Energy Security for America’s Transportation

Richard Moorer
U.S. Department of Energy

2002 CleanEnergy Seminar
Sacramento, March 20
• “...that the President direct the Secretary of Energy to establish a national priority for improving energy efficiency. (Recommendation 4.14)

• “Increase funding for renewable energy and energy efficiency research and development programs that are performance-based and cost-shared.” (page xii)

• “…Based on this review, the Secretary of Energy is then directed to propose appropriate funding of those research and development programs that are performance-based and modeled as public-private partnerships.” (Recommendations 4.2 and 6.3)
Directs the Secretary Of Energy “to develop next generation technology including hydrogen...”

“Focus research and development efforts on integrating current programs regarding hydrogen, fuel cells, and distribution...”

Develop legislation to provide for a temporary income tax credit available for the purchase of new hybrid or fuel cell vehicles.”

“The President’s Plan directs us to explore the possibility of a hydrogen economy....”

Spencer Abraham, Secretary of Energy
Support the development and use of advanced transportation vehicles and fuels which will reduce energy demand, particularly for petroleum; reduce greenhouse gas emissions; and enable United States transportation to sustain a strong competitive position in domestic and world markets.
Hybrid Systems R&D

Heavy Vehicle Systems R&D

Advanced Combustion Engine R&D

Fuel Cell R&D

Electric Vehicle R&D

Fuels Utilization R&D

Biofuels

Material Technologies

Transportation Technology Assistance
The “Oil Gap” is Growing

Highway Carbon Emissions
(million metric tons)

1990 2000 2010 2020
325 384 455 507

Domestic Oil Production

Millions of Barrels per Day


0 2 4 6 8 10 12 14

Automobiles
Light Trucks
Heavy Trucks
Commercial Vehicles
Passenger Vehicles

World Oil Reserves are Consolidating in OPEC Nations

- **OPEC**
  - Consumption: 8%
  - Production: 43%
  - Reserves: 79%

- **Rest of World**
  - Consumption: 19%
  - Production: 49%
  - Reserves: 66%

- **US**
  - Consumption: 26%
  - Production: 9%
  - Reserves: 2%
Transportation Emissions Remain an International Concern

- Transportation produces:
  - 79% of carbon monoxide,
  - 50% of nitrogen oxides,
  - 36% of volatile organics, and
  - 42% of carbon dioxide emissions
- Over 100 million people live in areas not meeting National Ambient Air Quality Standard (EPA, Oct. 1995)
Closing the Oil Gap

✓ Increase the Supply of Oil
✓ Reduce the Demand for Oil

-- Improve the Fuel Economy of Vehicles & other Oil Using Equipment
-- Replace Oil with Alternative Fuels (& Feedstocks)
5 MMB/D Savings in Highway Vehicle Energy Use Would Help Hold Oil Imports to 50% in 2020

Would need 64 MPG for new LDVs by 2020, 50% improvement in HDV MPG and 0.5 mmb/d cellulosic ethanol
Closing the “Oil Gap”

- Transportation Oil Use
- Domestic Production
- Actual
- Predicted
- Hydrogen Fuel Cell
- Hybrid + H2 Fuel Cell

Chart showing the comparison between actual and predicted oil use, domestic production, and the prediction of future trends in transportation and fuel use.
FreedomCAR is a Partnership

January 9, 2002
Secretary Abraham announces the FreedomCAR Partnership

- The CAR in FreedomCAR is for Cooperative Automotive Research
- The Partners are:
  - U.S. Department of Energy
  - U.S. Council for Automotive Research
  (USCAR is a cooperative endeavor of DaimlerChrysler, Ford and General Motors to conduct pre-competitive research)
Energy Security Through FreedomCAR Technology

America’s Transportation Freedoms

- Freedom from dependence on foreign petroleum
- Freedom from pollutant emissions
- Freedom to choose the vehicle you want
- Freedom to drive where you want, when you want
- Freedom to obtain fuel affordably and conveniently
• Develop technologies to enable mass production of affordable hydrogen-powered fuel cell vehicles and assure the hydrogen infrastructure to support them.

• Continue support for hybrid technologies and advanced materials that can dramatically reduce oil consumption and environmental impacts in the nearer term.

• Develop technologies applicable across a wide range of passenger vehicles.
Goals

• Develop reliable systems for future fuel cell powertrains with costs and performance comparable to conventional internal combustion engine/automatic transmission systems.

• Enable clean, energy-efficient vehicles operating on clean, hydrocarbon-based fuels powered by either internal combustion powertrains or fuel cells.

• Enable reliable hybrid electric vehicles that are durable and affordable.
• Enable the transition to a hydrogen economy, ensure widespread availability of hydrogen fuels while retaining the functional characteristics of current vehicles.

