Welcome!

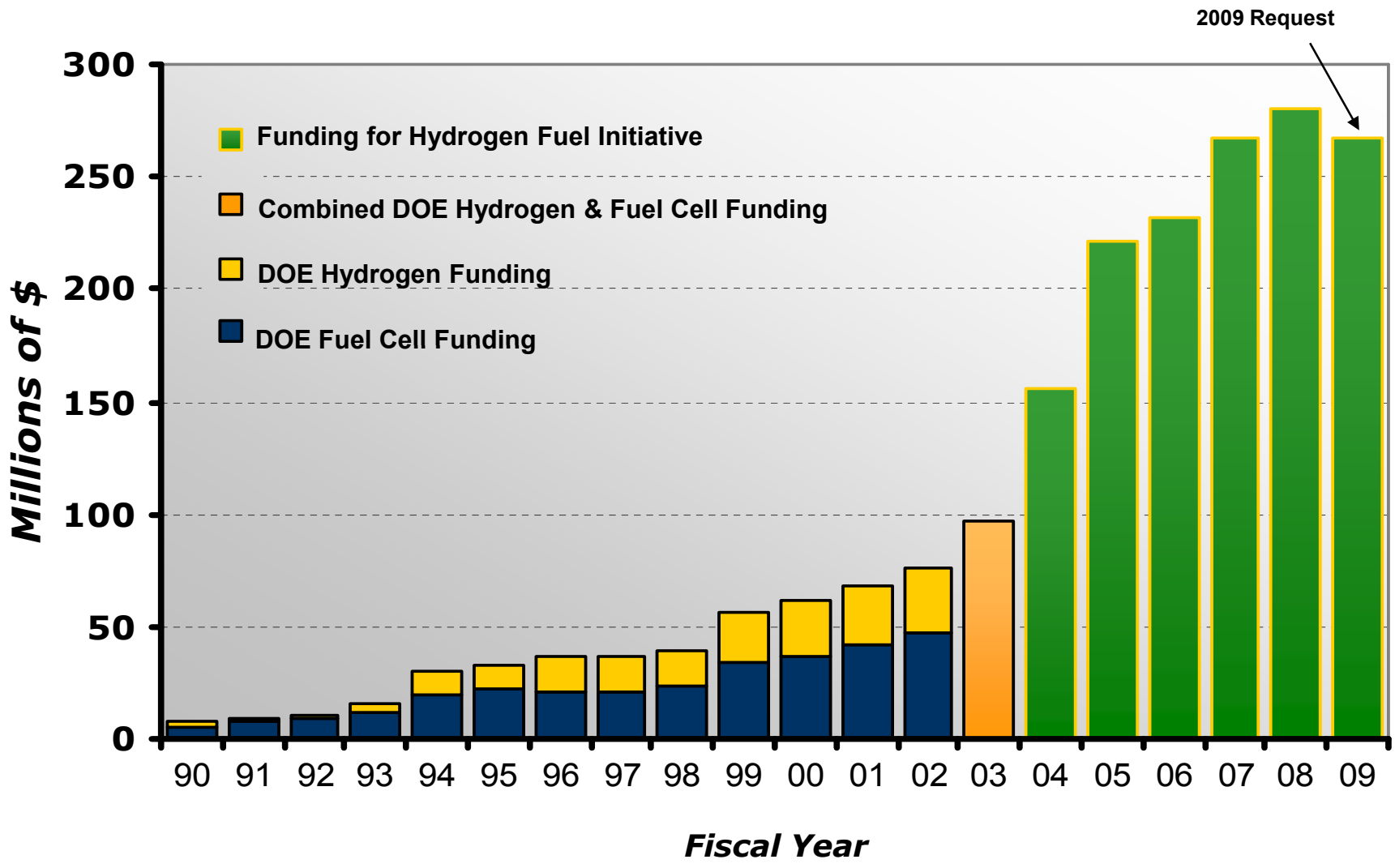
U.S. Department of Energy
Hydrogen Program

