U.S. DEPARTMENT OF ENERGY

President's Hydrogen Fuel Initiative FY2007 Budget Request Briefing

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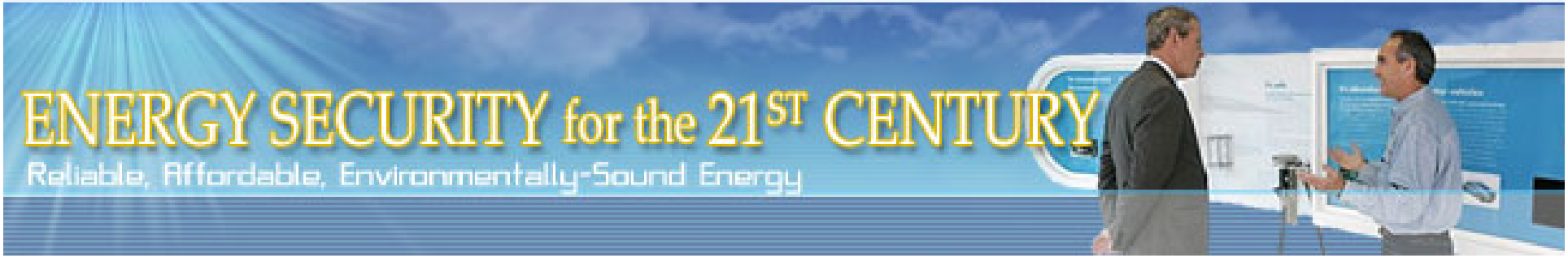
DOE Hydrogen Program Manager

February 6, 2006



President's State of the Union Address

"Keeping America competitive requires **affordable energy.** And here we have a serious problem: America is **addicted to oil,** which is often imported from unstable parts of the world.

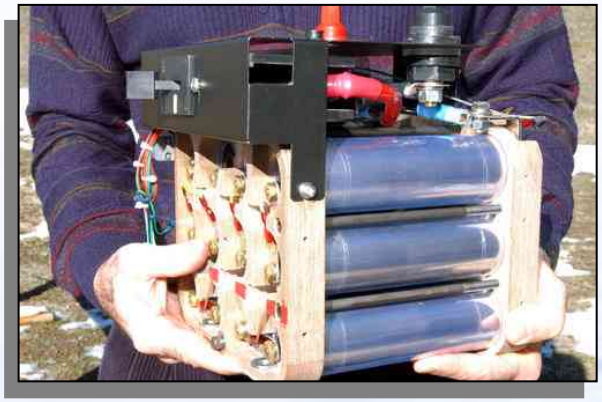
The best way to break this addiction is through **technology**… and we are **on the threshold of incredible advances**…

So tonight I announce…push for breakthroughs in two vital areas…**change how we power our homes and offices**,…**change how we power our automobiles**."

- President George W. Bush
State of the Union Address January 31, 2006

Changing How We Power Our Automobiles

- President's Biofuels Initiative
- FreedomCAR
- President's Hydrogen Fuel Initiative



Energy Policy Act of 2005
Title VIII - Hydrogen

EPAct 2005 (Public Law 109-58) "codifies" the President's Hydrogen Fuel Initiative.
The national leaders are in agreement that a hydrogen economy can lead to energy and environmental security.

President Bush signs Energy Policy Act into law on August 8, 2005

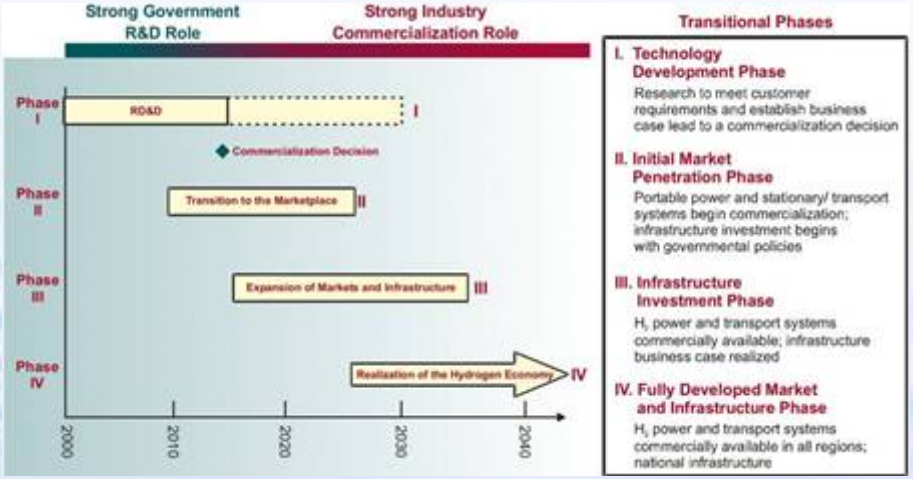
Congress reinforces the timeline developed by DOE in support of the President's Hydrogen Fuel Initiative –

