



Hydrogen and Fuel Cells in the US: The FreedomCAR and Hydrogen Fuel Initiative

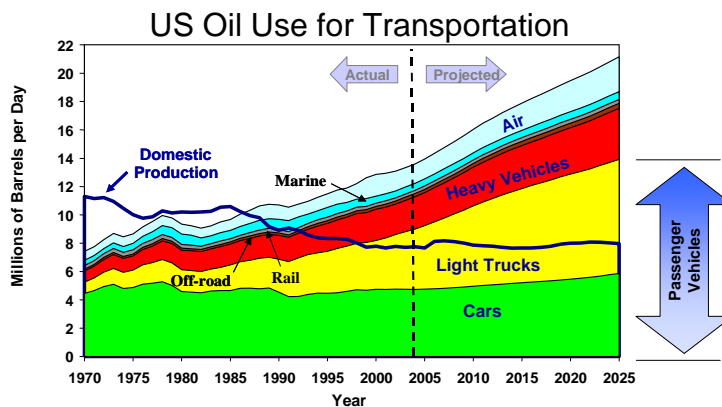
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Hydrogen- and Fuel Cell Based Energy Systems in a Future
Sustainable Energy World

31 March 2004
Vienna Austria



U.S. Energy Dependence is Driven By Transportation



Source: Transportation Energy Data Book, Edition 22, September 2002,
and EIA Annual Energy Outlook 2003, January 2003

- Transportation accounts for 2/3 of the 20 million barrels of oil the US uses each day.
- The US imports 55% of its oil, expected to grow to 68% by 2025 under the status quo.
- Nearly all of the cars and trucks currently run on either gasoline or diesel fuel.



Near-term strategy: Bridge Technologies

Hybrids

Hybrid electric vehicles combine greatly reduced emissions and fuel consumption, with extended range and convenient refueling

Toyota Prius 2004



Engines & Emission Control

Commercially viable engine and emission-control technologies for light-duty passenger vehicles and heavy-duty commercial vehicles lead to a reduction in transportation energy use and in petroleum use

Lightweight materials

Weight reduction is one of the most practical ways to increase the fuel economy of vehicles while reducing exhaust emissions

DOE's Office of FreedomCAR & Vehicle Technologies supports R&D of a number of bridge technologies such as hybrid electric vehicles, energy storage, combustion and emission control, and advanced materials. Advances in these technologies can make an immediate impact on dependence on fossil fuel and on emissions of greenhouse gases and criteria pollutants while long-term solutions such as hydrogen fuel cells are being developed. DOE's Office of Fossil Energy and Office of Science is supporting R&D in carbon sequestration, another bridge technology which will allow the use of coal and natural gas as clean fuel sources.



Long-term strategy: FreedomCAR and Hydrogen Fuel Initiatives

FreedomCAR Initiative – Launched in January 2002



Secretary Abraham joins with leaders of General Motors, DaimlerChrysler, and Ford in announcing FreedomCAR at the North American International Auto Show in Detroit.

January 9, 2002

Hydrogen Fuel Initiative – Launched in January 2003



"Tonight I am proposing \$1.2 billion in research funding ... so that the first car driven by a child born today could be powered by hydrogen, and pollution-free."

President George W. Bush
2003 State of the Union Address
January 28, 2003

**Freedom from petroleum dependence, criteria pollutants,
and greenhouse gas emissions**



*"If we develop hydrogen power to its full potential, (the US) can reduce our demand for oil by over **11 million barrels** per day by the year 2040."*

President George W. Bush

Energy Security

- Hydrogen can be produced from a variety of domestic sources

Environmental

- Criteria pollutants from vehicles eliminated
- Greenhouse gas emissions significantly reduced
- LDV carbon emissions may be reduced by more than 500 million metric tons of carbon equivalent (about a 70% reduction from the base case LDV carbon emissions)



Critical Path Technology Barriers:

- Hydrogen Storage (>300 mile range)
- Hydrogen Production Cost (\$1.50-2.00 per gge)
- Fuel Cell Cost (< \$45 per kW)
- Fuel Cell Durability – 5,000 hrs for automotive, 40,000 hrs for stationary

Economic/Institutional Barriers:

- Codes and Standards (Safety, and Global Competitiveness)
- Hydrogen Delivery (Investment for new Distribution Infrastructure)
- Education



Hydrogen, Fuel Cells, and Infrastructure Technologies

Program Focus: Research, develop, and validate fuel cell and hydrogen production, delivery, and storage technologies for transportation and stationary applications.

