The goals of the AEMC Partnership are to:

Increase U.S. competitiveness in the production of clean energy products: Strategically investing in technologies that leverage American competitive advantages and overcome competitive disadvantages.

Increase U.S. manufacturing competitiveness across the board by increasing energy productivity: Strategically investing in technologies and practices to enable U.S. manufacturers to increase their competitiveness through energy efficiency, combined heat and power, and taking advantage of low-cost, domestic energy sources.

The ultimate purpose of the AEMC Partnership is to inform and generate ideas, collect insights and serve as a platform to generate public-private partnerships (PPP) concepts to advance the AEMC Partnership goals.

AEMC Partnership: Mapping the Landscape

Throughout Winter 2012 and Spring 2013, building upon its rich history and deep intellectual capital in the study and formulation of public-private partnerships, the Council undertook an ambitious research and survey program that provided the intellectual foundations for the larger goals of the AEMC Partnership. This groundbreaking original research was the product of a comprehensive literature review, deep-dive research agenda, and broad leadership survey of existing public-private partnerships. With the goal of understanding the drivers and underlying factors contributing to the success, failure, sustainability, and impact of existing and past PPPs, the

1 President Barack Obama, Second Inaugural Address, January 21, 2013.

2 More information available at: http://www1.eere.energy.gov/energymanufacturing/index.html.

Power of Partnerships distilled 184 past and current research efforts across the United States and around the globe concerning 3 core topics:

- Linkages between manufacturer efforts in energy efficiency and renewable energy and manufacturing competitiveness;
- Energy-related barriers to manufacturing competitiveness; and
- Models for PPPs for fostering competitive industries.

This work also identified links, barriers and public-private partnership models that have not been studied or on which studies are out of date.

This work culminated in the seminal Council publications, *The Power of Partnerships*, and its companion piece, *A Summary of Public-Private Partnerships,*[3] released in March, 2013 at the Inaugural AEMC Dialogue in Washington, D.C. These reports paved the road for an intensive Dialogue Series and PPP concept development in the second Phase of the AEMC Partnership, in great part through the answers to the following questions:

- What prevents the United States from leading in the manufacturing of clean energy and energy efficient products or increasing energy productivity throughout the manufacturing sector?
  - High capital requirements
  - Lack of innovation infrastructure
  - Low investment in advanced manufacturing technology
  - Structural costs
  - Public and cyber infrastructure
  - Trade policy
  - Clean energy market risks
- What are the essential ideas and strategies necessary to co-create a successful clean energy manufacturing PPP?
  - Strong leadership
  - Clear, compelling mission
  - Early funding stream to establish a PPP usually from the public sector
  - Flexible intellectual property practices that draw corporate participation

The findings from the first Phase of the AEMC Partnership facilitated a natural transition and informed foundation upon which to launch the second Phase of the Partnership: the Progressive Dialogue Series.

AEMC Partnership: Progressive Dialogue Series

In 2013, the AEMC Partnership constituted four progressive dialogues with the mission of achieving the Partnership goals outlined below. To achieve these goals, the Council and EERE convened the dialogue series—progressive in that each dialogue built upon the previous one, and toward the next—and solicited input and insights from an impressive group of local, regional and national leaders from large manufacturers, SMEs, academia, the national laboratories, labor, and existing public-private partnerships.

3 These documents are available at: http://www.compete.org/publications/detail/2473/the-power-of-partnerships/ and http://www.compete.org/publications/detail/2474/a-summary-of-public-private-partnerships/.

CLEAN ENERGY MANUFACTURING INITIATIVE
U.S. DEPARTMENT OF ENERGY

Compete.
Council on Competitiveness

HISTORY OF AMERICAN ENERG MANUFACTURING COMPETITIVE

Building a Clean Energy Innovation Infrastructure

President's Mandate

"Building a robust clean energy sector is how we will create the jobs of the future -- jobs that pay well and can't be outsourced."

Phase 1 Survey & Research

Dialogue 1: LAUNCH @Gallup

Dialogue 3: EVALUATE @ General Electric

Public-Private Leadership Survey @Council on Competiveness

DOE announces $20M for small businesses to work with national lab resources via Small Business Vouchers pilot program.

DOE launches Lab-Corps – a new, $2.3M pilot program to acceler the transfer of innov clean energy technol from the Natl Lab into the commerci marketplace.

Dialogue 5: Strengthen @ Univ. of California, Berkeley

2013

2014

Partnership Announcement Oak Ridge Natl Lab

Dialogue 2: BRIDGE @ Univ. of Toledo

Dialogue 4: FOCUS @ Applied Materials Santa Clara, CA

AEMC Summit 1: AMPLIFY Washington, DC

AEMC Summit 2 Washington, DC

DOE Secretary Moniz announces Accelerate Energy Productivity 2030 partnership

Berkeley Lab's M37 project official launches as Cyclo Road –increase speed from lab market.

GY
ENESS PARTNERSHIP

"We're all interested in making sure that advanced manufacturing is taking place here in the United States."

Lawrence Livermore Natl Lab's HPC4Energy pilot examined for applicability to advanced manufacturing

DOE announced up to $3 million for industry partners to participate in its second Manufacturing Demonstration Facility, the **High Performance Computing for Manufacturing Program (HPC4Mfg).**

AEMC Summit 4 Northeast Regional @ City University of New York

DOE previewed the powerful data and analytical capabilities of the new Clean Energy Manufacturing Analysis Center (CEMAC).

AEMC Summit 3 Washington, DC

Dialogue 6: Scale Washington, DC

2016

2015

DOE announces $70M for the next National Network for Manufacturing Innovation institute, which will focus on smart manufacturing.

AEMC/CEMI Accelerating Advanced Materials Dialogue 1 @ University of Oregon

AEMC/CEMI Accelerating Advanced Materials Dialogue 3 @ Texas A&M University

DOE announces **seven "technologist" pairs** selected to receive $2.6 million to participate in its two-year **Technologist in Residence** pilot.

DOE launched $40M Energy Materials Network (EMN) to dramatically decrease the time-to-market for advanced materials innovations critical to many clean energy technologies.

AEMC/CEMI Accelerating Advanced Materials Dialogue 2 @ Argonne Natl Lab Chicago, IL

"We create. We innovate. We build. We do it together."

To its very core, the Dialogue Series was designed to reflect the inclusive focus of the Partnership. In orchestrating a program to capture the complexity and diversity of America's manufacturing ecosystem, the Council strategically chose dialogue locations crisscrossing the country, and co-hosts from across all stakeholder groups, spanning from one of America's iconic national laboratories at Oak Ridge, Tennessee to an academic powerhouse of America's manufacturing heartland at the University of Toledo in Toledo, OH to an epicenter of American innovation and manufacturing might at General Electric's Global Research Headquarters in Niskayuna, NY, to Silicon Valley, the pulsing heart of America's technology innovation hub, at Applied Materials headquarters in Santa Clara, CA, and to the nation's capital, Washington, D.C.

These dialogues captured the real-world experiences, insights, and challenges of practitioners from the business, policy, and academic arenas, in an effort to meet the objectives of this phase of the AEMC Partnership.

Objectives of the AEMC Partnership Dialogue Series included:

- State and define key barriers, challenges, and problems in U.S. competitiveness in manufacturing of clean energy products, energy efficiency products, and advanced manufacturing products.
- Dive deeply into these problems and generate possible policies, solutions, and models where the U.S. public and private sectors can work together to prioritize and solve these problems.
- Catalyze policy solutions to increase competitive manufacturing of clean energy and energy efficiency products in the United States.
- Elevate and increase awareness of the importance and benefits of competitive clean energy manufacturing in the United States, and explore other important energy and manufacturing issues impacting U.S. competitiveness.
- Understand how energy game-changers, like breakthrough technologies, impact U.S. clean energy and energy efficient manufacturing.

Together, these dialogue objectives contributed to the ultimate goal of the 2013 progress dialogue the series—the creation of PPP concepts—conceived of and honed through a collaborative process engaging all relevant stakeholders—to present to the Department of Energy at the inaugural AEMC Summit on December 12, 2013 in Washington, D.C.

