THE NON-PETROLEUM BASED FUEL INITIATIVE --NPBF--

Office of FreedomCAR and Vehicle Technologies

summarized from DOE EERE Fuels Technologies 5 year plan

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- Rich Bechtold, QSS Group
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- plus others

Outline of Talk

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- Origin of NPBF program
- What is NPBF
- NPBF and APBF
- Research plan
- Future goal

For Immediate Release

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Key Initiatives in the President's State of the Union Message

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•President Bush announced a $1.2 billion hydrogen fuel initiative to reverse America's growing dependence on foreign oil by developing the technology for commercially viable hydrogen-powered fuel cells to power cars, trucks, homes and businesses with no pollution or greenhouse gases. The hydrogen fuel initiative will include $720 million in new funding over the next five years to develop the technologies and infrastructure to produce, store, and distribute hydrogen for use in fuel cell vehicles and electricity generation. Combined with the FreedomCAR (Cooperative Automotive Research) initiative, **President Bush is proposing a total of $1.7 billion over the next five years to develop hydrogen-powered fuel cells, hydrogen infrastructure and advanced automotive technologies.**

•Under the President's hydrogen fuel initiative, the first car driven by a child born today could be powered by fuel cells. The hydrogen fuel initiative complements the President's existing FreedomCAR initiative, which is developing technologies needed for mass production of safe and affordable hydrogen-powered fuel cell vehicles. Through partnerships with the private sector, the hydrogen fuel initiative and FreedomCAR will make it practical and cost-effective for large numbers of Americans to choose to use clean, hydrogen fuel cell vehicles by 2020. This will dramatically improve America's energy security by **significantly reducing the need for imported oil**, as well as help clean our air and reduce greenhouse gas emissions.

Renewable Fuel Standard – RFS

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- Current Senate and House bills differ slightly
- Final passage not yet clear
- Amends the Clean Air Act to include 5 billion gallons by 2012 – 2015, ramping from 2004 - 2005
- Equivalent to about 5% of petroleum usage
- Can include ethanol, biodiesel, or other fuel blending components derived from biomass

DOE'S Office of Energy Efficiency and Renewable Energy Top Nine Priorities

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1. Dramatically reduce or even end dependence on petroleum

2. Reduce burden of energy prices on the disadvantaged
3. Increase viability and deployment of renewable energy
4. Increase reliability and efficiency of electricity generation, delivery and use
5. Increase the efficiency of buildings and appliances
6. Increase the efficiency/reduce the energy intensity of industry
7. Create the new domestic bioindustry
8. Lead by example through government's own actions
9. Change the way EERE does business

FreedomCAR and Fuel Initiative

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Energy Security

Regional H2 Production
H2 Storage

H2 Engine Tech

Non-petroleum Fuels
Advanced Combustion

Adv Power Electronics
Energy Storage

Gasoline/diesel
ICE
Conventional
Drivetrain

Gasoline/diesel
ICE
Hybrid

Hydrogenated Fuels
Advanced ICE
Hybrid

Hydrogenated Fuels
H2 ICE
Hybrid

H2 Fuel
H2 ICE
Hybrid

H2 Fuel
Fuel Cells
Hybrid

- Research will Make Technology Available
- Policies and/or Incentives will Ensure Market Penetration

Today

2020

NPBF - Three Key Project Areas

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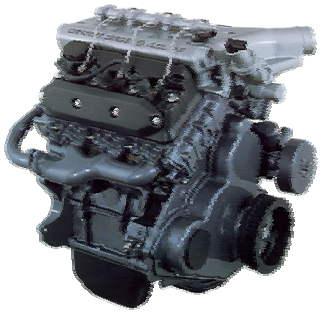
Enable immediate use of non-petrol fuels

Conduct research to aid immediate use of non-petrol fuels

Enable more efficient interim technologies

Identify fuel properties that can stretch ICE efficiency with near-zero emissions



Stimulate transition to hydrogen

Explore and identify fuels strategies for ICEs that can aid the transition to hydrogen & fuel cells

Enable immediate use of non-petroleum fuels and blends

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Low renewable content blends (up to 5%)

- •Biodiesel and biomass based
- •Possible new renewables
- •Petroleum displacement and global warming benefits

R&D focused on issues preventing market entry

- •Distribution and blending
- •Compatibility and durability
- •Specifications and quality standards
- •Regulated and non-regulated emissions
- •Catalyst compatibility

