



U.S. DEPARTMENT OF
ENERGY

Federal Support for Hydrogen and Fuel Cell Technologies

Patrick Davis

Acting Program Manager, U.S. DOE Hydrogen Program

Presentation to the

State and Regional Hydrogen and Fuel Cell Initiatives Call Group

May 9, 2007

Outline

- **Interagency funding and coordination**
- **Hydrogen Fuel Initiative funding**
- **DOE Hydrogen Program focus areas**
- **State Opportunities:**
 - **RFI**
 - **Future Solicitations**
 - **Resources**
- **Q&A/discussion**

Hydrogen and Fuel Cell Activities

Supported by Multiple Federal Agencies

- In FY2006, the Federal government spent nearly \$500M on hydrogen and fuel cell RD&D (10 agencies)
- Activities are coordinated through the Interagency Working Group on Hydrogen and Fuel Cells – for information on the activities and focus of each agency, see www.hydrogen.gov



NLST

Federal support of hydrogen and fuel cells continues to be strong:

A new, higher-level Interagency Hydrogen and Fuel Cell Task Force is forming, with members at the Assistant Secretary level. It will provide overall direction of Federal activities; the working group will implement task force decisions and continue to coordinate research, share lessons learned and technical expertise, and ensure efficient use of taxpayer resources.

Hydrogen Fuel Initiative

Total Budget

- **President Bush committed \$1.2 billion over 5 years (FY04 – FY08)**
- **Cumulative request has been consistent: \$1.2 billion (FY04 – FY08)**

Hydrogen Fuel Initiative* Funding (\$ in millions)				
FY2004 Approp.	FY2005 Approp.	FY2006 Approp.	FY2007 Approp.	FY 2008 Request
157	222	232	274	309

- **FY2008 increases funding:**
 - ***\$35 million increase for Hydrogen Fuel Initiative***
 - ***\$19.5 million increase for Hydrogen, Fuel Cells & Infrastructure Technologies***

** The Hydrogen Fuel Initiative Includes the Department of Energy (EERE, FE, NE, SC) and the Department of Transportation*

Revised May 3, 2007

Hydrogen Fuel Initiative

Budget by Participant Organization

Activity	Funding (\$ in thousands)			
	FY2005 Approp	FY2006 Approp	FY2007 Approp/CR	FY2008 Request
Hydrogen Fuel Initiative				
EERE Hydrogen (HFCIT)	166,772	153,451	193,551	213,000
Fossil Energy (FE)	16,518	21,036	23,611*	12,450
Nuclear Energy (NE)	8,682	24,057	19,265	22,600
Science (SC)	29,183	32,500	36,388	59,500
DOE Hydrogen TOTAL	221,155	231,044	272,815	307,550
Department of Transportation	549	1,411	1,420	1,425
Hydrogen Fuel Initiative TOTAL	221,704	232,455	274,235	308,975

* FY07 Request

Revised May 3, 2007

EERE FY2008 Budget Request

-- Hydrogen remains a top priority --

ACTIVITY	FY2006 Approp (\$000)	FY2007 Approp/CR (\$000)	FY2008 Request (\$000)
Biomass Program	89,776	199,687	179,263
Building Technologies	68,190	104,329	86,456
Federal Energy Management Program	18,974	19,480	16,791
FreedomCAR and Vehicle Technologies	178,351	188,024	176,138
Geothermal Technology Program	22,762	5,000	0
Hydrogen, Fuel Cells & Infrastructure Technologies Program	153,451	193,551	213,000
Industrial Technologies Program	56,856	56,563	45,998
Solar Energy Technologies Program	81,791	159,372	148,304
Weatherization & Intergovernmental Activities	316,866	281,731	204,904
Wind Energy and Hydropower Program	38,333	49,319	40,069
Facilities & Infrastructure	26,052	6,982	6,982
Program Support	13,321	12,281	13,281
Program Direction	101,868	105,013	105,013
TOTAL EERE	1,173,843*	1,474,285	1,236,199

*Congressionally directed activities = \$159 million

EERE Hydrogen

Objectives/Activities

PRIMARY OBJECTIVES:

Overcome critical path technology barriers to hydrogen and fuel cell commercialization

- Reduce the cost of hydrogen
- Reduce the cost of fuel cells, improve durability
- Improve on-board hydrogen storage technology

FY2008 FOCUS AREAS:

PRODUCTION & DELIVERY: Increase emphasis on R&D of renewable technologies (e.g., bio-liquid reforming, biomass gasification, photoelectrochemical, high temperature thermochemical, and electrolysis). Develop high efficient compressor and liquefaction technology for cost-effective hydrogen delivery.