As established early on by the Partnership, these concepts should meet a set of criteria against which all EERE investments are measured:

- This PPP is confronting, addressing, and helping to solve a high-impact problem.
- EERE funding will make a large difference relative to what the private sector (and other funding entities) is already doing.
- This PPP concept focuses on a broad problem the Department of Energy is trying to solve and is open to new ideas, new approaches, and new performers.
- EERE funding and participation will result in enduring economic benefit to the United States.

Foundation of AEMC Partnership

REPORTS

184 reviewed

↓

28 selected for in-depth analysis

↓

180 **recommendations**

26 **policy categories analyzed**

PUBLIC-PRIVATE PARTNERSHIPS

30+ reviewed

↓

19 selected for in-depth analysis

↓

4 **PPP models developed**

- EERE funding and participation will represent a proper, high-impact role of government versus something best left to the private sector to do on its own.

The inaugural dialogue in Washington, D.C. on April 11-12, 2013, laid out the objectives of the AEMC Partnership, and began the process of closely examining a range of PPP model types and technology areas, drawing on the real-world experience, insights, and knowledge of leaders and practitioners from across a range of stakeholders—including government, industry, academia, labor and the national laboratories.

President Lloyd Jacobs of the University of Toledo hosted the second dialogue on June 20th, continuing the discussions sparked during the inaugural dialogue. This dialogue focused on Toledo as a case study for successful informal and formal partnerships that can drive regional manufacturing transformation, in this case by leveraging materials science and engineering. The second dialogue drew heavily upon the literature review and survey results documented in the *Power of Partnerships*—as well as lessons learned from Toledo's and the Greater Ohio Region's experiences—to tease out perspectives from dialogue participants on the distinct PPP model-types identified in the report, and to determine which model-types best meet the present needs of America's energy manufacturing and innovation ecosystem.

Dr. Mark Little, Senior Vice President and Chief Technology Officer of GE and Director of the GE Global Research Center hosted the third dialogue at the GE Global Research Center in Niskayuna, New York, where the Council and EERE presented five specific PPP concepts for dialogue participants to discuss and critique to continue the process of homing in on potential PPPs. Discussions during the third dialogue continued to determine specific technology areas and barriers to/opportunities for the five presented PPP concepts capable of increasing the competitiveness of clean energy manufacturing in the United States.

Mr. Michael Splinter, Executive Chairman of the Board of Directors of Applied Materials, and Omkaram Nalamasu, Chief Technology Officer of Applied Materials, hosted the fourth dialogue that focused squarely on evaluating two PPP concepts and honing the attributes of a clean energy manufacturing public-private partnership.

Drawing on both quantitative and qualitative feedback gathered from participants at the third AEMC Dialogue, this fourth dialogue focused on two key areas that stakeholders identified as ripe for PPP development and impact:

- Lowering risk and accelerating the adoption of advanced materials in the clean energy space through materials characterization, quantification, and standards development, and
- Lowering barriers to the scaling of existing, promising prototypes in the clean energy space by placing strategic resources on both sides of the scale-up "valley of death."

Participants at the fourth dialogue vetted each of these PPP concepts, addressing both the overall barriers presented and the structure and menu of resources and services recommended by the Council to overcome them. Building upon the feedback from the dialogue, the Council undertook an extensive and iterative development of the two concrete PPP concepts vetted by stakeholders, reaching out to additional experts in their respective fields and to industry and government leaders to gauge support for the overall goals, structure, and instantiation process for each concept.

The 2013 activities of the multi-year AEMC Partnership culminate with the Inaugural AEMC Summit in Washington, D.C. on December 12, 2013. As the hallmark, national event addressing the importance of energy and manufacturing to U.S. economic competitiveness, the Summit draws on the rich findings uncovered throughout the AEMC Partnership Regional Dialogue Series to serve as a singular catalyst for actions that can be undertaken now, by industry, academia, labor, national laboratories and the government to work collectively to overcome barriers and bolster U.S. competitiveness. The Summit is designed to inform the public, through high-level discussions with senior leaders from all sectors on the current state of energy and manufacturing in the United States, celebrate the achievements of pioneering business and research efforts and collaborations in the energy and manufacturing sectors, and serve as a platform for key announcements from EERE and others of new efforts to strengthen America's manufacturing and innovation ecosystems.

Based on this review process, the Council believes both of these concepts illustrate great potential to reduce risk, increase investment, and bolster domestic manufacturing, and submits them to EERE for consideration.

Clean Energy Materials Accelerator

This PPP concept focuses on reducing the risks associated with deploying newly developed materials in commercial products and processes by creating a platform to identify and address common challenges; increasing access to existing materials qualification and characterization tools; and creating standards for advanced materials with leaders in industry, academia, government and other organizations.

Manufacturing and Energy Technology Accelerator

This PPP concept is a new, physical and virtual collaborative resource platform designed to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—to facilitate the transition of cutting-edge clean energy technologies into products, processes, or services that are manufactured in the United States.

PART TWO

AEMC Partnership Progressive Dialogue Series

Inaugural Dialogue: Launch

Washington, D.C.
April 11-12, 2013

Host: Mr. James Clifton
Chairman & CEO, Gallup

The inaugural American Energy & Manufacturing Competitiveness Partnership dialogue convened and engaged over 100 senior leaders from industry, government, academia, labor, and the national laboratory system. Co-hosted by the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness, and EERE Assistant Secretary David Danielson, the dialogue laid the foundation for future discussions by gathering input on fields in the clean energy manufacturing sector that could benefit from the creation of a public-private partnership and evaluate the benefits and challenges of different PPP structures—all with an eye toward enhancing the competitiveness of the U.S. manufacturing sector.

An important function of the inaugural dialogue was to identify, understand, and discuss the opportunities offered by clean energy manufacturing. Much of this exploration was intended to highlight the convergence of market forces, public interest, and private sector strategies making clean energy manufacturing compelling for public-private collaboration.

In her opening remarks, Ms. Wince-Smith noted:

> *Half of the new electricity-generating capacity installed to meet the growing global energy demand during the next 25 years is expected to come from clean energy. Furthermore, businesses, governments, and communities are embracing energy saving behaviors and technologies. These market and political forces are converging to create the national will to invest in developing, manufacturing, and deploying clean energy technologies, as well as ensuring that all industrial sectors of our economy are using energy efficiently to, in turn, drive industrial productivity.*

David Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Jason Miller, Special Assistant to the President for Manufacturing Policy, National Economic Council; Libby Wayman, Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; and Chad Evans, Executive Vice President, Council on Competitiveness.

Wince-Smith's remarks convey the sense of urgency expressed at the dialogue and around the country as to the importance of developing a clean energy manufacturing strategy and increasing energy productivity broadly in the U.S. manufacturing sector. With this common understanding of the current

clean energy manufacturing landscape, the AEMC Partnership tasked dialogue participants to generate ideas around two main themes:

- Leverage points in national investment in the clean energy manufacturing landscape—e.g. foundational technologies, road mapping, standards, policy tools, supplier relationships, domestic production barriers, etc.—with the potential to produce exponential impact and competitive advantage for all manufacturing sectors, and
- Public-private partnership concepts that would best use these leverage points and launch the United States ahead of international competitors.

The exceptional cross-section of industry, academic, labor, national laboratory and public sector leaders in attendance produced a robust discourse. Some key insights regarding potential leverage points and public-private partnership concepts from the inaugural dialogue include the following:

Insights on Potential Leverage Points

- Scaling technologies from prototypes to mass-manufactured products;
- Building a workforce that understands the challenges of scaling the production of newly created technologies in the United States;
- Developing and deploying advanced materials; and
- Diffusing tools including modeling and simulation, robotics, automation, sensor technologies, and additive manufacturing into the manufacturing sector.

The Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Pradeep Khosla, Chancellor, University of California, San Diego; and J. Michael McQuade, Senior Vice President for Science & Technology, United Technologies Corporation.

Insights on Public-Private Partnerships

- Designing the project with input from all stakeholders and with the outcome in mind greatly increases the likelihood of success;
- Charging the indirect cost of research facilities and equipment to the private sector is a barrier to private sector participation in a PPP;
- Facilitating the progress and success of a PPP is contingent on strong leadership by a single entity, such as a board, company, or other administrative body; and
- Creating boundaries and trust through intellectual property agreements is essential to develop an environment attractive for broad stakeholder participation.

