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U.S. Hydrogen Program Overview

Presented to the 10th Japan Hydrogen
Industrial Forum Conference
September 5, 2008



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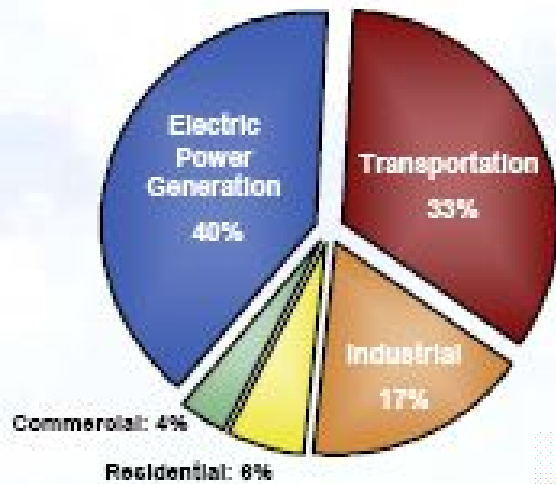


"With a new national commitment ...the first car driven by a child born today could be powered by hydrogen, and pollution-free. Join me in this important innovation to make our air significantly cleaner, and our country much less dependent on foreign sources of energy."

President Bush, State of the Union Address, January 28, 2003

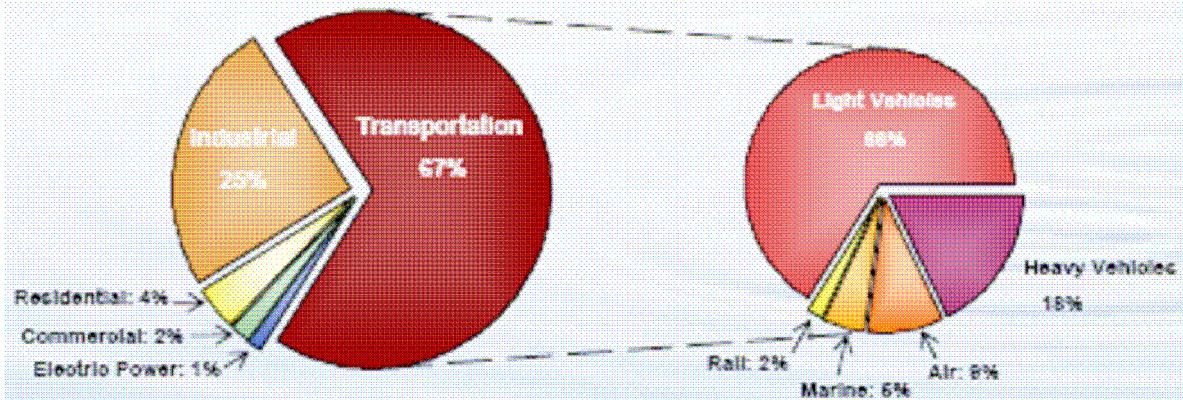


Domestic CO₂ Emissions by Sector



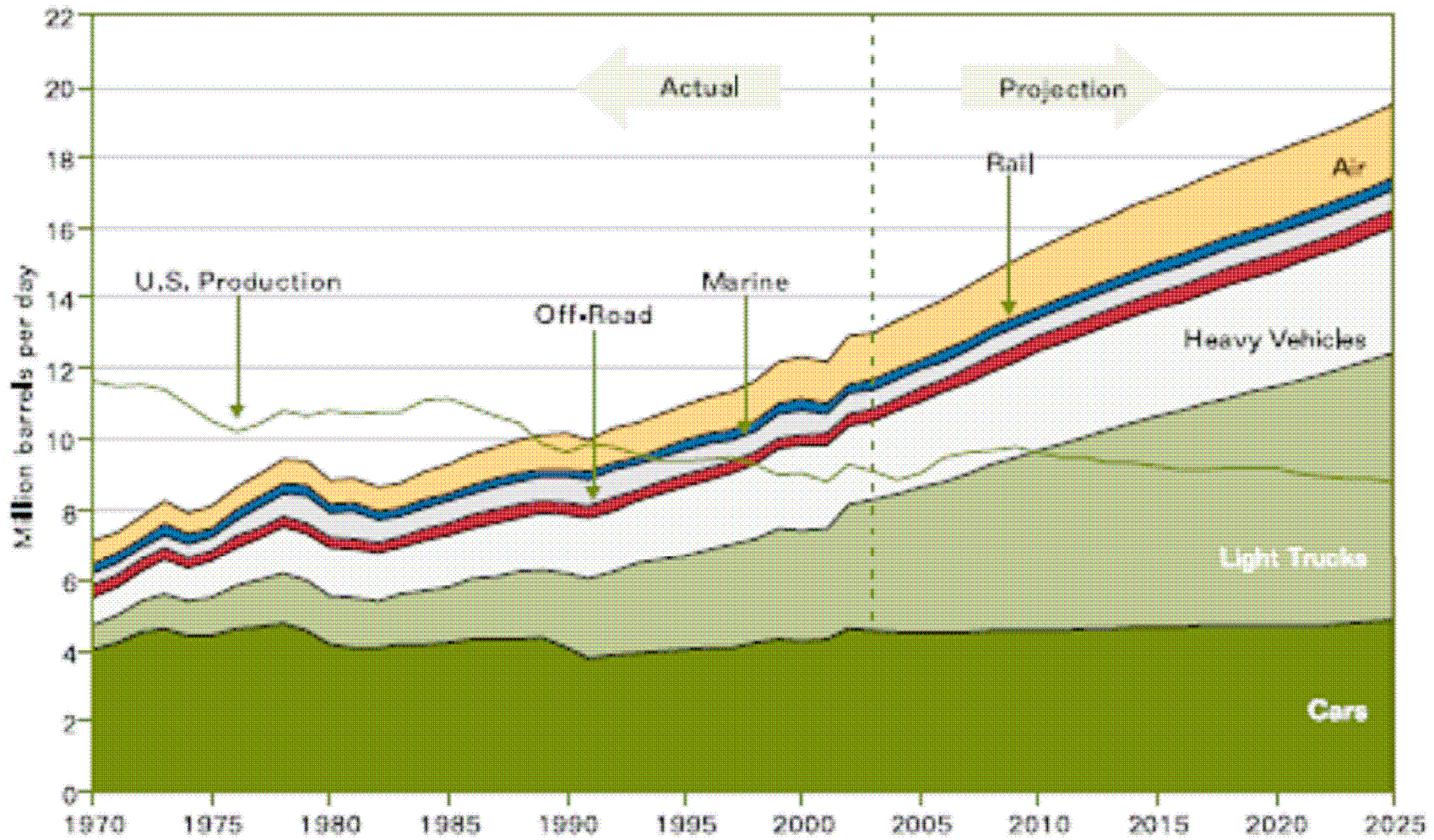
Why Transportation?