Annual Merit Review
& Peer Evaluation Meeting

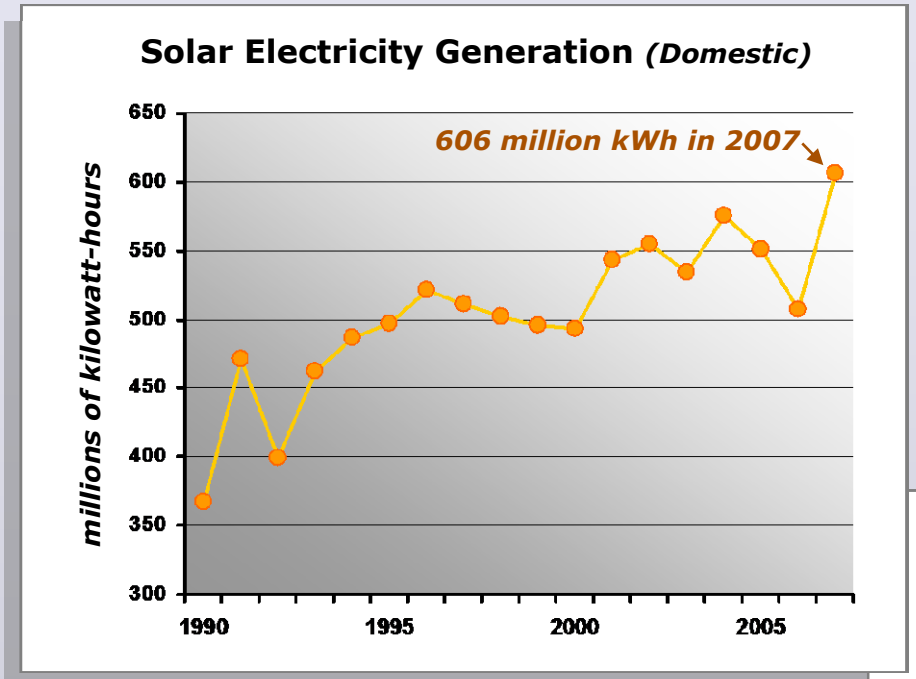
Arlington, Virginia • June 9_– 13, 2008

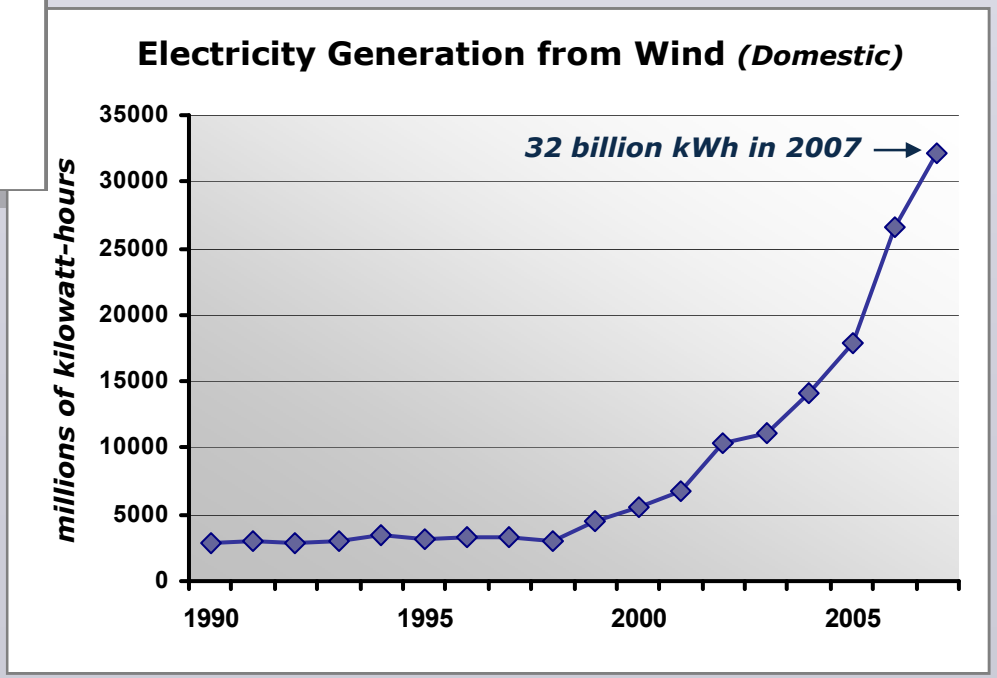
JoAnn Milliken
Program Manager

DOE Hydrogen & Fuel Cells Budget History



Growth in the Renewable Sector





H_2 & Fuel Cells in Transportation – 2008 Highlights

GM launches "Project Driveway"-- 100 FCVs in largest single deployment to date

Honda to lease up to 100 FCVs this summer in test market in US (up to 200 worldwide)

Daimler announces intent to begin producing one FCV per day in 2010, with potential for 100,000/year by 2014-2015

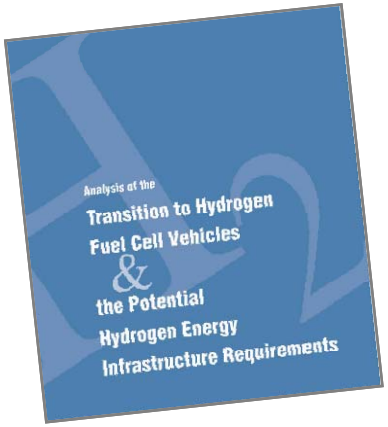
Hyundai announces plans to mass produce FCVs as early as 2012 and no later than 2015

BMW debuts H2ICE vehicle in US

Fuel cell buses: *AC Transit orders 8 more; London orders 10; BC transit orders 20; FTA selects 8 projects to add 11 new buses to demo fleet through 2010*

H_2 Transition Scenario Analysis Published by ORNL

Explores the infrastructure and policy requirements of potential market penetration scenarios for FCVs