Dialogue 2: Bridge

University of Toledo
Toledo, Ohio
June 20, 2013

Host: Dr. Lloyd Jacobs
President, University of Toledo

The second dialogue of the AEMC Partnership convened 40 regional and national clean energy manufacturing stakeholders from industry, academia, the national laboratories, non-profit organizations, and the public sector at the University of Toledo in Toledo, OH. The content development for this regionally-focused, nationally-cultivated conversation followed directly from key themes strategically culled from the inaugural dialogue and leveraged the deep industrial history embedded in the Toledo region. This dialogue also marked the first opportunity for a stakeholder discussion targeted at the PPP models uncovered in *The Power of Partnerships* report that underpinned the AEMC Partnership's launch.

Though the fundamental tasks of this regional conversation remained similar to the inaugural dialogue—identify nascent areas of innovation-driven strength for national investment in clean energy manufacturing and recommend PPP concepts to accelerate these strengths—this dialogue moved beyond the high-level exploration and ideation of the foundational inaugural dialogue and into determining actionable outcomes in preparation for the third dialogue. This strategy was reflected in the smaller size of the dialogue, which created an action-oriented atmosphere, as well as the make-up of the assembled group. Participants were selected based on their expertise in the dialogue content and, more broadly, experience in manufacturing and public-private partnerships.

David Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; Lloyd Jacobs, President, University of Toledo; and the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.

Participants suggested 17 distinct PPP concepts at the second AEMC Partnership dialogue. Five of the 17 public-private partnership ideas received strong support from participants at the second AEMC Partnership dialogue. Participants focused on PPPs addressing:

- Development of a fellowship program promoting personnel exchange between innovation institutions;
- The design, qualification and certification of advanced materials;
- The rapid prototyping and demonstration of new technologies using modeling and simulation and high performance computing tools;
- Build-out of a virtual platform where companies could submit industrial innovations and seek crowd-sourced funding; and
- The creation of a virtual portal that allows industry and research institutions to match real-world problems and challenges with tools and solutions.

Types of Public-Private Partnership Concepts

Technology Horizontal
A technology-agnostic PPP designed to lower barriers to clean energy innovation and manufacturing.

Technology Vertical
A PPP focusing on a statically chosen clean energy product or process that vertically integrates some or all stages of technology development.

A key differentiating factor between the broad range of PPP concepts presented revolved around technology, and whether the PPP was technology "horizontal or vertical." Slightly more than half of the suggested PPPs were technology horizontal in orientation.

The selection of a horizontal or a vertical PPP would have significant implications for a clean energy manufacturing public-private partnership. While both types of PPPs have the ability to drive the goals of the AEMC Partnership, the PPPs themselves would be different in terms of scale, scope, and sustainability. As such, the benefits and shortcomings of each type of PPP, as related to the twin goals of the AEMC Partnership, should be an important consideration as this initiative moves into the future.

This dialogue also moved the conversation beyond the literature-review based PPP model-types articulated in the Power of Partnerships to facilitate this dialogue series. While these PPP models were tremendously valuable as a platform to launch a national discourse, dialogue participants quickly molded and honed these models into the framework of deployable, scalable PPP concepts to drive the goals of the AEMC Partnership while being inclusive to all clean energy manufacturing stakeholders.

During the second AEMC Partnership dialogue, participants:

- Identified the essential inputs to the development of the successful Toledo solar energy cluster: industry leadership from an established manufacturing base; shared infrastructure; patient, diverse, and consistent funding; complementary policy tools; in-kind equipment contributions; talent spillover; and a focus on first-to-market differentiated technologies;
- Quantified four barriers to increasing the use of advanced materials in mass manufacturing: the cost of raw materials, processing speed, joining dissimilar materials, and the qualification and characterization of advanced materials;
- Identified institutional, practical, and administrative barriers to bridging the gap between businesses and external sources of innovation (e.g. university or national laboratories);
- Developed a set of principles intended to guide the process of selecting a target area for a clean energy manufacturing public-private partnership; and
- Proposed moving beyond conventional funding models, potentially leveraging the philanthropic community and crowd-sourcing to broaden the base of available risk capital;

This second dialogue generated a large pool of ideas and recommendations for leadership teams at the Council and EERE to evaluate and formulate—in concert with private and public innovation leaders—into PPP concepts to be presented at the third AEMC Partnership dialogue.

Figure 2. Summary of PPP Concepts from the Second AEMC Partnership Dialogue

Technology Horizontal

Fellowship program promoting personnel exchange between innovation institutions

Database of Department of Energy Solar Decathlon best practices with a tie to Property Accessed Clean Energy (PACE) Districts

Multi-stakeholder partnership to pilot an electricity free building

High Performance Computing Applications Store

Virtual portal that allows industry and research institutions to match real-world problems and challenges to solutions

Rapid prototyping and demonstration of new technologies through modeling & simulation tools/big data

A virtual platform where companies can submit industrial innovations and seek crowd-source funding

Research, development, and demonstration facility: Information Technology Enables Smart Manufacturing

Increase interaction between business and national laboratories by having each side commit to more engagement and enabling reforms, respectively

Test bed/demonstration facility on a city-scale

Technology Vertical

Photovoltaic certification institute to address quality and standardization issues as well as drive lending from commercial banks

Technology target area: advanced materials design, qualification, and certification

Technology target area: leveraging photovoltaic-enabled electric vehicles to create distributed energy generation (vehicle-to-grid)

Technology target area: tools to support mass-customization manufacturing

Technology target area: flexible electronics

Technology target area: next generation wind turbine

Technology target area: fuel cells

Dialogue 3: Evaluate

GE Global Research Center
Niskayuna, New York
August 12-13, 2013

Host: Dr. Mark Little
Senior Vice President and Chief Technology Officer of General Electric, and Director of GE Global Research Center

The third AEMC Partnership dialogue engaged over 60 leaders from industry, academia, non-profit organizations, and the national laboratory system. Co-hosted by the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; David T. Danielson, Assistant Secretary of the U.S. Department of EERE; and Mark Little, Senior Vice President and Chief Technology Officer of General Electric, and Director of GE Global Research Center; this dialogue strategically evaluated five public-private partnership concepts capable of driving the overarching goals of the AEMC Partnership generated over the previous six months of the AEMC Partnership.

The third dialogue was located at the GE Global Research Center in Niskayuna, NY. The New York Capital Region is exemplary of regional clusters that the AEMC Partnership aims to foster with its proximity to all major markets in the northeast, a highly skilled workforce, and many world renowned academic and research institutions. Additionally, General Electric has a more than 130-year tradition of innovation including public and private collaborations to address challenges in clean energy and advanced manufacturing—valuable expertise desired by the AEMC Partnership when formulating PPP concepts.

Following the inaugural and second dialogues, the third dialogue gathered stakeholders from across the U.S. innovation ecosystem to discuss five public-private partnership concepts culled from the previous dialogues, and molded by the Council and EERE. Participants in the third dialogue were strategically placed in five parallel working group sessions to discuss these distinct PPP concepts:

Chad Evans, Executive Vice President, Council on Competitiveness; Paul Tonko, U.S. House of Representatives; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; David Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; Libby Wayman, Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Jetta Wong, Deputy Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; and Mark Little, Senior Vice President and Chief Technology Officer, General Electric and Director, GE Global Research

- Innovation Exchange Fellowship Program: developing manufacturing leadership and enhancing knowledge spillover in the innovation ecosystem by expanding the intersections and points of exchange between the private sector and U.S. national laboratories and research universities through a fellowship program;
- Leveraging the Innovation Ecosystem: increasing

Shirley Ann Jackson, President, Rensselaer Polytechnic Institute, and former University Vice Chair, Council on Competitiveness; and the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.

accessibility to key national laboratory and university resources and providing manufacturers competitive user grants to reduce fees and lower barriers to use existing facilities and equipment;

- Advanced Materials Characterization, Experimentation, and Standardization: accelerating the time to, and increasing the rate of, adoption and commercialization of existing advanced materials by coordinating existing parts of the materials ecosystem, lower barriers to access equipment, and creating standards to ensure new materials function reliably and predictably before integration into new technologies and systems;
- Facilitating the Transition of Prototypes to Deployable Products: increasing the rate of graduation of prototypes into commercial markets by improving communication and transparency within the private sector, and increasing access to resources to facilitate the smooth transition across the scale-up "valley of death"; and
- Industrial Kickstarter and Manufacturing Marketplace: increasing access to risk-tolerant investment capital by convening investors, entrepreneurs, and manufacturers to front-fund and crowd-fund promising new technologies through a web-based advanced manufacturing portal and clearinghouse.

