Vehicle Technologies Program

Focus on the Future
Transportation Research Conference

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The Changing DOE / Auto Industry Relationship

Pre - 2008

• Largely an R&D role focused on spurring innovation. Also supported regulatory actions
  – Activity predates formation of DOE in 1977
  – Partnerships: PNGV, FreedomCAR and Fuel Partnership
  – R&D that helps identify regulatory limits

2008 and Beyond

• Key Responsibilities added
  – R&D Budget increased 75%
  – $25B Advanced Technology Vehicles Manufacturing (ATVM) Loan Program
  – Recovery Act: $2.8B in grants supporting manufacturing and vehicle/infrastructure demonstration
  – ARPA-e
  – Loan Guarantee Program
U.S. Vehicle Market

- 240 million vehicles on the road
- Approximately 9M new cars & light trucks for 2009. Average is 15.7 M/yr 2002-2007
- Hybrid vehicles now ~3% of sales
- 13 Million cars and light trucks taken out of use per year
- 11.5 Million barrels of oil per day consumed by on-road vehicles
Vehicle GHG emissions fall into 3 major groups:
- Conventional
- Electric-drive
- Combination electric-drive + biofuel

Petroleum consumption loosely mirrors GHG emissions

Analysis Informs Strategy

GHG Emissions and Petroleum Consumption by Vehicle Technology

Petroleum Consumption (gal gas-eq / mi)

GHG Emissions (g CO2-eq / mi)

Reference vehicle GHG emissions: 430 g CO2eq /mi

50% reduction from reference vehicle GHG emissions: 215 g CO2eq /mi

GHG Emissions fall into 3 major groups:
- Conventional
- Electric-drive
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Petroleum consumption loosely mirrors GHG emissions
Mission: Develop clean highway transportation technologies to enable America to use less petroleum and lower greenhouse gas emissions

**Distribution of Funding**

- Industry: 34%
- National Labs: 49%
- University: 3%
- Consortium: 10%
- Federal: 2%
- OEMs: 2%

**Vehicle Technologies Budget Trend**

- FY07: $184 million
- FY08: $208 million
- FY09: $267 million
- FY10: $311 million
- FY11 Request: $325 million
Hybrid-Electric Systems

Petroleum Displacement through Fuel Substitution and Improved Efficiency

Goal: 1 Million PHEVs by 2015

Types of Vehicles and Benefits

- **HEV**
  - Toyota Prius
  - 50 MPG

- **PHEV**
  - Chevy Volt
  - ~100 MPGe

- **EV**
  - Nissan Leaf
  - All Electric

Battery Cost Reduction

- Cell materials & fabrication represents about 3/4 the cost for PHEV batteries
- For significant cost reduction, new materials with increased energy density are needed to reduce:
  - material needs
  - cell count, and
  - cell/pack hardware

Status and Targets

2009 Status

- **Status**: $800-$1000 / kWhr
- **Status**: Current cost of the electric traction system is $40/kW

2014 PHEV: $300 / kWhr

2015 PEEM: Cost for elec. traction system no greater than $12/kW peak by 2015

0 100 200 300 400 500 600 700 800 900 1000

$/kWhr

- Pack
- Cells
- Electrodes
- Materials
Increasing engine efficiency is one of the most cost-effective approaches to increasing fuel economy.

### Benefits All Vehicle Classes

**Light-Duty**
- Cars
- 25-40% Improvement

**Heavy-Duty**
- Trucks
- Up to 50% Improvement

### Targets

**2015 Passenger Vehicle:** Improve gasoline vehicle fuel economy by 25% and diesel vehicle fuel economy by 40%; compared to 2009 baseline.

**2015 Commercial Engine:** Improve commercial engine efficiency by more than 20%; compared to 2009 baseline.

**2015 HEV & PHEV Improvements:** Could provide >70 MPG HEV

### R&D Focus

**Advanced Combustion Regimes (HCCI / low temp combustion)**
- Diesel-like efficiency
- Complex combustion modeling
- Computational fluid dynamics engine models

**Emissions Control Technologies**
- Improve NOx catalyst conversion efficiency
- Develop on-board diagnostics and sensors

**Waste Heat Recovery – Mechanical and Thermoelectric Devices**
- Increase practical conversion efficiency
- Increase durability

“Support improved mileage performance of internal combustion engines…” – Secretary of Energy Steven Chu
2009 Status

2009: Approximately 10.5 billion gallons of renewables used

2011 Target: Have answer on viability of E15 and B20

2022 Target: Attainment of RFS II mandate – 36 B gallons/year

Performance of legacy vehicles on intermediate ethanol blends

- Durability, driveability, and materials compatibility for vehicles, small engines, and infrastructure

E85 Optimized FFV Engines – Increase use of E85 by decreasing the fuel economy penalty of ethanol

- Eliminate half of energy content penalty by taking advantage of higher octane
- Utilizing turbo-charging, variable valve timing, direct injection, and compression ratio increase to achieve 15% increase in fuel efficiency with E85
Materials Development

Vehicle lightweighting is one of the most cost effective ways of reducing fuel consumption resulting in a 6-8% improvement in fuel economy with every 10% reduction in vehicle weight.