Domestic Oil Consumption





Transportation Oil Gap



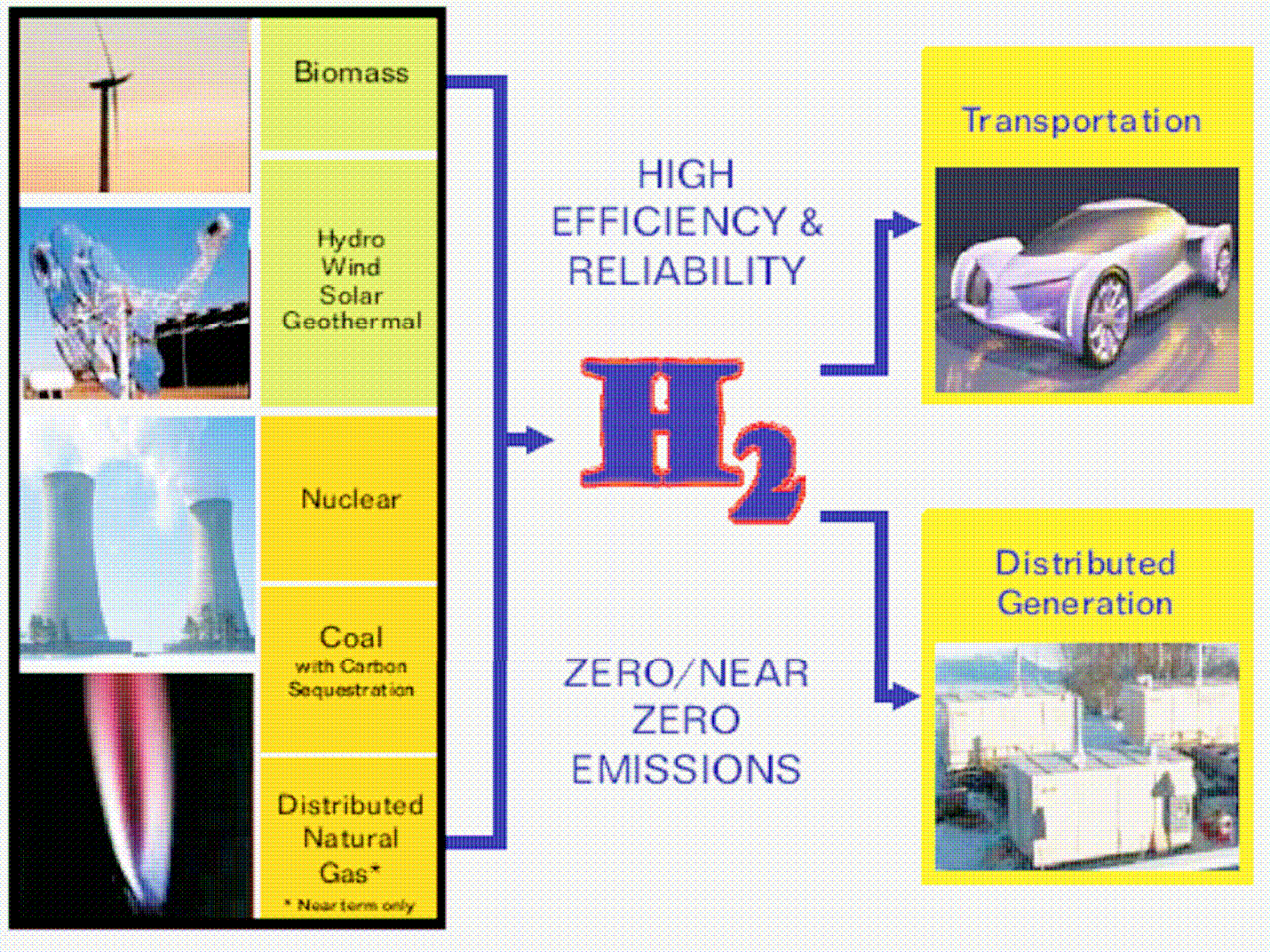


Why Hydrogen?

- Has the highest energy content per unit of weight of any known fuel.
- Can be produced from abundant domestic energy resources including fossil, nuclear, and renewable.
- Can be derived from diverse domestic resources (fossil, nuclear, renewable)
- Is compatible with high-efficiency fuel cells, combustion turbines and reciprocating engines to produce power with near-zero emissions of criteria pollutants
- Produces near-zero emissions of greenhouse gases from renewable and nuclear sources and from fossil fuel-based systems with carbon sequestration
- Can serve all sectors of the economy (transportation, power, industrial, and buildings)



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U.S. Hydrogen Program: Key Policies

- Hydrogen Fuel Initiative
- Advanced Energy Initiative
- Energy Policy Act of 2005
- Energy Independence and Security Act of 2007
- Industry and International Partnerships



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Hydrogen Fuel Initiative

- Announced January 2003
- \$1.2 billion over five years
- Establishes partnerships with private sector
- Develops hydrogen, fuel cell and infrastructure technologies
- Enables technology readiness for fuel cell vehicles by 2015