Analysis of relevant policy questions

- •Well-to-wheels analysis
- •Air quality impacts
- •Possible legislative drivers

Enable more efficient interim technologies

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Future engines will employ a range of advanced technologies:

- •Variable valve actuation, multiple injection events, variable geometry turbo
- •Variable compression ratio, internal EGR
- •Advanced catalyst systems

These enable highly efficient, low emissions operating strategies:

- •Low temperature combustion
- •Rich – smokeless combustion
- •Expanded range of HCCI operation
- •Miller cycle and other valve timing strategies

R&D focused on identifying fuel properties enabling greater benefits:

- •Renewables content
- •Mixture formation, ignition, low temperature combustion
- •Aftertreatment performance

Analyses to show benefits of new technologies

DOE Invitational Workshop on Advanced Combustion & Fuels

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- Advanced combustion regimes, fuel formulations, and interactions
- Argonne National Laboratory, June 2003
- 100 participants
  - industry, energy, DOE, national labs, universities
- Six discussion topics
  - **Base fuels**
  - **Blending agents**
  - Aftertreatment
  - Engines
  - Combustion modeling
  - In-cylinder combustion
- Final summary not issued yet

Input from Argonne Workshop

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- Low NOX combustion will probably not work under all operating conditions, necessitating the continued need for aftertreatment
- Everyone agrees on the importance of reducing sulfur in fuels, although there is not yet agreement as to the level needed
- There is not agreement relative to reducing aromatics
- Research is needed to determine optimal fuel properties for low NOX combustion engines.

General Fuels Issues from Argonne Workshop

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- Should sulfur be below current 15 ppm standard?
- Is is more economical to remove sulfur at refinery or on vehicle?
- Are lower aromatics needed?
- Refinery operating efficiency and maximizing refinery output most be considered in fuels decisions.
- Fuel safety must be considered in designing new fuels.
- Are there conflicting requirements for current and future engines?