Types of Materials and Benefits

**Magnesium**
25-35% Lighter than a Aluminum Engine Block

**Carbon Fiber**
50-60% Lighter than a Standard Steel Body in White

Targets and Status

**2009 Status:**
Modeling demonstrated that body and chassis weight reduction goal of 40% could be achieved, but not at cost parity.

**2010 Target:**
Cost-effectively reduce the weight of passenger vehicle body and chassis by 50% in high volume applications compared to 2002 vehicles.

Body/Chassis Weight Reduction of 50% Possible

- Through weight decompounding only 20-25% of primary weight reduction required
- Key Materials: Carbon fiber, Mg alloys, high strength steel

Weight Decompounding is an iterative solution: Lower overall weight reduces the engine size required, which in turn reduces weight, which in turn allows the vehicle structure to be reduced, etc.
Outreach and Deployment

Providing a new generation of engineers with knowledge/skills in advanced vehicle technologies

Advanced Vehicle Competitions

Since 1987, DOE has sponsored more than two dozen university-level competitions, providing engineering students an opportunity to conduct hands-on research and development. EcoCAR has 17 teams pursuing a variety of advanced vehicle technologies.

Graduate Automotive Training Education

Eight Centers of Excellence

University of California-Davis, Virginia Tech, Pennsylvania State University, The Ohio State University, University of Michigan-Dearborn, University of Tennessee, University of Illinois, Champaign-Urbana, University of Alabama-Birmingham

Improving the speed and scale of market penetration for alternative fuel vehicles and infrastructure

Focus

• Petroleum & Emissions Reduction
• Vehicles and Infrastructure
• Education and Outreach
• Economic Opportunities

Unique Assets

• Local Strategy Advances Nat. Goal
• Coordinators
• Coalitions
• Technical Information/Resources
  www.fueleconomy.gov
  http://www.afdc.energy.gov/afdc/
Recovery Act: $2.8 Billion
www.recovery.gov

$1.5 Billion in funding to accelerate the manufacturing and deployment of the next generation of U.S. batteries

$500 Million in funding for electric-drive components manufacturing

$400 Million in funding for transportation electrification

Recovery Act will fund 48 new projects in advanced battery and electric drive components manufacturing and electric drive vehicle deployment in over 20 states

Facilities and Equipment Upgrade up to $105 Million: User Centers, offer expert staff and unique equipment capabilities that no one industrial entity can afford to maintain.

Clean Cities: Petroleum Displacement through Alt Fuel Vehicles and Expanded Alternative Fuel Infrastructure

SuperTruck and Advanced Combustion R&D $104.4 Million Solicitation

- Demonstrate a 50% improvement in freight efficiency by 2015 in Class 8, long haul trucks
Advanced Technology Vehicle Manufacturing Loan Program

**Summary:** $25B in direct loans available to auto and components manufacturers for the cost of re-equipping, expanding, or establishing manufacturing facilities in the US to produce qualified advanced technology vehicles (ATVs) or components. Still accepting applications.

### Eligibility Requirements

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| **General Eligibility** | • Must locate manufacturing facilities (and eligible engineering integration) in the U.S.  
• Must relate costs to reequipping, expanding, or establishing a manufacturing facility |
| **Vehicles**            | • Must meet 125% of mpg in 2005 for “substantially similar vehicles”  
• Must meet Bin 5 Tier II emissions standards and any new particulate standard |
| **Components**          | • Must be specifically designed for installation in qualifying ATVs  
• Must contribute to the qualifying ATV’s performance requirements |

### Timeline Highlights

- **$25B appropriated for EISA 2007§136** 9/30/08
- **Interim Final Rule published in Federal Register** 11/05/08
- **$8B awarded in first 3 loans (Ford, Nissan, Tesla)** 6/23/09
- **$500M awarded in 4th loan (Fisker)** 9/22/09
- **$24M awarded for components in 5th loan (Tenneco)** 10/27/09