http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008_30.pdf

OAK RIDGE National Laboratory

Stationary & Niche Markets – 2008 Highlights

CRITICAL LOAD FACILITIES:

- *Fuel cells for combined heat/cooling and power in federal data centers*
- *Two hospitals in CT to install 7.2MW of fuel cells for combined heat and power*

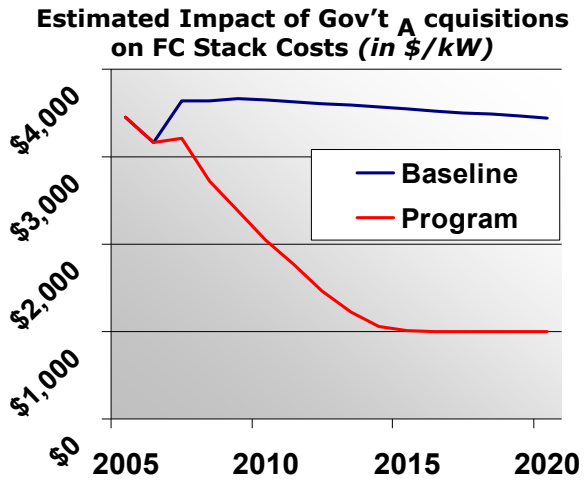
BACKUP POWER

- *FAA to deploy 20–30 fuel cells for backup power for communications towers*
- *US firm announces it has shipped 1MW of small backup power units (600W – 12kW)*

- **FORKLIFTS:**
- *DOD deploying up to 90 fuel cell forklifts at four sites around the country*
- *US Navy awards $5.6M in contract for FC forklifts*
- *Forklifts also in use (or test deployments) at: Wal-Mart distribution ctr; Bridgestone Tire plant; Ace Hardware distribution ctr.; Nissan plant in TN*

ORNL Analysis:
"Estimating the Impacts of a Government Acquisition Program for PEM Fuel Cells"

Shows that a federal acquisition program could drive down costs to a level that could sustain a viable domestic market