Stakeholders and experts evaluating these PPPs broadly supported the concepts and outlined the benefits each could provide to the innovation ecosystem. Two PPP concepts, however, received widespread support from the dialogue participants based on a collective understanding of need and the fulfillment of the criteria established by EERE in its "5 core metrics." These concepts are:

- Advanced Materials Characterization, Experimentation, and Standardization, and
- Facilitating the Transition from Prototypes to Commercially Deployable Products.

Collaborating to build one or both of these PPP in the near term, the dialogue participants concluded, would bolster dramatically U.S. energy, manufacturing, and economic competitiveness into the future.

Dialogue 4: Focus

Applied Materials
Santa Clara, CA
October 17, 2013

Co-Hosts: Mr. Michael Splinter, Executive Chairman of the Board, Applied Materials and Mr. Omkaram Nalamasu, Senior Vice President and Chief Technology Officer, Applied Materials

The fourth AEMC Partnership dialogue engaged over 50 regional and national leaders from industry, academia, non-profit organizations, and the national laboratory system. Co-hosted by the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Michael Splinter, Executive Chairman of the Board, Applied Materials, Inc.; and Omkaram Nalamasu, Senior Vice President and CTO, Applied Materials; this dialogue evaluated two public-private partnership concepts capable of driving the overarching goals of the AEMC Partnership.

Leading up to the fourth dialogue, the Council and EERE worked together to further build out the two PPP concepts selected by the participants during the third AEMC Partnership dialogue. In addition to tapping into insights from the previous three dialogues and the Power of Partnerships report, the Council undertook a survey campaign that tapped into national leaders from the private sector, the national laboratories, and universities to help construct and critique these models.

Below are brief summaries of the resulting PPP concepts that were presented to dialogue four participants to be explored and evaluated. Full summaries can be located in Focus., the full summary report of the fourth AEMC Partnership dialogue.

The Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.

Clean Energy Materials Accelerator

This Clean Energy Materials Accelerator PPP concept, formally the Advanced Materials Characterization, Experimentation, and Standardization PPP concept, focuses on reducing the risks associated with deploying newly developed materials in commercial products and processes by creating a platform to identify and address common challenges; increasing access to existing materials qualification and characterization tools; and creating standards for advanced materials with leaders in industry, academic, government, and other organizations.

Facilitating the Transition from Prototypes to Commercially Deployable Products

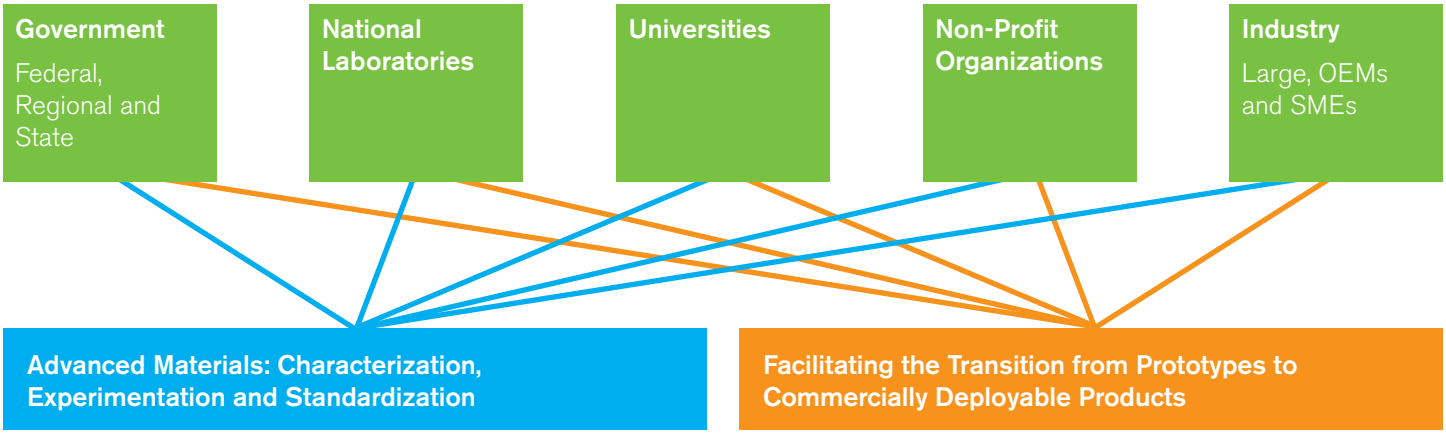
This PPP concept is a new physical and virtual collaborative resource platform that is designed to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—for the purpose

Michael Splinter, Executive Chairman of the Board, Applied Materials, and Industry Vice Chair, Council on Competitiveness.

of facilitating the transition of cutting edge clean energy technologies into products, processes, or services that are produced in the United States.

The PPP concepts were evaluated and critiqued by the dialogue participants both objectively and subjectively. The national landscape was surveyed by dialogue participants to reveal gaps in the U.S. innovation system that demonstrated—in the affirmative—the need for these PPP concepts. Moreover, the PPP concepts were viewed by the group through an organizational lens to enable dialogue participants to reflect on the ability of each PPP concept to meet the needs of their organization.

Figure 3. Leveraging the Innovation Ecosystem



PART THREE

Presented Public-Private Partnership Concepts

PPP Recommendations

After a year of research; dialogues with the most senior leaders from industry, academia, labor, the national labs, and government; targeted stakeholder outreach and interview—the Council is recommending the following PPP concepts to EERE.

Clean Energy Materials Accelerator

Overview

The Manufacturing and Energy Technology Accelerator (based on the Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept presented in dialogue four) is a new, physical and virtual collaborative resource platform designed to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—to facilitate the transition of cutting-edge clean energy technologies into products, processes, or services that are manufactured in the United States.

Feedback gathered from the participants at the four AEMC Partnership dialogues in 2013 revealed that, while significant efforts to discover and develop advanced materials is already in place and carried out independently in public and private sectors, moving a new material into widespread adoption is larger in scope and more multi-faceted than the focus, jurisdiction, perspective, and capabilities of any one private or public entity. The scope often includes defining roadmaps and norms on which a range of entities across the supply chain can agree. As many of these steps require agreement and input across a wide range of stakeholders, a lack of multi-stakeholder collaboration can slow or even halt the transition of an otherwise high-impact material into widespread use.

This PPP Concept attempts to close this resource gap by:

- Creating a virtual collaboration platform that:
  - Connects innovators producing advanced materials with technology developers who could implement advanced materials into products,
  - Provides access to a database for technical information on the characterization and qualification of existing advanced materials, and
  - Streamlines access to advanced material characterization and qualification resources at national laboratories, research universities, and private laboratories.
- Supporting the characterization and qualification for advanced materials with grants rewarded through a competitive Request for Proposal (RFP) solicitation, and
- Convening advanced materials stakeholders for the development of consensus-based standards, when appropriate.

PPP Concept Key Organizational Elements

Throughout the 2013 AEMC Partnership dialogue series, several organizational elements have been discussed. These topics have ranged from Intellectual Property Agreements to the selection of topics in the PPP. While these topics are all important, the Council recommends that the Department of Energy consider first the selection of materials to accelerate, the funding for the PPP, and the selection of PPP leadership. These topics are discussed in further detail below.

Selection of Materials to Accelerate

The selection of materials to accelerate—by whom and when—was the subject of considerable debate throughout the 2013 AEMC Partnership dialogue series. Particular for advanced materials, the equipment and resources needed to support a PPP and the interested stakeholders may differ depending on the selection. While potential industrial partners clearly preferred to select a particular material class integral to their business as a focus for the Clean Energy Materials Accelerator PPP, dialogue participants acknowledged that PPP leadership could identify high both high-priority materials for acceleration and actionable development challenges to tackle.[4]

The Council recommends that the Department of Energy use a Request for Information (RFI) to collect input from the private sector and other stakeholders before selecting the first material class aligned with the mission of the Clean Energy Manufacturing Initiative (CEMI) and, more broadly, the Office of Energy Efficiency and Renewable Energy.

