Overview of FreedomCAR & Vehicle Technologies Program

Dr. Phyllis Yoshida, Director
FreedomCAR and Fuel Partnership
A prosperous future where energy is clean, abundant, reliable, and affordable.
Specifically, an energy future where: ... Our cars and trucks will be more efficient and will be powered by a variety of clean domestic fuels and technologies that free us from dependence on foreign supplies of energy.

**EERE’S #1 Priority**
Dramatically reduce or even end dependence on foreign oil

Developing and accelerating the deployment of more energy efficient and environmentally friendly automobile and truck technologies that will enable America to use less petroleum.

Benefits
- Reduce dependence on oil through fuel substitution & higher efficiency in both passenger vehicles & commercial fleets.
- Reduce greenhouse gas emissions.

<table>
<thead>
<tr>
<th>Impacts</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Savings (MBPD)</td>
<td>2.90</td>
<td>6.48</td>
</tr>
<tr>
<td>Carbon Emission Reduction (MM tons of carbon/yr)</td>
<td>117</td>
<td>260</td>
</tr>
</tbody>
</table>

FY2007 GPRA
# FCVT BUDGET

## Activity

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid Electric Systems</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>80,664</td>
</tr>
<tr>
<td>Vehicle Systems</td>
<td>13,875</td>
<td>13,004</td>
<td>13,056</td>
<td>13,315</td>
<td>0</td>
</tr>
<tr>
<td>Hybrid &amp; Electric Propulsion</td>
<td>43,390</td>
<td>44,066</td>
<td>43,997</td>
<td>50,841</td>
<td>0</td>
</tr>
<tr>
<td>Advanced Combustion Engine R&amp;D</td>
<td>52,736</td>
<td>48,480</td>
<td>42,746</td>
<td>46,706</td>
<td>34,550</td>
</tr>
<tr>
<td>Materials Technology</td>
<td>38,622</td>
<td>36,042</td>
<td>35,269</td>
<td>29,786</td>
<td>33,382</td>
</tr>
<tr>
<td>Fuels Technology</td>
<td>15,887</td>
<td>12,419</td>
<td>13,709</td>
<td>13,845</td>
<td>13,845</td>
</tr>
<tr>
<td>Technology Integration</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13,697</td>
</tr>
<tr>
<td>Technology Introduction</td>
<td>4,802</td>
<td>4,944</td>
<td>6,250</td>
<td>11,031</td>
<td>0</td>
</tr>
<tr>
<td>Innovative Concepts</td>
<td>494</td>
<td>494</td>
<td>495</td>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>Technical/Program Mgt. Support</td>
<td>2,095</td>
<td>1,877</td>
<td>2,475</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Biennial Peer Reviews</td>
<td>494</td>
<td>0</td>
<td>990</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Congressionally Directed Activities</td>
<td>0</td>
<td>0</td>
<td>24,255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>172,395</strong></td>
<td><strong>161,326</strong></td>
<td><strong>183,242</strong></td>
<td><strong>166,024</strong></td>
<td><strong>176,138</strong></td>
</tr>
<tr>
<td>FreedomCAR &amp; Fuel Partnership Activities</td>
<td>86,653</td>
<td>85,282</td>
<td>96,549</td>
<td>109,774</td>
<td>126,619</td>
</tr>
<tr>
<td>21st Century Truck Partnership Activities</td>
<td>76,339</td>
<td>70,055</td>
<td>45,267</td>
<td>42,021</td>
<td>29,792</td>
</tr>
</tbody>
</table>
The transportation sector accounts for 67% of the oil use in the United States and is the fastest growing petroleum consuming sector.
Carbon Dioxide Emissions by End-Use Sector

- Transportation: 33%
- Electric Power: 39%
- Industrial: 18%
- Commercial: 4%
- Residential: 6%

The transportation sector accounts for 1/3 of the carbon dioxide released in the United States and is the fastest growing source.
GLOBAL CONTEXT

→ China: Growth in Number of Vehicles in Use

GLOBAL CONTEXT

→ US & China CO₂ Emissions

Overcoming Our Addiction
Begins with Efficiency & Fuel Substitution R&D

- Research & Development
- Demonstration & Deployment
- Raising the bar through innovative technology
- Accelerating marketplace impacts through partnerships

U.S. Department of Energy
Energy Efficiency and Renewable Energy
The Challenge
3/4 of the energy in every gallon is lost!