Budget

Funding (dollars in thousands)			
Activity	FY03 Approp.	FY04 Approp.	FY05 Request
Hydrogen Technology			
Production and Delivery R&D	11,215	22,564	25,325
Storage	10,790	29,432	30,000
Infrastructure Validation	9,690	18,379	15,000
Safety, Codes & Standards, and Utilization	4,531	5,904	18,000
Education and Cross-Cutting Analysis	1,897	5,712	7,000
Fuel Cell Technology			
Transportation Systems	6,160	7,506	7,600
Distributed Energy Systems	7,268	7,408	7,500
Stack Component R&D	14,803	25,186	30,000
Fuel Processor R&D	23,489	14,815	13,858
Technology Validation	1,788	9,877	18,000
Technical/Program Management Support	398	395	542
Total	92,019	147,178	172,825

Key Activities

- Initiate three "Centers of Excellence" for hydrogen storage meeting 2010 targets of 2.0 kWh/kg and 1.5 kWh/L
- Complete testing of 10,000 psi tanks achieving 2005 targets of 1.5 kWh/kg and 1.2 kWh/L
- Initiate comprehensive safety research for codes and standards development.
- Complete research on distributed NG production technologies leading to \$3.00/gge at the station.
- Initiate new industry projects that will use wind and biomass to produce hydrogen for \$4.60/gge by 2009.
- Reduce cost of a 50kW fuel cell power system to \$125/kW (assume high volume production.)
- Validate current technology through vehicle/ infrastructure "learning" demonstrations.



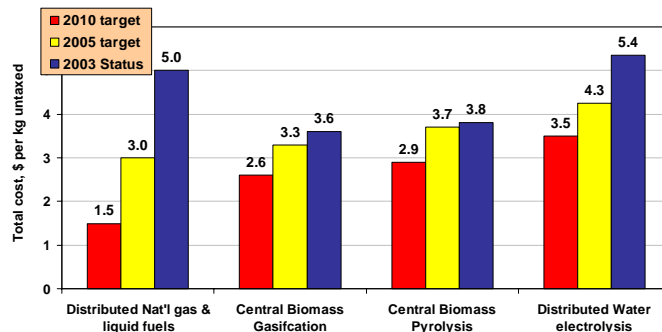
Hydrogen Production and Delivery

Hydrogen Production: Develop efficient, cost-effective production technologies from diverse, renewable and non-renewable, energy sources.

Hydrogen Delivery: Develop cost-effective, energy-efficient delivery technologies for hydrogen to enable the introduction and long term viability of hydrogen as an energy carrier.



Status & Targets of Various Methods of Hydrogen Production: Total cost

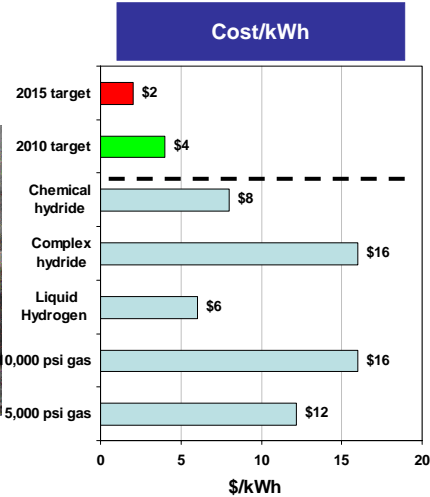
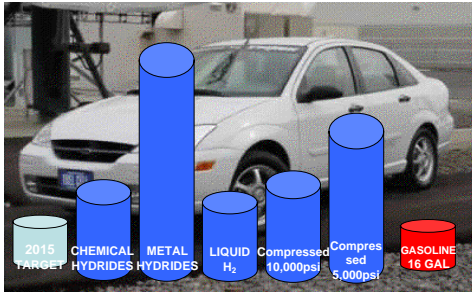