Funding

The Clean Energy Materials Accelerator could be funded at different levels depending on the scope of work. At the fourth AEMC Partnership dialogue, participants suggested that this PPP start small—within EERE's existing authority—and use relatively low levels of capital to fill the critical gaps in both the innovation pipeline and DOE's project portfolio. A participant in the AEMC Partnership dialogue suggested that this PPP could start small by aligning its funding stream with complementary funding sources. These funding sources could include federal initiatives such as the Small Business Innovation Research (SBIR) program, third party capital, state and local initiatives, as well as venture capital.

The Council recommends that the funding from EERE should– at a minimum—finance the operational costs of the PPP including the salaries of management organization and the creation and maintenance of the Industrial Marketplace. When developing the financial model of the PPP, EERE should consider ways to leverage several possible sources of capital to increase the relevance, impact, and reach of the PPP.

Selection of PPP Leadership

From discussions throughout the 2013 AEMC Partnership dialogue series, the Clean Energy Materials Accelerator PPP should be led by an Executive Committee, with representatives from the Department of Energy, national laboratories, and universities, but with a majority representation from industry. The Executive Committee should be responsible for setting the strategic vision of the Clean Energy Materials Accelerator. The decisions of the Executive Committee should be advised by a Technical Advisory Board, composed of relevant representatives from founding industry partners and experts in relevant fields.

The day-to-day activities in the PPP should be completed by a contracted organization with an individual director who can execute this vision as he or she sees fit. This management structure will ensure that PPP remains focused on the interests of the nation and not the interest of a select few companies.

4 One concern expressed by dialogue participants was that PPP leadership should not select a material class for the Clean Energy Materials Accelerator based solely on the need for a particular material in the market. If the need in the market for an advanced material is strong, a company could accomplish the tasks in the PPP scope of work on its own, leaving no proper role for the government in the PPP activities.

PPP Concept Key Functional Elements

Many activities could fit the scope of the Clean Energy Materials Accelerator, from streamlining access to the national laboratory and research university resources to characterize advanced materials to convening interested parties to develop standards for advanced materials. Throughout the 2013 AEMC Partnership dialogue series, the following key functional elements have been suggested as relevant and necessary to accelerate advanced materials into manufactured products or manufacturing processes. These topics are discussed in further detail below.

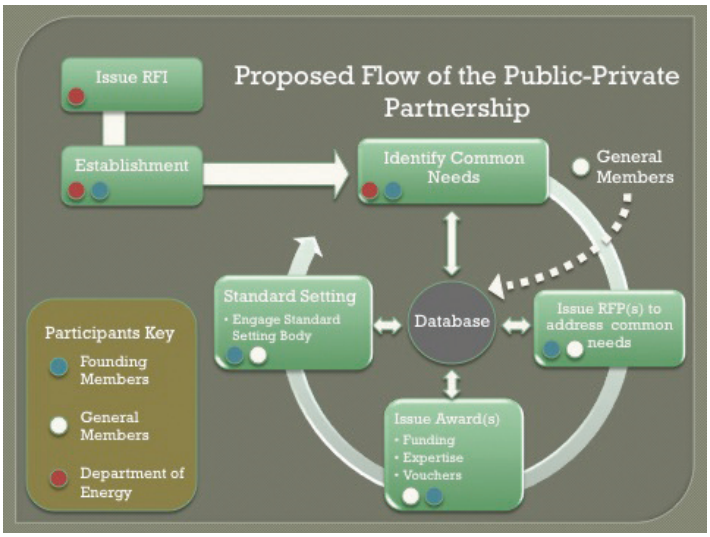
Develop a Path to Accelerate the Use of Advanced Materials

Once the material class is selected by the Department of Energy, the Executive Committee should convene and identify the path to reducing the risk in implementing the material into manufactured products and manufacturing processes. This may include establishing a roadmap, creating modeling and simulation tools, making advanced materials properties widely available, or establishing universal standards for the selected material. If relevant to the selected material, the Clean Energy Materials Accelerator should support the implementation of the material by organizing an industry-guided, high-profile competitive process where awardees may access materials characterization equipment and technical assistance at a subsidized cost.

Industrial Materials Marketplace

The Industrial Materials Marketplace is a virtual mechanism to integrate the nation's collective materials science expertise and assets. The online platform will provide information on tools needed to properly characterize and qualify materials and how to access them. The Industrial Materials Marketplace may serve additional functions by connecting companies with materials needs with those who develop materials for products and collecting characterization data and materials properties to facilitate the use of advanced materials by product designers.

Figure 4. Organization and Structure for the Clean Energy Materials Accelerator



Alignment with EERE Core Metrics

Throughout the Dialogue Series, the Council and EERE have returned to the five foundational "core criteria" outlined by Assistant Secretary David Danielson early in the Partnership to serve as a compass for EERE investment and participation in the formulation of a new public private partnership. Both dialogue participants and the Council have tested this PPP concept against these criteria and believe it meets each, and as such is a strong candidate for further consideration by EERE.

This PPP is confronting, addressing and helping to solve a high-impact problem.

The deployment of advanced materials into the market addresses a high-impact, systemic problem that has not been adequately addressed for many material classes by the private sector alone. With the actions in the scope of the Clean Energy Materials Accelerator, the increased implementation of advanced materials may transform materials and technology industries.. The increased implementation of advanced materials, also has the capacity to improve clean energy products and increase the energy productivity of manufacturing processes.

> *The entire semiconductor industry has been transformed by two things–standards and the International Technology Roadmap for Semiconductors (ITRS). Together, these have created a vector comprised of goals and milestones for the semiconductor industry.*
>
> **Dr. Mehdi Vaez-Iravani**
> Corporate Vice President, Applied Materials

EERE funding will make a large difference relative to what the private sector (and other funding entities) is already doing.

EERE funding for the Clean Energy Materials Accelerator addresses a systemic problem in the innovation process by unleashing the power of existing advanced materials through increased access to expertise, resources, and capital not currently available to many clean energy small and medium-sized enterprises. EERE and the Department of Energy involvement will convene a large group of stakeholders to mature advanced materials, which have not been accomplished by the private sector in many classes of materials.

This PPP concept focuses on a broad problem the Department is Energy is trying to solve and is open to new ideas, new approaches, and new performers.

The Clean Energy Materials Accelerator focuses on deploying advanced materials—broad in its applicability, yet specific to the selected material. This PPP will provide publicly available information and serve as a platform for all new ideas and approaches to be discussed and new performers to be included.

> *Methods to measure or characterize new, advanced materials–such as ceramic metal composites, high temperature nickel-based super alloys–are not established. Thus, the methods and tools to unlock the information to better understand the performance of these materials do not yet exist.*
>
> **Amy Linsebigler**
> Technology Leader, Materials Characterization & Chemical Sensing, Chemistry and Chemical Engineering Domain, and Business Program Manager for Morpho Detection, Inc., GE Global Research

EERE funding and participation will result in enduring economic benefit to the United States.

With the Clean Energy Materials Accelerator, EERE supports a platform for leaders across the innovation ecosystem to communicate advanced materials ideas and access resources and expertise. In addi-

tion to sponsoring materials characterization, the PPP creates connections between organizations—even those not directly funded by the PPP. Each of these activities will result in enduring economic benefit to the United States.

EERE funding and participation will represent a proper, high-impact role of government versus something best left to the private sector to do on its own.

EERE funding for the Clean Energy Materials Accelerator to accelerate the implementation of advanced materials provides national breadth, organization and unbiased perspective that could not be achieved through private sector alone because many companies delay innovations in their "race to be second." The convening power of the Department of Energy in many fields of expertise and across the country in this PPP amplifies any private sector investment. By funding and participating in this PPP, EERE will reduce risk in incorporating advanced materials—a proper high-impact role of the government.

> *Alcoa has been the maker of 95 percent of every aluminum alloy flying around the world today. Yes, our closest competitor is, in many cases, eating our lunch because they did not need to make the investment required to develop those alloys.*
>
> **Rodney Heiple**
> Director of Business Technology, Alcoa, Inc.

Manufacturing and Energy Technology Accelerator

Overview

The Manufacturing and Energy Technology Accelerator (based on the Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept presented in dialogue four) is a new, physical and virtual collaborative resource platform designed to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—to facilitate the transition of cutting-edge clean energy technologies into products, processes, or services that are manufactured in the United States.