By 2015: Enable commitment by industry for fuel cell vehicles and hydrogen infrastructure

By 2020: Enable consumers to purchase vehicles and make hydrogen available

Congress makes the long-term commitment required for realization of the hydrogen economy by authorizing the Program through 2020

Hydrogen Economy Timeline



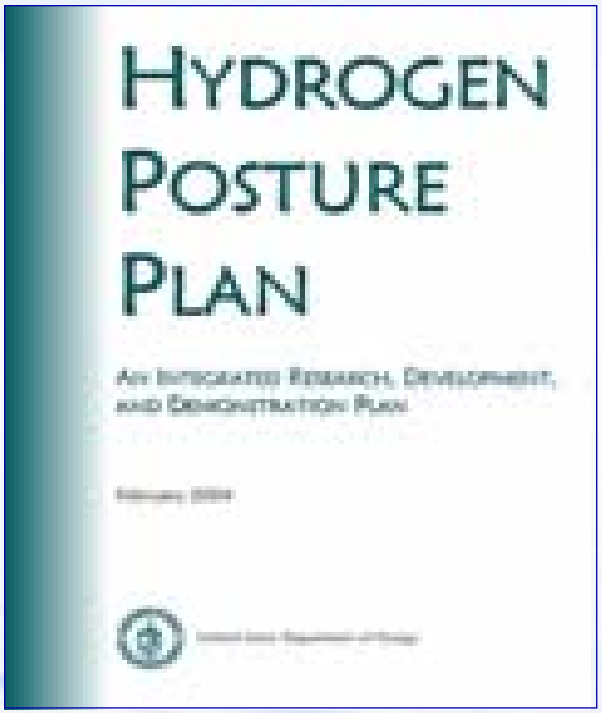
Hydrogen Barriers

Critical Path Technology Barriers:

- Hydrogen Storage (>300-mile range)
- Fuel Cell Cost ($30 per kW)
- Hydrogen Cost ($2.00 - 3.00 per gge)

Economic/Institutional Barriers:

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



www.hydrogen.energy.gov/pdfs/hydrogen_posture_plan.pdf

Moving Closer to a Hydrogen Economy

One Accomplishment at a Time (FY06)

- **R&D Advances**
  - Develop and demonstrate improved hydrogen storage materials and complete sub-scale system prototype with 2.5 wt% projected system capacity in 2006 (150% improvement over 1 wt% baseline in 2003).
  - Reduce the high-volume cost of automotive fuel cells from $275/kW (2002) to $110/kW (2005) by increasing the power density and reducing the platinum loading (to be independently verified in FY06).
  - Reduce the cost of natural gas-based hydrogen production from $5.00 per gallon gasoline equivalent (gge) in 2003 to $3.00 per gge in 2006 (research progress in reforming and purification technologies to be independently verified in FY06 and validated in full-scale hardware in 2009).

President Bush Visits Washington, DC
Hydrogen Fueling Station, May 2005

- **Validating Research Targets through Vehicle and Infrastructure Learning Demonstrations**
  - Four Learning Demonstration teams are submitting fuel cell, vehicle and refueling station operational and maintenance data (63 fuel cell vehicles and 9 hydrogen refueling stations).
  - Validate the technology against time-phased performance targets

2009 Targets	
Fuel Cell Durability	2000 hours
Range	250+ miles
H2 cost	$3 / gge

GM/Shell

Chevron/Hyundai-Kia

Daimler Chrysler/BP

BP station

Ford/BP

President's Hydrogen Fuel Initiative

- **President Bush committed a $1.2 billion over 5 years (FY04 – FY08) to accelerate R&D to enable industry commercialization decision by 2015.**

Hydrogen Fuel Initiative Funding[1] ($ in millions)			
FY2004 Approp	**FY2005** Approp	**FY2006** Approp	**FY2007** Request
157	**222**	**236**	**289**

- **President's cumulative request has been consistent with the commitment – $958M (FY04 – FY07).**