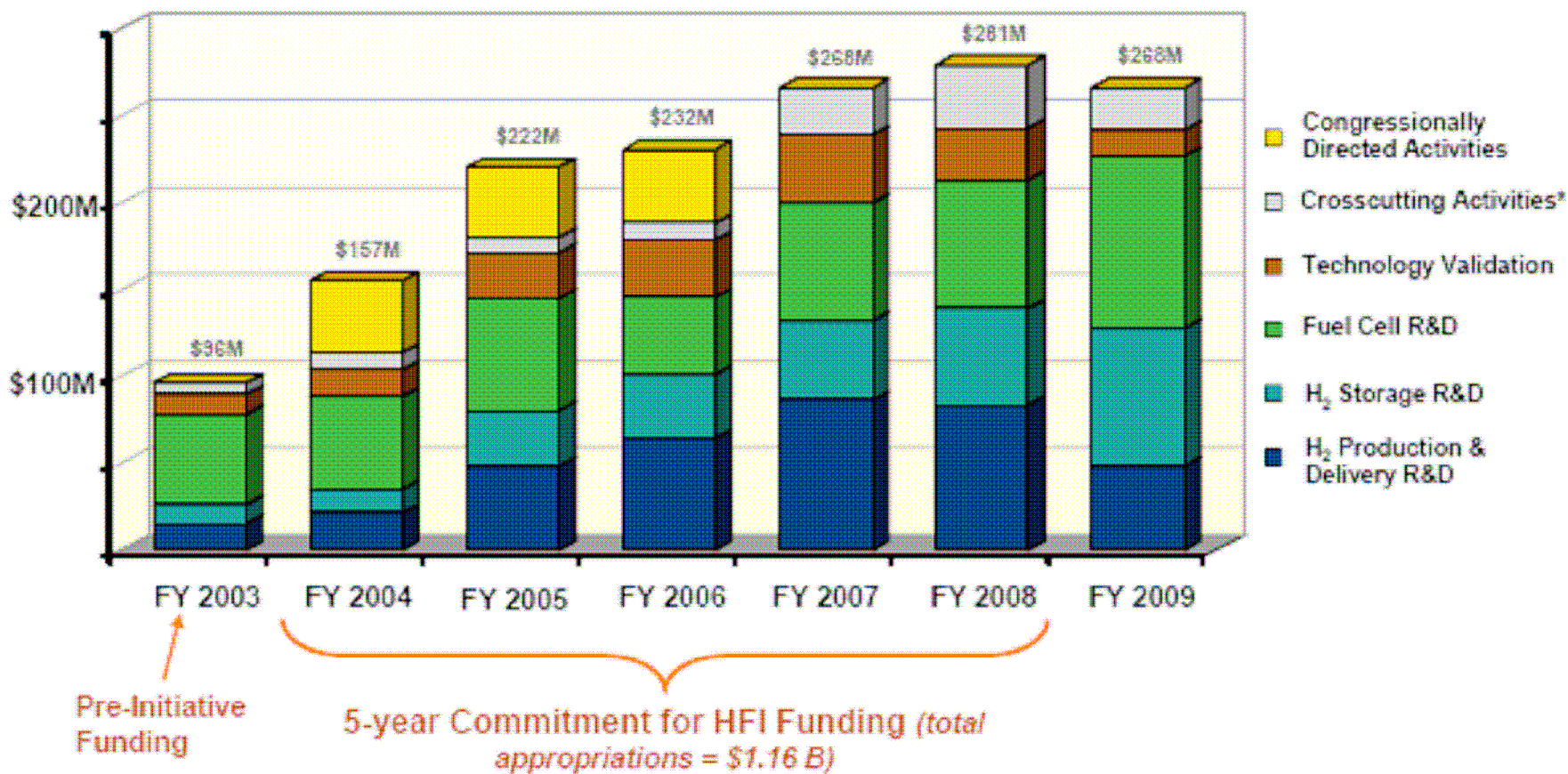


Hydrogen Fuel Initiative Goals

- Energy security associated with a transportation fuel that can be produced domestically from a diversity of feedstocks
- Reduction of the environmental impact of transportation applications and stationary markets
- Economic advantages which would ensue from a new domestic fuel technology and infrastructure



Hydrogen Fuel Initiative Funding





Advanced Energy Initiative

- Implemented February 2006
- 22% increase in funding for clean energy research
- Reinforces Hydrogen Fuel Initiative & accelerates R&D of near-term options
- Aims to make hydrogen fuel cell vehicles and fueling stations available to consumers in the 2020 timeframe



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Key Hurdles to H₂ Development

- Cost
- Storage
- Infrastructure
- Standards/Safety
- Education



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Cost Targets

- Hydrogen Cost Target \$2-\$3 gge
- Hydrogen Storage Capacity and Cost Targets 2.7 kWh/L, 3kWh/kg, \$2/kWh
- Fuel Cell Cost and Durability Targets \$30/kW, 5000-hour durability