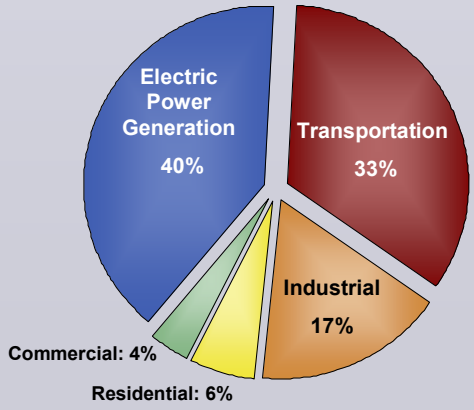


PROGRAM MISSION –

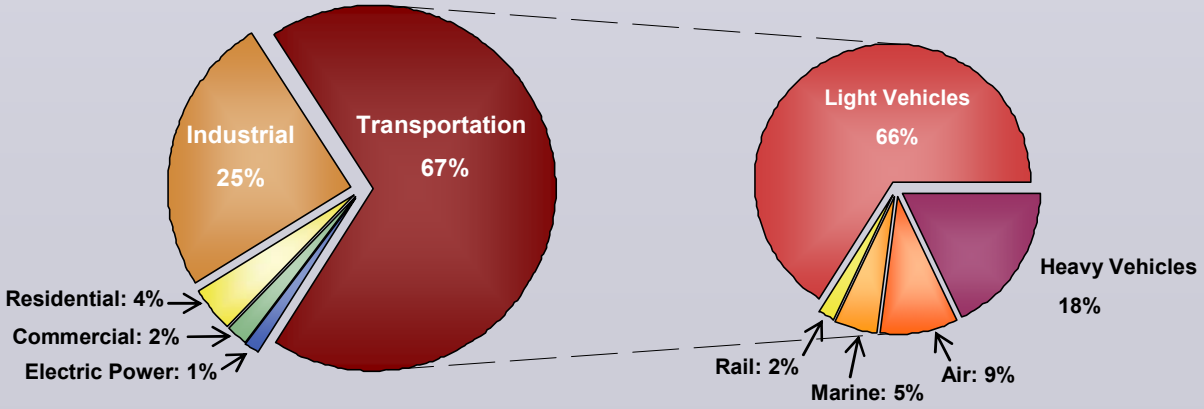
Reduce Oil Consumption & GHG Emissions

The Hydrogen Program's Mission *is to reduce oil use and carbon emissions in the transportation sector, and enable clean, reliable energy for stationary and portable power generation. The Program aims to accomplish this mission by researching, developing, and validating hydrogen and fuel cell technologies and by overcoming the non-technical barriers to their commercialization.*

U.S. CO_2 Emissions by Sector (2006)



U.S. Oil Consumption (2006)



Challenges & Barriers

Technology Barriers

Hydrogen Cost

(One cost-competitive pathway required for critical path. *Target ($2 – 3 /gge) has been met by distributed reforming of natural gas*)

H_2 Storage Capacity & Cost

(Targets: 2.7kWh/L, 3kWh/kg, and $2/kWh)

Fuel Cell Cost and Durability

(Targets: $30 per kW, 5000-hour durability)

Technology Validation:

(Technologies must be demonstrated under real-world conditions)

Economic & Institutional Barriers

Safety, Codes & Standards Development

Delivery Infrastructure

Domestic Manufacturing and Supplier Base

Public Awareness & Acceptance

Critical Path Barriers for Fuel Cell Vehicle Technology Readiness Targets to be achieved in 2015

Targets for stationary and portable power fuel cells have also been developed.