Possible fuel requirements for HCCI-type combustion

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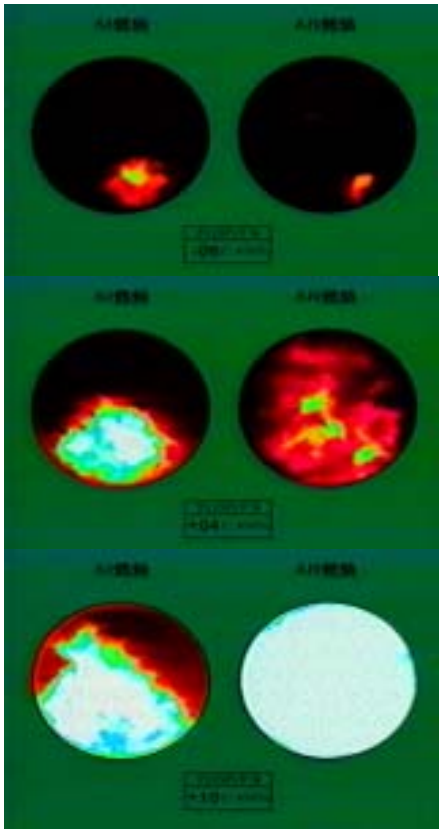
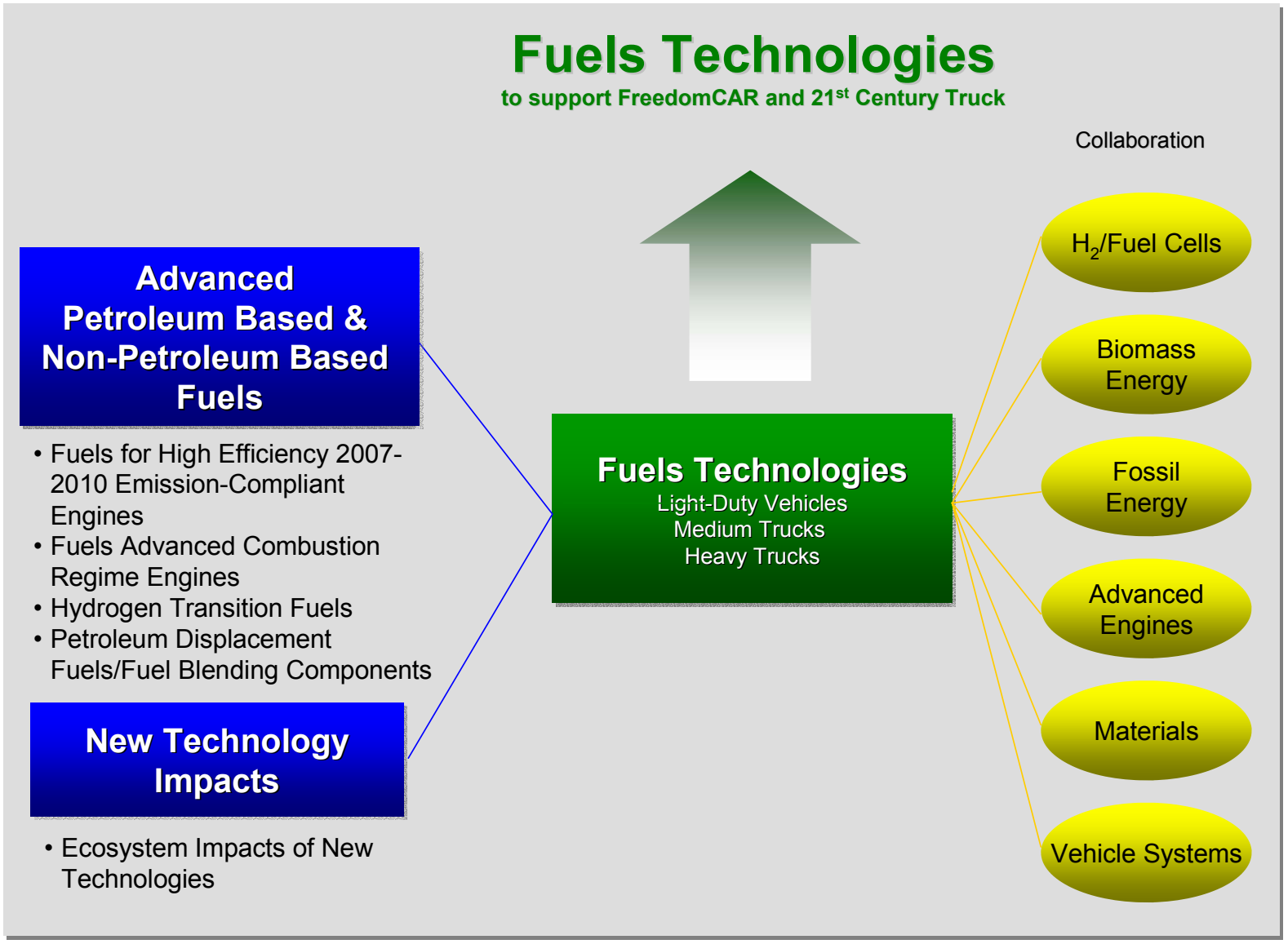
- Lower cetane for longer mixing time?
- Higher octane for knock resistance?
- New measure for combustion characteristics?
- Less variation of fuel properties for better control?
- Narrower boiling range?
- More volatile fuel?



Honda Photographs

Fuels Technologies

to support FreedomCAR and 21st Century Truck



NPBF and APBF – companion programs

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- APBF
  - Started in 2000
  - Multi-year research plan in place
  - Many accomplishments reported at DEER conferences
- NPBF
  - Started in 2003
  - Multi-year research plan beginning

Barriers and research needs

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Impact of fuel properties on combustion and engine optimization.

Impact of fuel properties on emissions and emission control systems.

Impact of new fuels on system durability.

Compatibility and infrastructure issues with new fuels.

Full cost analysis for new fuels.

Health and safety issues

Program Timeline

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- 2007
  - Fuel specifications for advanced combustion regime engines
  - Identify potential for 5% replacement of petroleum fuels
- 2010
  - Non-petroleum based fuels
  - Advanced engine concepts, high efficiency, low emissions
  - Validate 5% replacement of petroleum fuels over next decade
- 2020
  - Hydrogen-based transportation commercially viable

A child born today should have the option of a hydrogen vehicle for their first car