STORAGE: Ramp-up hydrogen storage materials research and engineering science. Evaluate lab-scale regeneration energy efficiency for chemical hydrogen storage.

FUEL CELLS: Reduce 80kW vehicle fuel cell system cost to \$70/kW (high-volume production) toward achieving 2015 goal of \$30/kW. Improve electrical efficiency for natural gas/propane-fueled 5-250 kW stationary fuel cell system to 35% at full power.

EERE Hydrogen *Activities (ctd.)*

FY 2008 FOCUS AREAS (ctd.):

MANUFACTURING: Initiate R&D to lower manufacturing costs of fuel cell and hydrogen technologies and create a competitive domestic supplier base.

TECHNOLOGY VALIDATION: Continue “learning demonstration” with auto & energy industry and validate 250-mile driving range.

SAFETY, CODES & STANDARDS: Publish a best-practices manual for hydrogen safety, an on-line resource detailing practices and lessons-learned for the safe use of hydrogen.

EDUCATION: Initiate new end-user activities to support market transformation efforts. Expand training opportunities for emergency responders, code officials, and state and local government representatives.

SYSTEMS ANALYSIS: Develop macro-system model of hydrogen fuel infrastructure to meet transportation needs.

EERE Hydrogen

Early Market Transformation

- **EARLY ADOPTION PARTNERSHIPS**

- Federal Agencies
 - Bring together manufacturers and government facilities managers
 - Support Federal deployment in early markets (lift trucks, backup power)
 - EPACT 2005, Section 783 (Federal purchase requirements): Calls for Federal procurement of stationary, portable, and micro fuel cells
- DOE RFI – financial assistance for early markets, fuel cell performance testing, and community partnerships

- **EDUCATION**

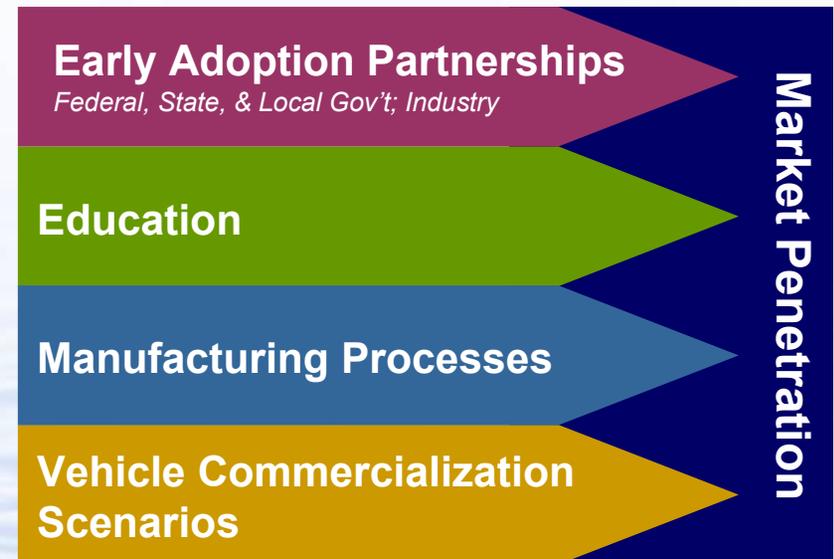
- Educate safety and code officials, early adopters, and the public

- **MANUFACTURING**

- Develop critical manufacturing processes

- **VEHICLE COMMERCIALIZATION SCENARIOS**

- Work with automotive manufacturers and energy industries to develop feasible fuel cell vehicle commercialization scenarios



EERE Hydrogen

State Opportunities

Request for Information (RFI)

- **Seeks input on proposed hydrogen and fuel cell early market activities; allows public to help shape potential future funding opportunity**
 - Cultivate demand for new hydrogen and fuel cell technologies
 - Accelerate market development
 - Reduce non-R&D barriers that hinder market penetration
- **RFI Topics:**
 - Early market financial assistance
 - Fuel cell performance testing
 - Community partnerships
- **Open to all – Federal, state, and local governments; industry; public**

http://hydrogen.energy.gov/news_markets.html

EERE Hydrogen

State Opportunities

Upcoming Solicitations

- **Planned education solicitation for FY2008**
- **Manufacturing pre-solicitation meeting**
 - Friday, May 18, 2007 (in conjunction with DOE Hydrogen Program Annual Merit Review – Arlington, VA)
 - Seeking input on planned FY2008 solicitation