Strategic Partnerships

U.S. PARTNERSHIPS

- **FreedomCAR and Fuel Partnership:** *Chrysler, Ford, GM, BP America, Chevron, ConocoPhillips, ExxonMobil, and Shell Hydrogen*
- **Hydrogen Utility Group:** *Xcel Energy, Sempra, DTE, Entergy, New York Power Authority, Sacramento Municipal Utility District, Nebraska Public Power Authority, Southern Cal Edison, Arizona Public Service Company, Southern Company, Connexus Energy, etc.*
- **State/Local Governments:** *California Fuel Cell Partnership, California Stationary Fuel Cell Collaborative, co-coordinators of Bi-Monthly Informational Call Series for State and Regional Initiatives with the National Hydrogen Association and the Clean Energy Group*
- **Industry Associations:** *US Fuel Cell Council, National Hydrogen Association*
- **Federal Interagency Partnerships:** *Hydrogen and Fuel Cell Interagency Task Force and Working Group, Interagency Working Group on Manufacturing, Community of Interest on Hydrogen and Fuel Cell Manufacturing*

INTERNATIONAL PARTNERSHIPS

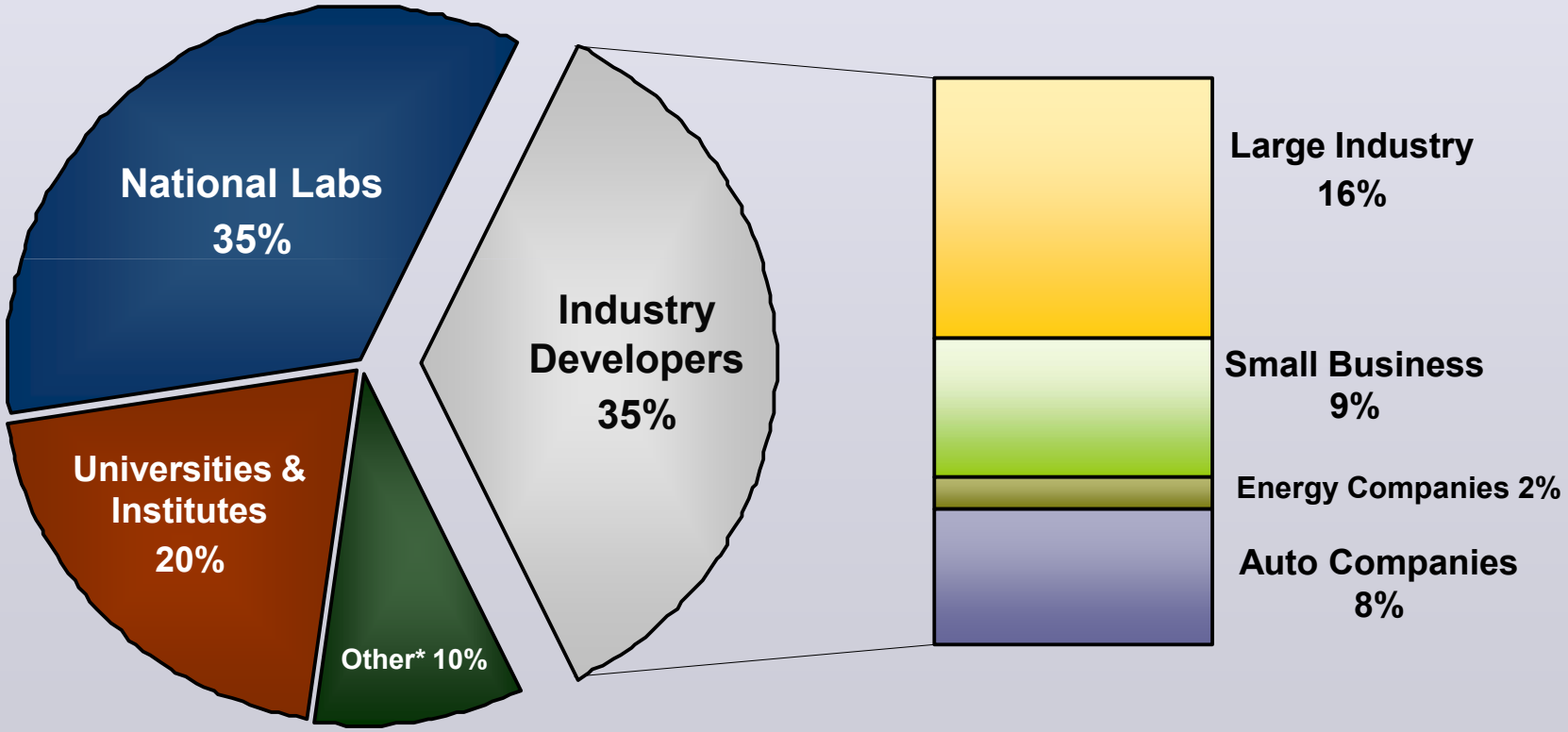
International Partnership for the Hydrogen Economy