Hydrogen Storage

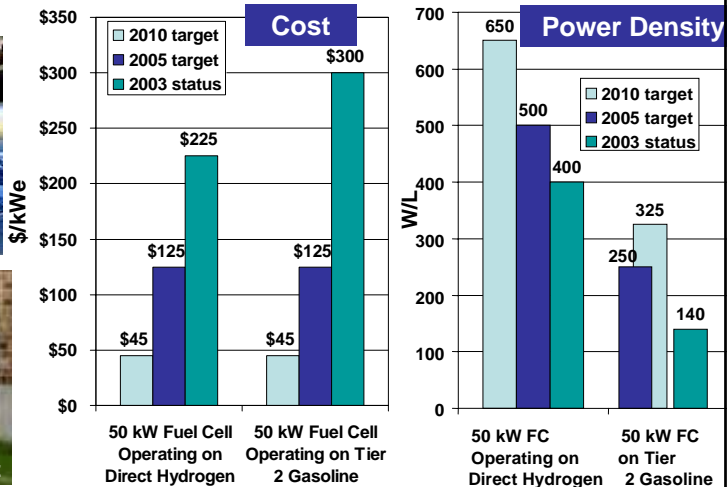
Hydrogen Storage: Develop and demonstrate viable hydrogen storage solutions for transportation and stationary applications.

No current material or technology meets the DOE/FreedomCAR range target of greater than 300 miles



Fuel Cells

Fuel Cells: Develop and demonstrate fuel cell power system technologies for transportation, stationary, and portable applications





Cross-Cutting Program Elements

Technology Validation: Validate integrated hydrogen and fuel cell technologies in a systems context under real operating conditions

Safety, Codes & Standards: Facilitate the development and adoption of building codes and equipment standards, international standards, and safe practices that promote insurability.

Education: Educate key audiences about fuel cell and hydrogen systems to facilitate commercialization and market acceptance of these technologies



International Partnership for the Hydrogen Economy

"The vision of the International Partnership for the Hydrogen Economy is that a participating country's consumers will have the practical option of purchasing a competitively priced hydrogen powered vehicle, and be able to refuel it near their homes and places of work, by 2020." Secretary of Energy Abraham

Goal: To organize, evaluate, and coordinate multinational research, development and deployment programs that accelerate the transition to a global hydrogen economy.



The Ministerial Meeting was held 19-21 November 2003 in Washington DC, USA. Terms of Reference were signed. 700+ delegates from approximately 30 countries attended.



16 IPHE Partners



Russian Federation



USA



Canada



Iceland



Japan



South Korea



China



India



Australia



Brazil



Norway



European Community



United Kingdom



France



Germany



Italy

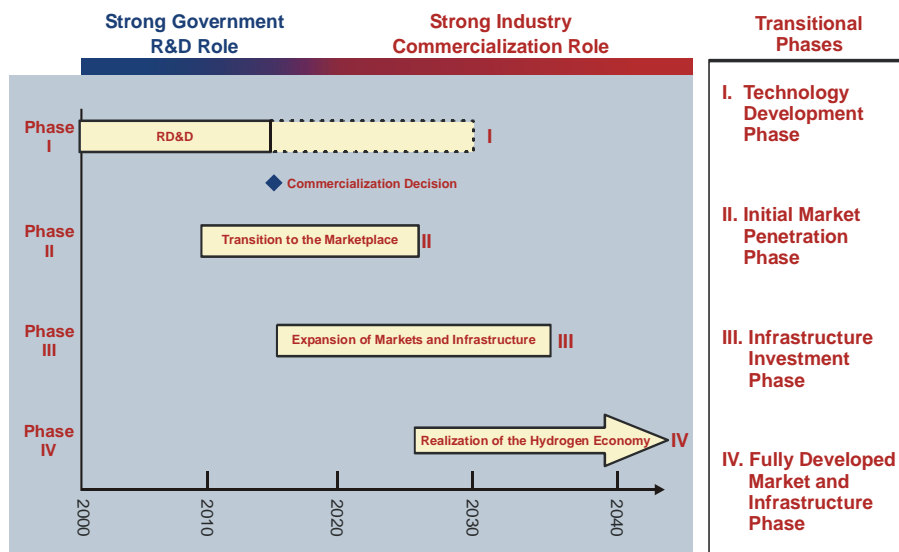


IPHE Partners' Economy:

- Over \$35 Trillion in GDP, 85% of world GDP
- Nearly 3.5 billion people
- Over 75% of electricity used worldwide;
- > 2/3 of CO₂ emissions and energy consumption



Timeline for the Hydrogen Economy





- **Office of Hydrogen, Fuel Cells, and Infrastructure Technologies website:**
www.eere.energy.gov/hydrogenandfuelcells



<http://www.eere.energy.gov/hydrogenandfuelcells/mypp/>



<http://www.eere.energy.gov/hydrogenandfuelcells/pubs.html#progress>