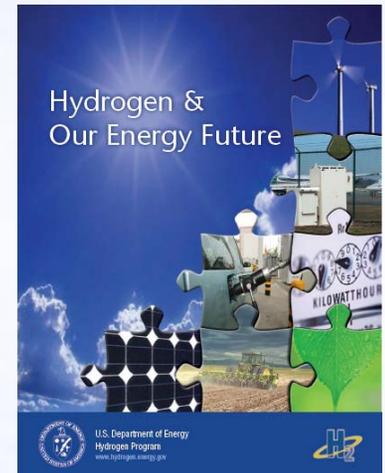
**Check our website for
upcoming announcements**
www.hydrogen.energy.gov/

EERE Hydrogen State Opportunities

Resources

Available for distribution as part of your outreach efforts

- Fact sheets – technology intros, early markets
- Hydrogen overview book (new!) →
- Downloadable radio spots (coming soon)
- Podcasts (coming soon)
- Vidcast on early markets (coming soon)



Order free print copies from the DOE/EERE Information Center (877-EERE-INF(O)/877-337-3463) or download PDFs from www.hydrogen.energy.gov – follow the “Increase Your H2IQ” link →

The image is a screenshot of the U.S. Department of Energy Hydrogen Program website. The address bar shows "http://www.hydrogen.energy.gov/". The website has a yellow header with the text "U.S. DEPARTMENT OF ENERGY Hydrogen Program". Below the header is a navigation menu with links: Home, About, DOE Participants, International, Library, and News/Events. On the left side, there is a list of links: > Hydrogen Production, > Hydrogen Delivery, > Hydrogen Storage, > Hydrogen Manufacturing, > Conversion / Fuel Cells, > Applications / Technology Validation, > Safety, and > Codes & Standards. On the right side, there is a blue box with the text "INCREASE YOUR H2IQ" and "Announcement Register Now for 2007 Annual Merit Review and Hotel Accommodations". Below this, there is a "News" section with the headline "HTAC To Hold Meeting This Month" and the text "The Hydrogen Technical and Fuel Cell Advisory Committee (HTAC) will hold a meeting in Arlington, Va., May 16-17, 2007. May 1, 2007 More >".

2007 Annual Merit Review

DOE Hydrogen Program projects are evaluated by independent expert panels at the Annual Merit Review and Peer Evaluation Meeting

May 15 - 18, 2007

**Crystal Gateway Marriott Hotel
Arlington, Virginia**

Hydrogen and fuel cell principal investigators funded by the offices of ***Energy Efficiency and Renewable Energy, Fossil Energy, Nuclear Energy, and Science*** will present their project status and results in oral and poster presentations

Can't make it? Annual Merit Review proceedings will be posted on the DOE Hydrogen Program website:

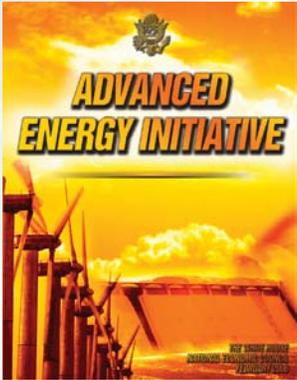
www.hydrogen.energy.gov

The background of the slide is a composite image. The top half shows a bright blue sky with a large, fluffy white cloud. The bottom half shows a blue water surface with concentric ripples emanating from a central point. A dark blue rectangular box is centered horizontally across the middle of the image.

BACKUP

CONTEXT: Policy (2006 – present)

ADVANCED ENERGY INITIATIVE (Feb. 2006):



- Accelerates research on technologies for reducing dependency on oil for transportation and natural gas for power generation
- 22% increase in funding for clean energy research
- Reinforces **Hydrogen Fuel Initiative**
- Accelerates R&D of near-term transportation options: biofuels and plug-in hybrids

“20-in-10” INITIATIVE (Jan. 2007):



- Sets fuel standard at 35 billion gallons of renewable and alternative fuels by 2017, to displace 15% of annual gasoline use in 2017
- Expands scope of Renewable Fuel Standard (RFS) to “Alternative Fuel Standard” (*The Alternative Fuel Standard will include sources such as corn ethanol, cellulosic ethanol, biodiesel, methanol, butanol, hydrogen, and alternative fuels.*)

CONTEXT: Policy (2003-2005)

HYDROGEN FUEL INITIATIVE (Jan. 2003):



- \$1.2 billion over five years
- Establishes partnerships with private sector
- Develops hydrogen, fuel cell and infrastructure technologies
- Goal: to make fuel cell vehicles practical and cost-effective by 2020

“Manufacturing in America” INITIATIVE (Jan. 2004):