International Energy Agency – Implementing Agreements

- ***Hydrogen Implementing Agreement***
- ***Advanced Fuel Cells Implementing Agreement***

Program Spending — *A balanced, diverse portfolio, involving universities, industry, and national labs*

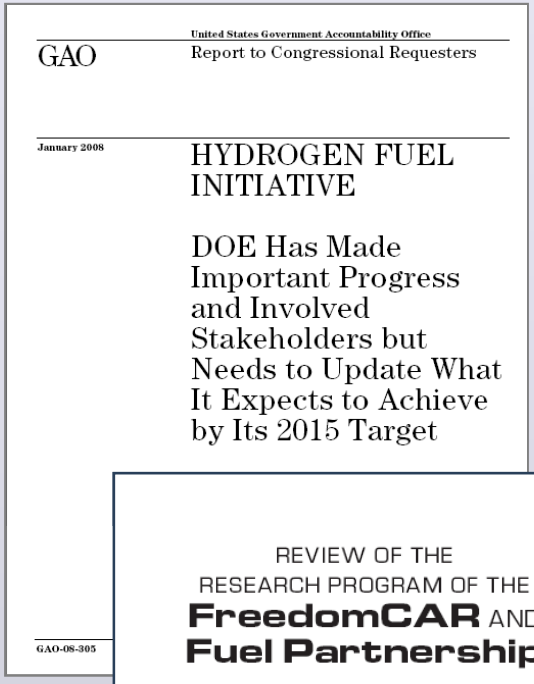
FY 2007 Hydrogen Program Spending Distribution

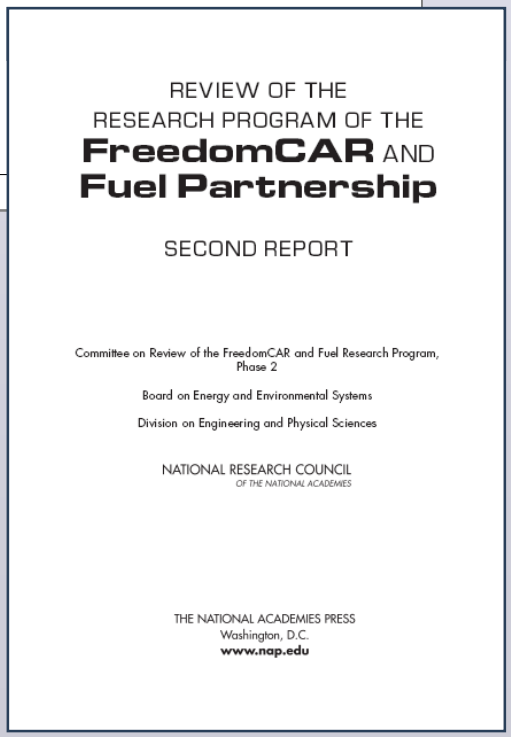


* "Other" includes: SBIR/STTR and various crosscutting support activities, such as the Annual Merit Review and required EPAct studies and reports

External Review/Strategic Input

- **GAO Report on the Hydrogen Fuel Initiative:** *Released January 2008*
  - *"DOE has effectively involved industry in designing and reviewing its hydrogen R&D program ..."*
  - *"DOE's Hydrogen Program has made important progress in all R&D areas, including both fundamental and applied science ... However, some of the most difficult challenges lie ahead..."*
- **NAS Review of FreedomCAR Partnership — Phase II:** *Completed April 2008*
  - *"The FreedomCAR and Fuel Partnership is well planned, organized, and managed. It is an excellent example of an effective industry/government cooperative effort."*
  - *"There has been significant progress in most areas since the Phase 1 report, and the committee commends management on its thorough and generally receptive responses to the recommendations in that report. "*