1 - Includes Department of Transportation

Revised February 6, 2006

Hydrogen Fuel Initiative FY2007 Request

Activity	Funding ($ in thousands)		
	FY2005 Approp	**FY2006** Approp	**FY2007** Request
Hydrogen Fuel Initiative			
EERE Hydrogen	166,772	155,627	195,801
Fossil Energy (FE)	16,518	21,635	23,611
Nuclear Energy (NE)	8,929	24,750	18,665
Science (SC)	29,183	32,500	50,000
DOE TOTAL	**221,402**	**234,512**	**288,077**
Department of Transportation	549	1,411	1,420
TOTAL	**221,951**	**235,923**	**289,497**

Revised February 6, 2006

Key FY2007 Activities

- Ramp up R&D for breakthrough hydrogen storage materials through Centers of Excellence and independent projects; down-select materials to meet 2007 targets of 4.5 wt.% system capacity (EERE).
- Expand fuel cell stack component research on membranes, water transport, cathode catalysts and supports, cell hardware, innovative concepts, and effects of impurities (EERE).
- Restart and fully fund competitively awarded renewable hydrogen production R&D including photoelectrochemical, high temperature thermochemical, biomass/ethanol and reforming, and electrolysis technologies (EERE).
- Initiate configuration studies for scaling up hydrogen membrane reactors and advanced CO2/H2 separation for coal-based hydrogen systems (FE).
- Complete assembly and pre-operational testing of integrated laboratory-scale sulfur-iodine thermochemical and high-temperature electrolysis experiments (NE).
- Expand basic research on nanomaterials for hydrogen storage, catalysis for fuel cells, and bio-inspired and solar hydrogen production. Increase emphasis on nanostructured design, novel synthesis, and theory and modeling of the physical and chemical interactions of hydrogen with materials (SC).
- Develop national safety guidelines, support the development of long term vehicle system safety and materials compatibility codes and standards, and support medium and heavy duty truck and bus demonstrations (DOT).

Hydrogen, Fuel Cells & Infrastructure Technologies (EERE)

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

Budget

Activity	Funding ($ in thousands)		
	FY 2005 Approp	FY 2006 Approp	FY 2007 Request
Hydrogen Production & Delivery	13,303	8,512	36,844
Hydrogen Storage R&D	22,418	26,600	34,620
Fuel Cell Stack Component R&D	31,702	31,595	38,082
Technology Validation	26,098	33,594	39,566
Transportation Fuel Cell Systems	7,300	1,080	7,518
Distributed Energy Fuel Cell Sys.	6,753	962	7,419
Fuel Processor R&D	9,469	617	4,056
Safety and Codes and Standards	5,801	4,727	13,848
Education	0	495	1,978
Systems Analysis	3,157	4,925	9,892
Manufacturing R&D	0	0	1,978
Technical/Program Mgt. Support	535	0	0
Congressionally Directed Act.	40,236	42,520	0
TOTAL	**166,772**	**155,627**	**195,801**