Feedback gathered from the participants during the 2013 AEMC Partnership dialogues—coupled with groundbreaking, original research performed by the Council and EERE captured in the Power of Partnerships and its companion piece A Summary of Public-Private Partnership—defined a resource gap that inhibits promising clean energy technologies in the pilot-line phase from reaching manufacturing at scale. This gap marks a second valley of death in the technology innovation cycle, often referred to as the scale-up valley of death. Without manufacturing innovation infrastructure—including human capital—and funding to scale production of a new technology, pilot-lines often fail to make the transition to a commercially deployable product—in the United States or

elsewhere. The Manufacturing and Energy Technology Accelerator attempts to close this resource gap by:

- Connecting SMEs, technologists, and entrepreneurs—directly or indirectly—with the expertise, funding, and potential integrators they need to manufacture their technologies in the United States.
- Connecting established firms with prototypes that address a specific technology challenge or need within their existing product portfolio or prototypes that allow these firms to move into new markets.
- Incentivizing and de-risking private sector investment in revolutionary clean energy technologies to be manufactured in the United States.

PPP Concept Key Elements

Considerable intellectual ground was covered during the four AEMC Partnership dialogues on the topics of PPP best practices and success factors—from intellectual property rights, funding mechanisms, measurement and evaluation, leadership structure, political design, etc. These very important conversations between national leaders and clean energy manufacturing stakeholders—rich with insight—are captured in the each of AEMC Partnership Dialogue Post Reports, which can be found at www.compete.org. Presented below are a select set of key PPP elements—the pillars around which this PPP should be constructed to ensure success.

Key Organization Elements

Management of the PPP

The PPP should be governed by an Executive Committee, yet have organizational independence. The Executive Committee should be industry-led with Department of Energy representation and be responsible for setting the strategic vision—including the technology verticals of national strategic importance. However, there should be an individual PPP director with the autonomy to execute this vision as he or she sees fit. Functionally, this translates into the PPP being managed by a contracted organization. This will ensure that PPP remains focused on the interests of the nation and not the interest of a select few companies.

Selection of Technology Verticals

The selection of technology verticals—by whom and when—was the subject of considerable debate throughout the AEMC Partnership dialogue. A technology vertical is a particular market or group of enterprises in which related or complementary products or services are developed around a common technology platform. While potential industrial partners made it clear they wished to select the technology verticals, commitments by these companies to invest in the PPP were hindered in part, by the lack of information about the technology focus area.

To establish the working entity that will be the PPP, the Department of Energy should select the technology vertical with input from the private sector—using a RFI (Request for Information) as the vehicle to gather this information—that is aligned with the mission of the AEMC Partnership and, more broadly, the Office of Energy Efficiency and Renewable Energy. DOE selection of the technology verticals is not intended to be the long-term model of the PPP;

this is only to facilitate the establishment of the PPP. Subsequently, technology verticals should be selected by the Executive Committee of the PPP so long as they remain connected to two goals of the AEMC Partnership.

Funding

The funding needed to bridge the scale-up valley of death can range from $30 million to $1 billion depending upon the technology and industry, according to the AEMC Partnership dialogue participants. On the high side, this is more than half of the EERE annual budget. The DOE funding for this model is not intended to fund the construction of manufacturing plants in the United States. The funding from EERE should be—at a minimum—targeted at the operational costs of the PPP including the salaries of management, the Tiger Team and the creation and maintenance of the Industrial Marketplace (see below for descriptions of the Tiger Teams and the Industrial Marketplace).

The funding for an individual company to scale production in the United States—independently or with an industrial partner - should come from private sector investors. This PPP is intended to incentivize as well as de-risk—not provide—the investment necessary to bridge the scale-up valley of death.

In the pilot phase, this PPP will inevitably reside in one region of the United States, which will most likely be derived from the selection of the initial technology vertical. When developing the financial model of the PPP, EERE should consider ways to leverage local sources of capital—such as state funding—to increase the impact and reach of the PPP.

Key Functional Elements

Tiger Teams

The Tiger Team, a group of experts assigned to solve technical problems, is the central functional element that will provide—through onsite collaboration and consultation—SMEs, technologists, and entrepreneurs with manufacturing expertise.

Scaling a new technology from prototype to a product that can be manufactured at high volume is more than just a multiplication of the same processes used to create the prototype. Scale-up is innovation. Even the very best technologies have trouble making it to market without a manufacturing review early in the technology development process. This includes analyses and decisions on hard tooling, soft tooling, automation, design for flexible manufacturing, etc. Scale-up can also be as rigorous as designing and building entirely new manufacturing technologies. Innovating for manufacturability is a unique skill that—as the AEMC Partnership dialogue series has revealed—does not often reside within the team that created the prototype and is difficult for many companies to access.

The composition of the Tiger Team will be dependent on the target technology vertical (or verticals) of the PPP and will be constituted from the nation's innovation institutions such as universities, national laboratories, independent laboratories, and the Manufacturing Extension Program.

Fellowship Program—Workforce Development

Implicit on the Tiger Team concept is the understanding that the United States is currently facing a shortage of manufacturing talent—a result of the decades of U.S. manufacturing moving offshore. While the Tiger Team provides an immediate solution to this challenge, this PPP concept aims to rebuild

the manufacturing talent base in the United States. Functionally, this is accomplished by integrating a fellowship program into the Tiger Team. Fellows could come from academia, national laboratories, or for-profit companies to work on the Tiger Team on a scale-up project and learn valuable skills that U.S. manufacturing firms seek. Over time, the Tiger Team members and fellows will begin to form a national network of manufacturing excellence.

Industrial Marketplace

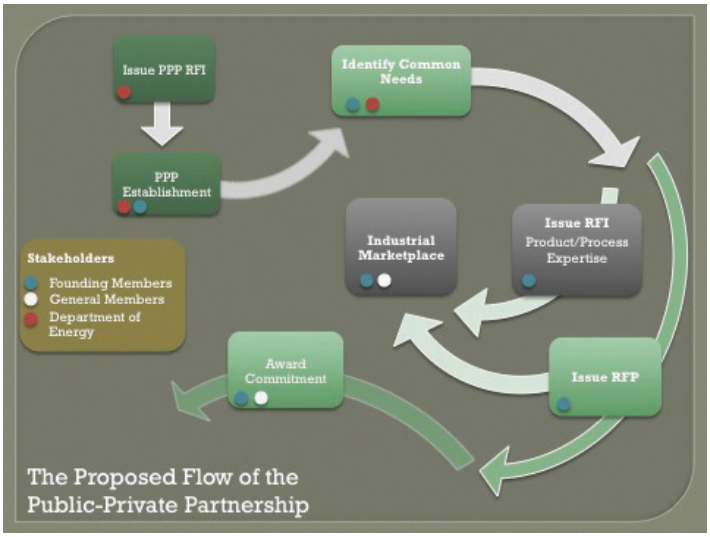
This PPP is designed for broad impact. However, not all companies interested in the PPP's direct services can be feasibly accommodated—at least in the beginning stages.

The Industrial Marketplace is a virtual complement to the physical aspects of the PPP and a mechanism to integrate the nation's collective technology expertise and assets. It is an online platform intended to provide virtual access to manufacturing expertise and sources of scale-up capital, as well as to connect companies with technological challenges with those that have solutions.

Alignment with EERE Core Metrics

Throughout the Dialogue Series, the Council and EERE have returned to the five foundational "core criteria" outlined by Assistant Secretary David Danielson early in the Partnership to serve as a compass for EERE investment and participation in the formulation of a new public private partnership. Both dialogue participants and the Council have tested this PPP concept against these criteria and believe it meets each, and as such is a strong candidate for further consideration by EERE.

Figure 5. Organization and Structure for Manufacturing and Energy Technology Accelerator



This PPP is confronting, addressing and helping to solve a high-impact problem.

In the context of R&D and manufacturing, "scale" is the process of expanding production beyond a pilot facility or process into mass-manufacturing. Scale, however, can also be thought of as the ability for the United States to capture value from the technologies that American scientists and engineers imagine, create, and incubate inside industry, universities, and government laboratories. Whichever country or region produces these new technologies—or applies them to an existing manufacturing process—benefits from the jobs created and increased economic activity that will result. Simply stated, America's ability to scale is directly linked to its ability to provide opportunities for Americans to prosper.