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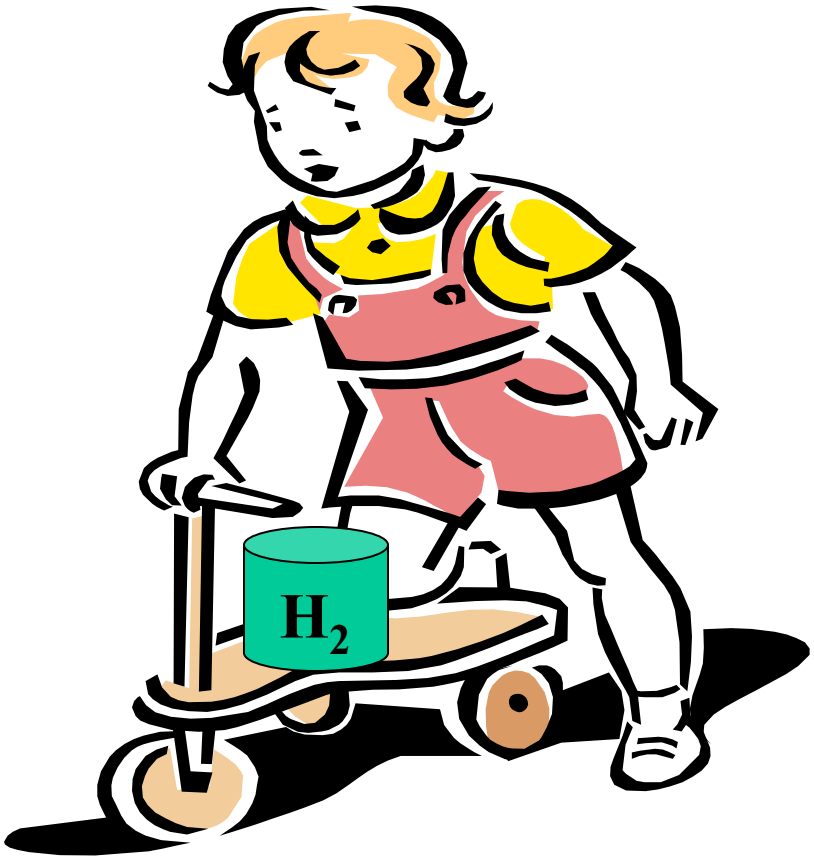

THE NON-PETROLEUM BASED FUELS INITIATIVE (NPBF)

Bruce G. Bunting, Oak Ridge National Laboratory, and others

Slide 1: This talk summarizes the work of a large group of people at DOE and government labs.

Slide 2: We will explain the origins of the NPBF program, and how it relates to other DOE fuels programs.

Slide 3: Non-petroleum based fuels were given a large boost in President Bush's January 2003 State of the Union Address, when he expressed his goal to develop hydrogen-based energy as an alternative to imported oil.

Slide 4: An additional need for non-petroleum based fuels is in support of the Renewable Fuels Standard

Slide 5: DOE's Office of Energy Efficiency and Renewable Energy's top priority is to reduce dependence on foreign oil.

Slide 6: The transition to hydrogen-based transportation is shown on the chart, moving to advanced combustion and hydrogen rich fuels, to hydrogen internal combustion engines, to hybrid vehicles, and finally to hydrogen powered hybrid fuel cell vehicles.

Slide 7: The transition away from petroleum starts with non-petroleum based fuels, through development of advanced technologies, and finally to a hydrogen-based transportation system.

Slide 8: Research on non-petroleum based fuels should focus on displacement of petroleum, removal of market barriers, and developing data to support policy decisions.

Slide 9: As fuels evolve, a major focus needs to be engine efficiency and fuel economy. Advanced engine and combustion technologies should allow improved efficiency while meeting new emissions regulations.

Slide 10: DOE held a workshop on advanced combustion and fuels at Argonne in June 2003. The workshop was attended by about 100 people from industry, energy companies, DOE, national labs, and universities.

Slide 11: It was generally agreed that new fuels may help more efficient modes of engine operation, but that conventional aftertreatment will still be needed for some operating modes.

Slide 12: Fuel properties such as aromatics and sulfur level need further research. Fuel property changes need to be weighed against refinery yield, fuel safety, and compatibility with older vehicles.

Slide 13: Several suggestions were made for fuel variations which might enable more use of HCCI combustion, but further research is needed to understand the impact and benefits of fuel changes.

Slide 14: Fuels development is being coordinated with vehicle, engine, and component research.

Slide 15: The new NPBF program is a companion program to the existing APBF program.

Slide 16: Research needs for new fuels include optimization of engines, combustion, efficiency, and emissions as well as addressing issues of infrastructure, compatibility, and fuel safety. A full cost analysis is needed to weigh benefits.

Slide 17: A program timeline includes identifying potential for petroleum displacement, validating displacement of petroleum, and transitioning to hydrogen based fuels.

Slide 18: In the future, a person will be able to select a hydrogen-powered vehicle in the marketplace.