Key Activities

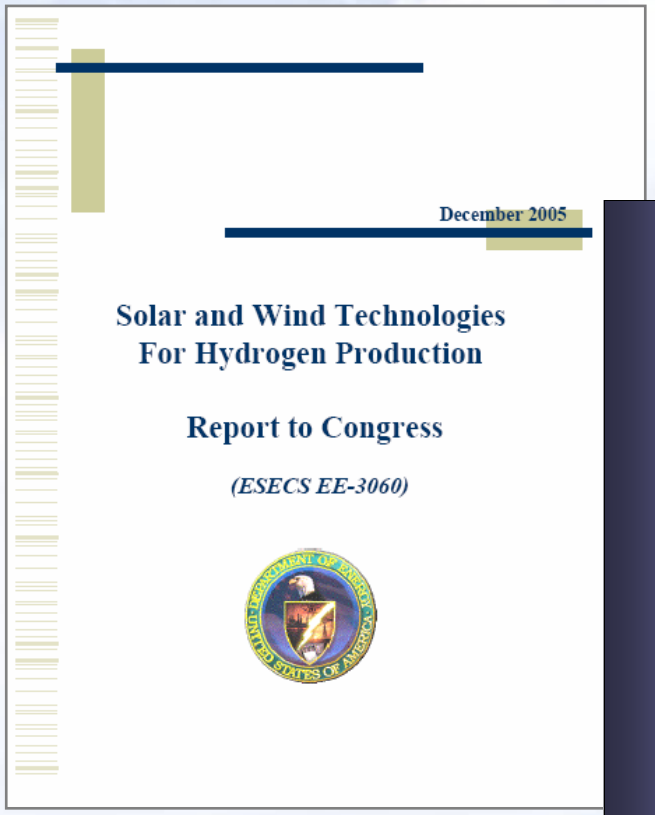
- Initiate new manufacturing research to lower manufacturing costs of membrane electrode assemblies for both fuel cells and electrolyzers.
- Restart and fully fund competitively awarded renewable hydrogen production R&D including photoelectrochemical, high temperature thermochemical, biomass/ethanol and reforming, and electrolysis technologies.
- Develop and down-select materials to meet 4.5 wt.% hydrogen storage system target.
- Reduce 80kW vehicle fuel cell system cost to $90/kW (high volume production) toward achieving 2010 goal of $45/kW.
- Conduct “learning demonstrations” with auto & energy industry:
  - Begin operation and data collection of 2nd generation vehicles to meet 2,000 hour fuel cell durability target by 2009.
  - Validate refueling time of 5 minutes or less for 5 kg of hydrogen at 5,000 psi.
- Improve electrical efficiency for natural gas/propane fueled 5-250 kW stationary fuel cell system to 34 % at full power.
- Complete R&D on the safety of high pressure (10,000 psi) hydrogen refueling including understanding systems limitations on refueling rate.
- Develop training modules for emergency responders and code officials. Restart state and local government training and university learning centers.
- Develop models for complete energy efficiency and emission lifecycle analysis of distributed natural gas and electrolysis pathways.