EERE funding will make a large difference relative to what the private sector (and other funding entities) is already doing.

This PPP Concept was designed to address systemic barriers that hinder the ability of innovators, technologists, and entrepreneurs to manufacture their technologies in the United States—one such barrier is the lack of sufficient access to risk capital, which is especially difficult in clean energy markets. Venture capital investment in clean energy innovation plummeted 33 percent last year[5] and traditional avenues to scaling manufacturing are must less common today than they were three decades ago.

> *Clearly, capital requirements are important [and] the clean technology industry is not very well-aligned with the venture capital model. So I think absolutely, the government has to do this.*
>
> **Mr. Steven Visco**
> Chief Executive Officer and Chief Technology Officer, Polyplus Battery Company

In the past, vertically integrated firms housed basic and applied R&D as well as production within the same company. When innovation grew from the efforts of these large firms, they had the resources to scale the production of new technologies or processes.[6] The 1980s, however, witnessed the beginning of the transformation of the global industrial landscape—vertically integrated corporations off-loaded production processes to focus on their core competencies and shifted R&D to focus on the near-term needs of the business units.[7] This began the era of globally distributed manufacturing as well as a shift in the innovation landscape. Foundational technological breakthroughs in the United States are now more likely to come from universities, national laboratories, and small start-up companies.[8] This broken linkage of R&D to manufacturing—a linkage that was once a mainstay of the U.S. industrial sector—has created the scale-up valley of death in the United States.

The very presence of this valley of death is evidence that the private sector—due to high capital requirements coupled with high risk and uncertainty—is foregoing investment in the production of new clean energy technologies in the United States.

This PPP concept focuses on a broad problem the Department of Energy is trying to solve and is open to new ideas, new approaches, and new performers.

This PPP Concept complements the investments EERE is current making in basic and applied research for energy efficiency and renewable energy technology by providing a vehicle to move these technologies from lab to market. As such, this PPP is well aligned the problems EERE is currently trying to solve.

The structure of this PPP is designed to accommodate a wide range of the technology verticals and activities within and across these verticals. What has been designed is a process that has a wide range of applications and, thus, is accommodating to new ideas, new approaches, and new performers.

5 Martin LaMonica, MIT Technology Review, "For Energy Startups, a Glass Half Full or Empty?", January 2013.

6 Massachusetts Institute of Technology, "Report of the MIT Taskforce on Innovation and Production in the Innovation Economy Report", Editors: Richard M. Locke and Rachel Wellhausen, February 2013.

7 Ibid. pg. 20.

8 Ibid. pg. 21.

EERE funding and participation will result in enduring economic benefit to the United States.

Recent research is beginning to highlight the possibility that a region's ability to support businesses that successfully scale depends on complementary capabilities and assets (including financial) available in-house or within a regional industrial ecosystem. Since the decline of patient, vertically integrated firms conducting extensive fundamental research, these capabilities are rarely found "in-house" in multinational corporations. These capabilities could be provided by a region's complementary resources and assets—i.e. the industrial commons.

Industrial commons are geographically rooted collective R&D, engineering and manufacturing capabilities that sustain innovation.[9] This concept is at the center of the "clusters of competitiveness and innovation" work by the Council and Professor Michael Porter of the Harvard Business School.[10] Moreover, it is a key theme—under the names of innovation infrastructure or shared infrastructure—in recent writings on U.S. leadership in advanced manufacturing by the President's Council of Advisors on Science and Technology (PCAST) and the National Science and Technology Council (NSTC).[11] [12]

Simply stated, America's ability to scale is directly linked to its ability to provide opportunities for Americans to prosper.

The creation of industrial commons is both a public and private effort—and this PPP Concept is a building block in a renewed U.S. industrial commons that is essential if the United States intends to overcome competitive disadvantages in the technologies of clean production and to increase industrial EE.

For this PPP to have enduring economic impact, it must also endure within the portfolio of investments at EERE. This is the basis for the Council's recommendation to keep the technology verticals in the mission scope of the EERE. In order to attract sustainable funding, the focus of the partnership should to be in the purview of the government agency providing the funding. If the PPP activities are linked to the agency's activities and mission, the likelihood it will survive administration changes will increase.

9 Pisano, Gary P. and Willy C. Shih, "Restoring American Competitiveness," *Harvard Business Review*, July-August 2009.

10 The Council on Competitiveness, Michael E. Porter, Monitor Group, On The Frontier, *Clusters of Innovation Initiative: Regional Foundations of U.S. Competitiveness*, October 2012.

11 President's Council of Advisors on Science and Technology, *Report to the President on Ensuring American Leadership in Advanced Manufacturing*, June 2011.

12 National Science and Technology Council, *A National Strategic Plan for Advanced Manufacturing*, February 2012.

EERE funding and participation will represent a proper, high-impact role of government versus something best left to the private sector to do on its own.

> *Make no mistake out about it; manufacturing is a national team sport. If we don't recognize that, we are going to get crushed.*
>
> **Nolan Browne**
> Former Managing Director, Fraunhofer CSE

Evidence has revealed that public-private partnerships—and the industrial commons that they create—are a differentiating factor between places where many firms start-up but fail to scale, such as the United States, and places where scale-up occurs, such as Germany. As described in the Report of the MIT Taskforce on Innovation and Production, "It's impossible to understand the different fates of manufacturing in the U.S. and Germany without comparing the density and richness of the resources available in the industrial ecosystem across much of Germany to the thin and shrinking resources available to U.S. manufacturers across much of our country."[13] The Fraunhofer Institutes (a network of 80 research units and 60 institutes that partner with industry to provide a wide variety of services for businesses of all sizes with a particular emphasis on small and medium-sized enterprises [SMEs] that do not maintain their own R&D departments) are a differentiating resource in the German system, at least relative to the United States. German firms able to tap into the Fraunhofer network—among other publicly-supported shared assets—often find themselves competitively positioned against U.S. and other global manufacturers.

13 Massachusetts Institute of Technology, "Report of the MIT Taskforce on Innovation and Production in the Innovation Economy Report", Editors: Richard M. Locke and Rachel Wellhausen, February 2013.

The Path Forward

The inaugural AEMC Summit is the emerging platform for one of the most important national conversations for the nation to ensure long-term productivity and prosperity by supporting the energy and manufacturing sectors and recognizing their interconnectedness and tight coupling. This inaugural AEMC Summit begins the series of annual AEMC Summits, which will continue to highlight advances in energy and manufacturing and convene pre-eminent leaders from industry, academia, labor, the national laboratories, government and media to:

- Discuss the most critical energy and manufacturing challenges and opportunities facing U.S. prosperity, sustainability, and security;
- Accelerate a movement to increase U.S. competitiveness in the production of clean energy products, and increase U.S. manufacturing competitiveness across the board through greater energy productivity; and
- Commit to concrete actions to spark continued innovation and industrial transformation needed for economic growth and job creation.

These AEMC Summits will be supported by continued dialogue and engagement—through multiple means over the coming years.

At the inaugural AEMC Summit, the Council presents to EERE two scalable public-private partnerships with the potential to increase U.S. competitiveness of clean energy products and increase U.S. manufacturing competitiveness by increasing energy productivity. The Clean Energy Materials Accelerator and the Manufacturing and Energy Technology Accelerator both aim to increase U.S. competitiveness, but through two types of research and development efforts, namely through implementation of advanced materials and technology maturation. These two PPP concepts emerged after nearly a year of identifying factors that increase the success for a PPP to support advanced manufacturing and energy innovation, and engaging hundreds of leaders across the country to collect insights and perspectives. EERE and the Department of Energy ought to consider both of these PPP concepts as methods to support existing activities and the overall mission space.

Following the Inaugural summit, the Council held an additional five dialogues across the country, as well as three additional national summits, further exploring issues that arose.

AEMC: 2014-2016

Dialogue 5: Strengthen

Dr. Nicholas Dirks, Chancellor of The University of California, Berkeley, hosted the fifth dialogue on the university campus, where the Council and EERE presented a case study of one tool-based PPP centered around increasing awareness and access to advanced computing resources. Discussions during the fifth dialogue supported the mutual benefit of partnerships to organizations across the ecosystem, when aligned around a need such as materials characterization or manufacturing optimization or around streamlined access to a tool, such as advanced computing resources.