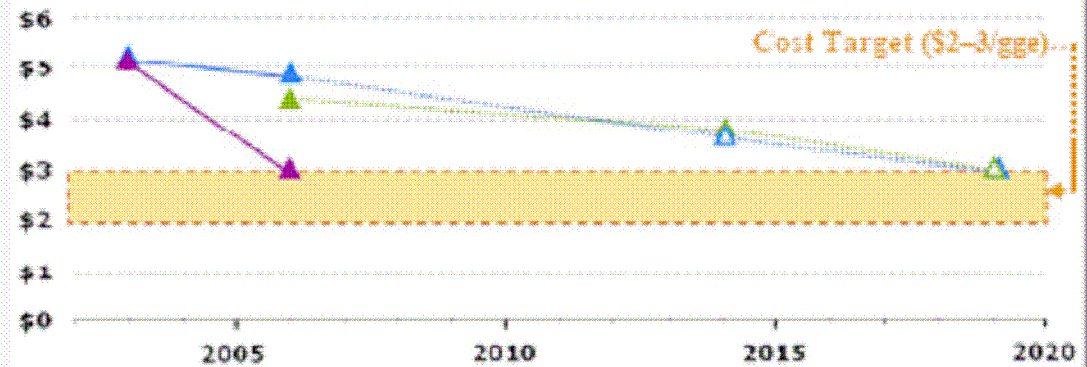
Cost Reduction: H₂ Production

Cost of Hydrogen (Delivered) — Status & Targets (In \$/gallon gasoline equivalent (gge), untaxed)

NEAR TERM: Distributed Production

→ Hydrogen is produced at station to enable low-cost delivery

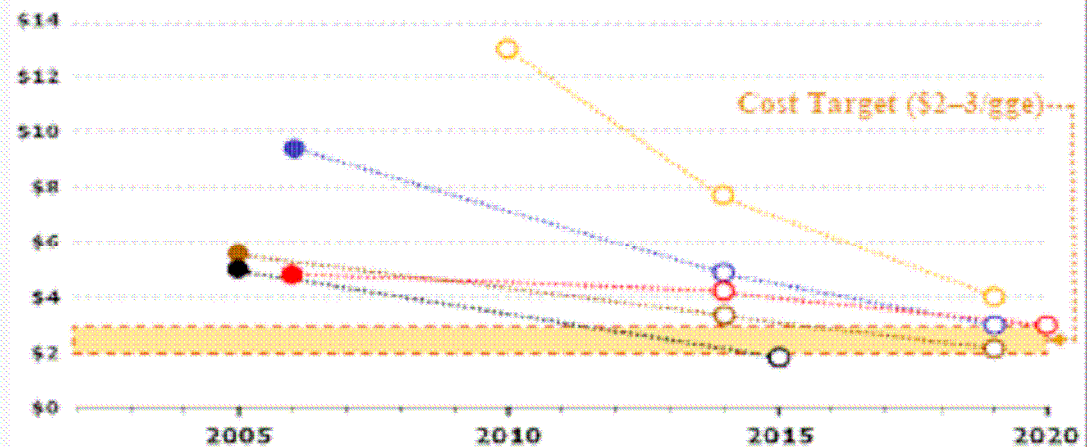
- ▲ Distributed Natural Gas
- ▲ Distributed Electrolysis
- ▲ Distributed Bio Derived Renewable Liquids



LONGER TERM: Centralized Production

→ Large investment in delivery infrastructure needed

- Biomass Gasification
- Coal Gasification with Sequestration
- Solar High-Temperature Thermochemical Cycle
- Central Wind Electrolysis
- Nuclear





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Current Technological Validation



Verified performance more than 120 fuel cell vehicles and 16 hydrogen stations:

- **EFFICIENCY: 53 – 58%** (>2x higher than gasoline internal combustion engines)
- **RANGE: 103 – 190 miles**
- **FUEL CELL SYSTEM DURABILITY:**
 - 1900 hours, projected (~57,000 miles)
 - 1200 hours, actual (~36,000 miles)

Demonstrated Fuel Cost: \$3/gge, from natural gas

DOT is demonstrating fuel cell buses and providing data to DOE for analysis

Eight buses in California, Massachusetts, New York, South Carolina, and Washington, DC





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Standards and Safety

- **Increase understanding of hydrogen behavior and material compatibility**
- **Promote safe use of hydrogen industry-wide, through education activities and information tools**
- **Conduct research to enable codes and standards to be developed for hydrogen in all applications**
- **Facilitate the development and harmonization of domestic and international codes and standards**



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Education

- **Educate target audiences to facilitate near-term demonstration, commercialization, and long-term market acceptance.**
- **Focus on near-term high-priority target audiences: safety and code officials; local communities; state and local government officials; end-users/early adopters**
- **Example: Hydrogen Road Tour '08**



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Partnerships

- Industry: FreedomCAR & Fuel Partnership
- International Partnership for the Hydrogen Economy
- International Energy Agency Implementing Agreements



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U.S.-Japan Collaboration

- USDOE has worked with METI via hydrogen fuel cell demo project
- 3 party MOU on cooperation and information exchange
- Meetings and workshops
- LANL-AIST project on neutron scattering for hydrogen storage materials