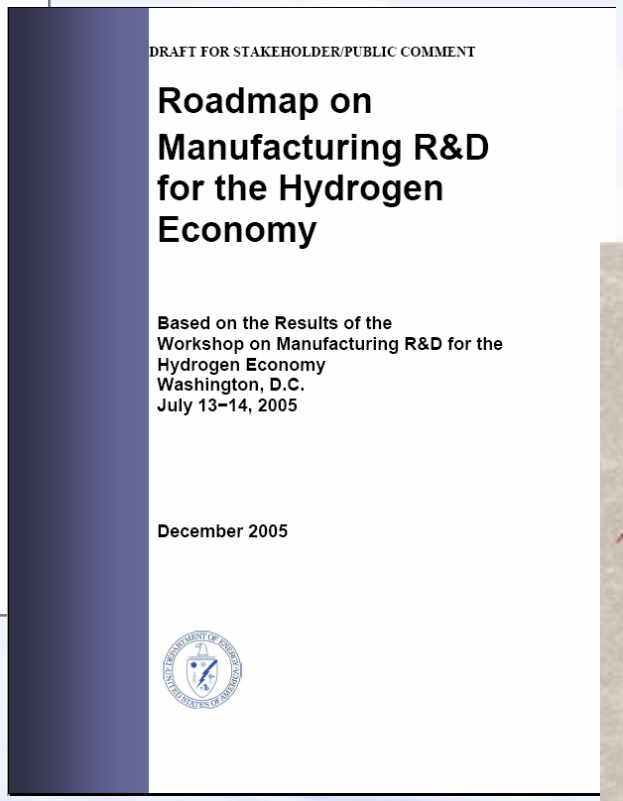
EERE FY2007 Budget Request

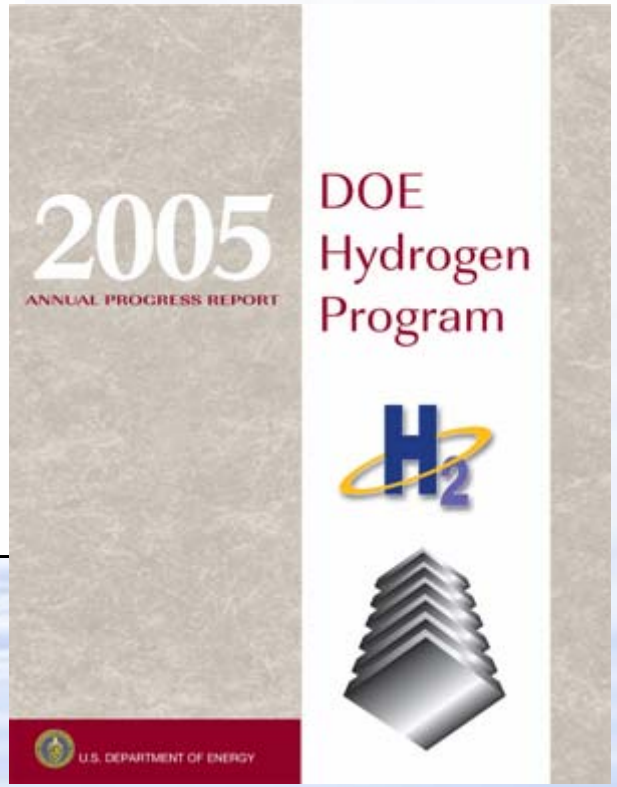
Activity	FY2006 Approp ($000)	FY2007 Request ($000)
Biomass and Biorefinery Systems R&D	90,718	149,687
Building Technologies	69,266	77,329
Federal Energy Management Program	18,974	16,906
Geothermal Technology	23,066	0
Hydrogen Technology	155,627	195,801
Hydropower	495	0
Industrial Technologies	56,855	45,563
Solar Energy	83,113	148,372
Vehicle Technologies	182,104	166,024
Weatherization & Intergovernmental Activities	316,866	225,031
Wind Energy	38,857	43,819
Program Support	13,321	10,930
Program Direction	98,529	91,024
TOTAL EERE	**1,173,843***	**1,176,421**

***Congressionally directed activities = $159 million**

Recent Program Publications

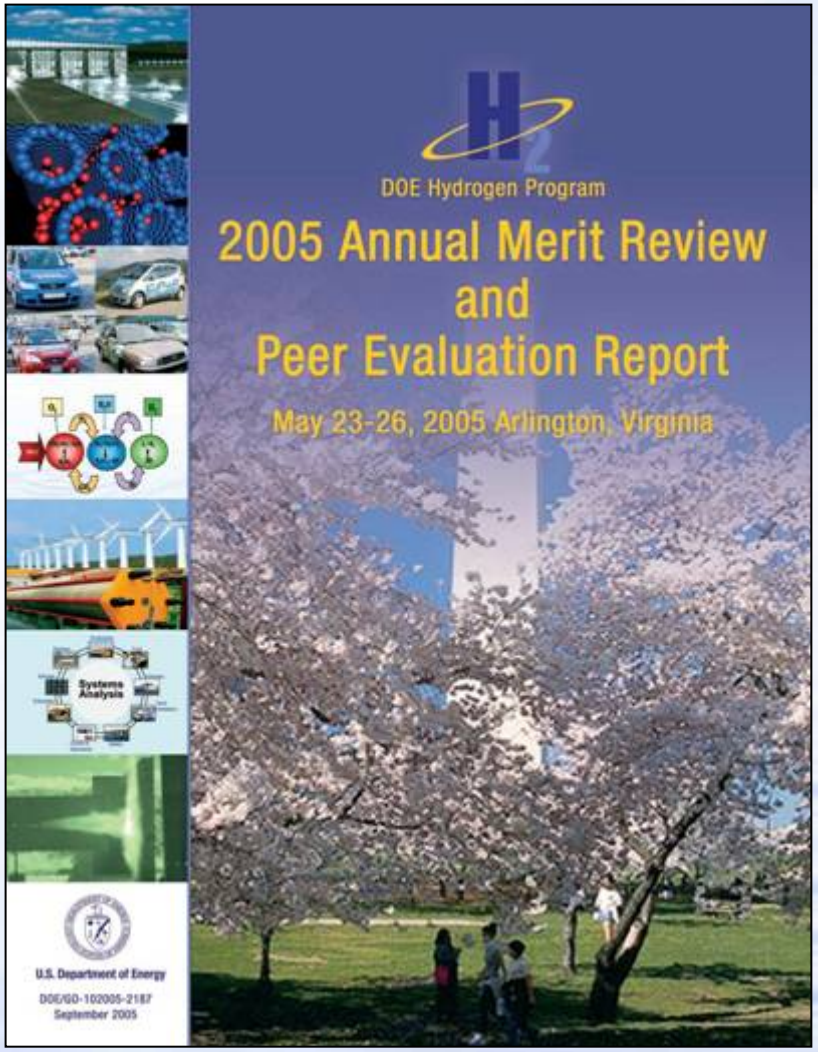






2006 Annual DOE Hydrogen Program Merit Review and Peer Evaluation Meeting

May 16-19, 2006 - Arlington, VA



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