Dialogue 6: Scaling Innovation to Manufacturing

The sixth dialogue, hosted by the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness, and DOE Assistant Secretary for Energy Efficiency and Renewable Energy David T. Danielson, focused on the critical theme pervasive in the first five dialogues of identifying pathways and partnerships to scale innovative ideas and concepts to manufacturability. Based on a study of financial returns of early-stage risk capital across multiple sectors and a set of case studies, this dialogue specifically examined a group of potential public private partnership models that could more effectively support innovation and entrepreneurship in clean energy by strengthening the scale-up pipeline between prototype and first manufacturing.

Dialogues 7, 8 and 9: Accelerating Advanced Materials to Manufacturing

In 2015, the AEMC Partnership embarked on a path of deepening the conversations that emerged in the first two years of the partnership around the critical importance of advanced materials to long-term manufacturing competitiveness. In a partnership with DOE's Office of Fossil Energy—alongside EERE and other stakeholders in DOE—the AEMC Partnership launched a regional series of three dialogues specifically focusing on accelerating advanced materials manufacturing. There was a specific cross-cutting focus on materials for extreme environments, which had been identified as crucial for competitiveness in energy applications.

Setting the Stage for AEMC Partnership Materials Manufacturing Accelerator Dialogue Series

Advanced materials can drive significant enhancements products and the economy by increasing the efficiency and optimizing energy products. Moreover, material technologies have the ability to increase the competitiveness of all manufacturing sectors, for example through broadly applicable advances in heat recovery processes, lubricants that reduce wear and on process equipment, and shaping processes that reduce material waste. As such, materials science and engineering have remained a central leverage point capable of meeting the goals of the AEMC Partnership.

Building a program around accelerating the development, manufacture, and deployment of advanced materials also helps address three specific manufacturing barriers that inhibit dramatic progress in clean energy manufacturing: insufficient access to capital, technical uncertainties from technical risk and imperfect information, and insufficient access to innovation infrastructure.[14]

- **Capital Requirements:** While insufficient capital is often attributed to a dearth of new innovative energy technologies, insufficient capital also strangles the design, development, manufacture and deployment of advanced materials. The amount of investment required to design, develop, manufacture, and deploy advanced materials can shelf a project mid-stream or even inhibit a project from beginning.
- **Overcoming Technical Uncertainty & Imperfect Information:** Market incentives encourage firms to focus on low-risk incremental improvements to existing technologies rather than investing in new and unproven transformational technologies. Often, innovators and investors lack adequate information to make informed decisions. These high technical risks dampen the incentives to the increased creation and use of new technologies.
- **Industrial Innovation Infrastructure & Expertise:** This barrier refers to a lack of access to shared infrastructure and expertise on which industry scientists and engineers could draw to increase speed and lower costs on the path from design to production and commercialization. Typically, innovation infrastructure refers not only to shared research and testing equipment, but also to university or national laboratory personnel with specialized knowledge and skills.

Dialogue 7: Accelerating Advanced Materials Manufacturing

Dr. Ed Ray, President of Oregon State University; Dr. Cynthia Powell, Director for the Office of Research at the National Energy Technology Laboratory; Dr. S. Julio Friedmann, DOE Principal Deputy Assistant Secretary for Fossil Energy; Mr. Reuben Sarkar, Deputy Assistant Secretary for Transportation and Executive Director, CEMI, Office of Energy, Efficiency & Renewable Energy; Dr. Mark Johnson, Director, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy; and Mr. Chad Evans, Executive Vice President, Council on Competitiveness, co-hosted the first dialogue in the Materials Manufacturing Accelerator series.

Dialogue 8: Accelerating Advanced Materials Manufacturing

Dr. Peter Littlewood, Director of Argonne National Laboratory; Mr. David Mohler, DOE Deputy Assistant Secretary, Clean Coal and Carbon Management, Office of Fossil Energy; Mr. Reuben Sarkar, Deputy Assistant Secretary for Transportation and Executive Director, CEMI, Office of Energy, Efficiency & Renewable Energy; Dr. Mark Johnson, Director, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy; and Mr. Chad Evans, Executive Vice President, Council on Competitiveness, co-hosted the second dialogue in the Materials Manufacturing Accelerator series.

Dialogue 9: Accelerating Advanced Materials Manufacturing

Dr. M. Katherine Banks, Vice Chancellor and Dean of Engineering, and Director, Texas A&M Engineering Experiment Station, at Texas A&M University; Mr. Regis Conrad, DOE Director of the Division of Advanced Energy Systems; Mr. Reuben Sarkar, Deputy Assistant Secretary for Transportation and Executive Director, CEMI, Office of Energy, Effi-

14 The Council identified and documented 20 unique manufacturing barriers in the *Power of Partnerships* during Phase One of the AEMC Partnership. During Phase Two of the AEMC Partnership, regional and national clean energy manufacturing stakeholders from the public and private sectors shared insights and validated this list of barriers.

ciency & Renewable Energy; Dr. Mark Johnson, Director, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy; and the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness, co-hosted the third dialogue in the Materials Manufacturing Accelerator series.

In these three dialogues, intentionally located in geographic regions with differing manufacturing sector strengths, cross-cutting themes emerged regarding scaling and qualification of advanced materials which could be addressed through public-private partnership frameworks to accelerate a transition from discovery to manufacturing.

First, there is a need to organize and make readily available to manufacturers the materials qualification data coming from fundamental research. Second, there is a need to enhance the awareness and accessibility of unique materials research infrastructure in publicly-sponsored research laboratories for manufacturers (particularly for small and medium-sized manufacturers in a supply chain). And third, there is a need to develop shared materials processing capabilities for scaling materials innovations from the gram-scale to the kilogram-scale during extended application qualification. Overcoming these three barriers would accelerate U.S. competitiveness in advanced materials, particularly for materials to be used in extreme environments of energy applications where qualification and validation processes which occur across supply chains are an existing limitation to the pace of innovation.

Public-Private Partnership Concepts Evaluated through the AEMC Partnership

Through the 2012-2015 research effort and progressive dialogue series, the AEMC Partnership detailed barriers to U.S. leadership in manufacturing of clean energy products, and produced and evaluated PPP strategies, qualities, and concepts that could be applied to clean energy manufacturing to increase U.S. competitiveness throughout the entire innovation ecosystem.

- A range of PPP concepts were generated during the AEMC Partnership dialogue series to bridge gaps in the nation's innovation ecosystem. Each PPP concept was measured using five, key decision criteria the Assistant Secretary has articulated as critical to measure the success of any public-private partnership in which DOE might engage.
- This PPP is confronting, addressing and helping to solve a high-impact problem.
- DOE funding will make a large difference relative to what the private sector (and other funding entities) is already doing.
- This PPP concept focuses on a broad problem DOE is trying to solve and is open to new ideas, new approaches, and new performers.
- DOE funding and participation will result in enduring economic benefit to the United States.
- DOE funding and participation will represent a proper, high-impact role of government versus something best left to the private sector to do on its own.

By developing these PPP concepts through the AEMC Partnership progressive dialogue series, key stakeholders have shared their input on the most critical energy and manufacturing challenges and opportunities affecting U.S. prosperity, sustainability, and security. And they have highlighted opportunities for partnerships designed to cultivate the conditions in this country to promote increased energy productivity, the adoption of renewable technologies, and increased clean technology manufacturing investment.

About the Council on Competitiveness

For more than three decades, the Council on Competitiveness (Council) has championed a competitiveness agenda for the United States to attract investment and talent and spur the commercialization of new ideas.

While the players may have changed since its founding in 1986, the mission remains as vital as ever—to enhance U.S. productivity and raise the standard of living for all Americans.

The members of the Council—CEOs, university presidents, labor leaders and national lab directors—represent a powerful, nonpartisan voice that sets aside politics and seeks results. By providing real-world perspective to policymakers, the Council's private sector network makes an impact on decision-making across a broad spectrum of issues—from the cutting-edge of science and technology, to the democratization of innovation, to the shift from energy weakness to strength that supports the growing renaissance in U.S. manufacturing.

The Council firmly believes that with the right policies, the strengths and potential of the U.S. economy far outweigh the current challenges the nation faces on the path to higher growth and greater opportunity for all Americans.

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