- Outlines strategy to ensure government fosters a favorable environment for domestic manufacturing
- Includes language supporting R&D in new energy technology and continued funding of **Hydrogen Fuel Initiative**

EPACT 2005 (Public Law 109-58) TITLE VIII HYDROGEN:



- “Codifies” **Hydrogen Fuel Initiative** and reinforces DOE timeline
- By 2015: Commitment by industry for fuel cell vehicles and hydrogen infrastructure
- By 2020: Vehicles and hydrogen available for consumers
- Program authorized through 2020

Hydrogen Fuel Initiative

– Key FY 2008 Activities –



DOE - EERE

--Specific Breakdown on following slides--



DOE - FOSSIL ENERGY

Continue studies for scaling up hydrogen membrane reactors and CO₂/H₂ separation technologies for coal-based hydrogen systems.



DOE - NUCLEAR ENERGY

Operate sulfur-iodine thermochemical and high-temperature electrolysis experiments to gather data on operability and reaction rates.



DOE - SCIENCE

Expand basic research on nano-materials for storage, catalysis for fuel cells, and bio-inspired and solar H₂ production. Increase emphasis on nano-structured design, novel synthesis, and theory and modeling of the physical and chemical interactions of hydrogen with materials.



DEPARTMENT of TRANSPORTATION

Develop national safety standards to enable the introduction of hydrogen-powered vehicles to the market.

EERE Hydrogen Budget

Hydrogen, Fuel Cells & Infrastructure Technologies

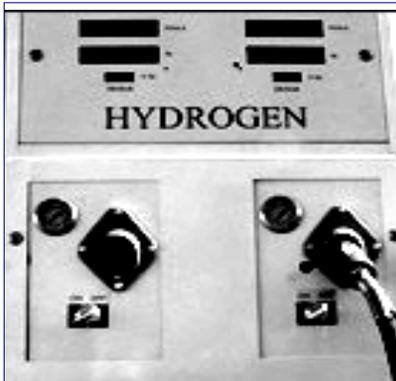
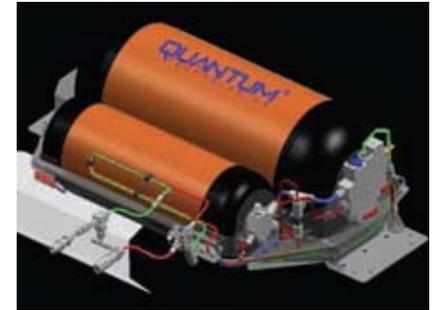
Activity	Funding (\$ in thousands)			
	FY2005 Approp	FY2006 Approp	FY2007 Request	FY2008 Request
Hydrogen Production & Delivery	13,303	8,391	34,594	40,000
Hydrogen Storage R&D	22,418	26,040	34,620	43,900
Fuel Cell Stack Component R&D	31,702	30,710	38,082	44,000
Technology Validation	26,098	33,301	39,566	30,000
Transportation Fuel Cell Systems	7,300	1,050	7,518	8,000
Distributed Energy Fuel Cell Sys.	6,753	939	7,419	7,700
Fuel Processor R&D	9,469	637	4,056	3,000
Safety, Codes & Standards	5,801	4,595	13,848	16,000
Education	0	481	1,978	3,900
Systems Analysis	3,157	4,787	9,892	11,500
Manufacturing R&D	0	0	1,978	5,000
Technical/Program Mgt. Support	535	0	0	0
Congressionally Directed Activities	40,236	42,520	0	0
TOTAL	166,772	153,451	193,551	213,000

FY '06 Accomplishments:

Steady Progress Toward Program Goals

- **R&D Advances**

- Distributed hydrogen from natural gas -- 5000psi hydrogen at \$3/gge.
- Reduced electrolyzer cost from \$2500/kW to approx. \$1250/kW.
- New high-capacity storage materials identified.
- Fuel Cells: High-volume cost of automotive fuel cells reduced to \$107/kW, and durability increased to 2000 hrs.



- **Validating Research Targets through Vehicle and Infrastructure Learning Demonstrations**

- Currently operating 69 fuel cell vehicles and 10 fueling stations.
- Installed and completed 1000 hours of testing for a refueling station.
- Demonstrated ability to provide hydrogen from natural gas for a projected untaxed cost of \$3/gge.
- Verified 53-58% efficiency of fuel cells.
- Verified 103-190 mile range and 950 hour durability (~30,000 miles).

- **Safety, Codes & Standards, and Education**

- Created two online hydrogen safety databases.
- Released a multimedia web-based course introducing hydrogen to first responders.