• Develop material manufacturing technologies for light weight, high volume production vehicles.
## 2010 FreedomCAR Technology Specific Goals

<table>
<thead>
<tr>
<th>Fuel Cell System</th>
<th>Efficiency</th>
<th>Power</th>
<th>Energy</th>
<th>Cost**</th>
<th>Life</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>60% (hydrogen)</td>
<td>325 W/kg</td>
<td>2 kW-h/kg</td>
<td>$45/kW (2010)</td>
<td>15 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45% (w/ reformer)</td>
<td>220 W/L</td>
<td>1.1 kW-h/L</td>
<td>$30kW (2015)</td>
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<table>
<thead>
<tr>
<th>Hydrogen Fuel/ Storage/ Infrastructure</th>
<th>Efficiency</th>
<th>Power</th>
<th>Energy</th>
<th>Cost**</th>
<th>Life</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>70% well to pump</td>
<td>&gt;55 kW 18 s 30 kW cont.</td>
<td>2 kW-h/kg</td>
<td>$5/kW-h $1.25/gal (gas equiv.)</td>
<td>15 years</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>Electric Propulsion</th>
<th>Efficiency</th>
<th>Power</th>
<th>Energy</th>
<th>Cost**</th>
<th>Life</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;55 kW 18 s</td>
<td>$12/kW peak</td>
<td>15 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 kW cont.</td>
<td></td>
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<tr>
<th>Electric Energy Storage</th>
<th>Efficiency</th>
<th>Power</th>
<th>Energy</th>
<th>Cost**</th>
<th>Life</th>
<th>Weight</th>
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<tbody>
<tr>
<td>25 kW 18 s</td>
<td>$20/kW</td>
<td>15 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 W-h</td>
<td></td>
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<table>
<thead>
<tr>
<th>Materials</th>
<th>Efficiency</th>
<th>Power</th>
<th>Energy</th>
<th>Cost**</th>
<th>Life</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>45% peak</td>
<td></td>
<td>$30/kW</td>
<td>15 years</td>
<td></td>
<td></td>
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<table>
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<tr>
<th>Engine Powertrain System*</th>
<th>Efficiency</th>
<th>Power</th>
<th>Energy</th>
<th>Cost**</th>
<th>Life</th>
<th>Weight</th>
</tr>
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<tbody>
<tr>
<td>45% peak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15 years</td>
</tr>
</tbody>
</table>

* Meets or exceeds emissions standards.
** Cost references based on CY2001 dollar values.
Executive Steering Committee
USCAR Vice Presidents of R&D
DOE EERE Assistant Secretary, OSTP Associate Director for Technology
Designated Observers -- OVP, OMB

FreedomCAR Operations Group
USCAR Director and Industry FreedomCAR Directors
DOE FreedomCAR Partnership Director, OAAT & Hydrogen Program Office Directors

Technical Team*
Technical Team
Technical Team
Technical Team

Consultations:
Gov’t Agencies, Energy Industry, Suppliers, Etc.

Consultations With DOE Offices
Fossil Energy, Office of Science, Etc.

* Number & Composition of Technical Teams TBD

February 5, 2002
FreedomCAR FY03 Budget Request
Reflects Fuel Cell and Hydrogen Priorities

Trans-Related Hydrogen 25,820
Advanced Combustion Engine 14,076
Hybrid Vehicle Comp. 38,500
Electric Vehicle 3,500
Small Business Universities 2,000
Materials 10,800
Fuels 5,600
Fuel Cells 50,000

Totals = $150,296

($K)
FreedomCAR encompasses support for technologies with the potential to dramatically reduce oil consumption and environmental impacts in the period prior to the introduction of affordable fuel-cell vehicles.

- Hybrid Electric Drivetrains
- Advanced Internal Combustion Engines
- On-Board Fuel Processors for Fuel Cells
- Lightweight Materials, Energy Storage, Electronic Components
“The Department should report to the House and Senate Committees on Appropriations, within twelve months of the date of enactment of this Act, on the technical and economic barriers to the use of fuel cells in transportation, portable power, stationary, and distributed generation applications. The report should include recommendations on program adjustments based on an assessment of the technical, economic, and infrastructure requirements needed for the commercial use of fuel cells for stationary and transportation applications by 2012.”
FreedomCAR Partnership

A Long-Term Effort to Achieve Clean Energy-Efficient Automotive Transportation Based on Hydrogen-Powered Fuel-Cell Vehicles

With

✓ Intermediate Goals and Metrics to Ensure Measurable Progress

While

✓ Ensuring America’s Transportation Freedoms