Hybridization & Advanced Combustion Research
Address the Top Losses
Strategic Approach to Future Transportation

Developing a Continuum of Energy-Efficient Technologies for Sustainable, Fuel-Flexible Vehicles

- Today: Gas/Diesel Engine Conventional
- Transition Period:
  - Power Electronics, Electric Motors & Energy Storage
  - High Efficiency, Clean Combustion & Fuel Technologies
  - Advanced Engine & Renewable Liquid Fuel
  - Advanced Engine & Plug-in Hybrid
- Zero-Petroleum Vehicles Dominate the Market
- Diverse Domestic Fuel Production Technologies
- Domestic Fuel & Advanced Hybrid
- Zero Petroleum & Emission

Lightweight Materials and Vehicle Systems Research are Integral to All Technologies
Vehicle Technologies
Accelerating Results that make a Difference

Advanced Technologies for High Efficiency Clean Vehicles

Vehicle Systems
- Aerodynamics
- Rolling Resistance
- Systems Analysis and Target Setting

Hybrid Propulsion
- Hybrid Electric Systems
- Power Electronics
- Advanced Batteries
- Inverters/Controllers
- Motors

Advanced Combustion Engines
- Low Temp. Combustion R&D
- Emission Controls
- Light- & Heavy-Duty Engines
- Waste Heat Recovery
- Health Impacts

Fuels Technologies
- Bio-Based Fuels
- HCCI Fuel Characteristics
- Fischer-Tropsch Fuels & Blendstocks
- Advanced Lubricants

Tech Introduction
- EPACT
- Legislative & Rulemaking
- Clean Cities
- Validation
- Student Competitions
- GATE

Materials Technology
- Lightweight Structures
- Metal Processing
- Composite Development
- Processing and Manufacturing
- Design Data Test Methods
- Recycling Technology
- HTML
Technology Barriers
Research Seeks to Overcome These Hurdles

• Components & Systems
  – Cost
  – Performance
  – Size and weight
  – Reliability

• High Volume Manufacturability

• Deployment & Infrastructure
• **Hybrid Powertrains**
  – Motors and electronics
    • Reduce cost
  – Batteries
    • 15 year lifetime
    • 1/3 today’s cost

• **Engines**
  – Optimize engine design for biofuels
  – Advanced combustion - lower emissions, higher efficiency
Research Success is Only the First Step Along the Pathway to Commercialization

1. Research & Development
   - Engineering Feasibility: Validation, Demonstration
     - 7-9 years
   - Intent to Produce
     - 3 years
   - Commercial Deployment
     - 3 years
   - 12+ years

Infrastructure Development
1. Codes & Standards
2. Infrastructure Refinements
3. General Education & Special Training
4. Incentives

Maximum Market Penetration
• Consumer
  – Limited market drivers (consumer perception that fuel price increases are temporary)
  – Incremental cost of technology
  – Relatively low fuel cost

• Manufacturer
  – High R&D cost
  – Cost of replacing sunk investments
  – Uncertain market – spurs compromise solutions
  – Pre-buys (heavy truck market)
It takes about 15 years for a technology to reach maximum penetration in new vehicle sales and another 15 years for the technology to be ubiquitous.

Policy and incentives can accelerate market penetration.

## Examples of Major Technology Success Stories

<table>
<thead>
<tr>
<th>Deployed Technologies</th>
<th>Technology Partners</th>
<th>Policy Implications</th>
<th>Market Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Sulfur Diesel Fuel</td>
<td>ORNL NREL</td>
<td>Informed EPA of sulfur effects from fuel research</td>
<td>40B gallons of low sulfur diesel fuel used annually</td>
</tr>
<tr>
<td>Nickel Metal Hydride Batteries</td>
<td>Cobasys</td>
<td>Royalty payments to Treasury</td>
<td>Every US Hybrid Vehicle sold has IP from this battery research</td>
</tr>
</tbody>
</table>
• **Current Projects**
  – DOE funded 16 state projects in FY 2006 to Increase Use & Availability of Alternative Fuels
  – Clean Cities Coalitions (>90)
  – Testing Plug-in Hybrid Vehicles for NYSERDA

• **Further Opportunities**
  – Vehicle testing with other state agencies
  – Gathering state data on alternative fuel usage, market drivers, and market roadblocks