2008 Program Highlights

Fuel Cells: Developed membrane electrode assembly with >7300-hour durability (target is 5000 hrs for fuel cell system)

Production & Delivery:

- Developed electrolyzer with higher efficiency (67%), higher output pressure (1200 psig), & lower capital cost ($987/kW)
- Developed high-temperature membrane for H_2 from coal, which meets or exceeds key 2010 targets
- Started & operated integrated lab-scale experiments for producing H_2 from nuclear power
- Developed prototype electrochemical hydrogen compression cell

Storage: Identified materials with H_2 storage capacities of up to 10% by weight; enabled room temperature H_2 storage in sorbents; and increased rates of H_2 release by a factor of 60

Basic Science: Developed unique and highly efficient hybrid hydrogen generator by utilizing a special molecular wire to link a highly efficient biological solar absorber with a robust inorganic catalyst

Technology Validation: More than 1 million miles traveled *(by fleet of 92 vehicles)* in learning demo; Demonstrated 1200-hour system durability, with 1900-hour projected durability; demo includes 15 stations

Safety, Codes & Standards: Released *Permitting Compendium*, an online resource that streamlines the permitting process for hydrogen fueling stations

Education: By the end of the fiscal year, will have completed beta versions of a new introductory course for code officials and an advanced hands-on training course for first responders

Systems Analysis: *Hydrogen Transition Scenario Analysis* published by ORNL; NREL study on *Hydrogen-Based Energy Storage for Electric Utilities*

Funding Opportunities — *Current Solicitations*

Fuel Cell RD&D

- Up to $130M over 3 years; ~50 projects
- Topics include: R&D in fuel cells for transportation, stationary, and portable power; demonstration of stationary PEM and solid oxide fuel cells; and market transformation activities

Loan Guarantee Program

- Up to $10B in loan guarantees for renewable energy, energy efficiency, & electr. transmission projects

State Energy Program Competitive Activities

- ~$7.5M; topics are Advanced Building Energy Codes and Utility-Scale Clean Energy Capacity; offered by EERE's Weatherization and Intergovernmental Program; closes July 10, 2008

H-Prize Administration

- Solicitation for "Administering Entity" to implement the H-Prize (H-Prize established by EISA 2007; DOE will award cash prizes to advance the RD&D and commercial application of hydrogen energy technologies; first H-Prize will be in the area of hydrogen storage)
- ~1.3M (pending appropriations), for one project, 3 years; closes June 25

SBIR/STTR

- Annual solicitations on a wide variety of topics
- 2009 Solicitation subtopics to be released in the Fall

Since the start of the HFI, the Program has awarded *$800M in funding* to nearly *350 projects*, through more than *30 competitive solicitations*

The 2008 Annual Merit Review and Peer Evaluation Meeting

The goal of this meeting is to evaluate projects for their contribution to the Program mission.

Reviews are based upon each project's:

- *Technical accomplishments and progress*
- *Relevance to overall objectives of the Hydrogen Program*
- *Approach to performing the R&D*
- *Collaborations with other institutions*
- *Proposed future research*

Other Meeting Objectives

- *Communicate the status of the technologies, the latest progress, and future plans*
- *Provide valuable networking opportunity to foster collaboration*
- *Demonstrate accountability to Congress and taxpayers*

The 2008 Annual Merit Review and Peer Evaluation Meeting

Plenary Session Agenda:

1:30 Welcome & Program Update: JoAnn Milliken, H_2 Program Manager

2:15 Basic Energy Sciences: Harriet Kung, Director of Material Science & Engineering

2:35 Production & Delivery: Rick Farmer

2:45 Production, Nuclear Energy: Thomas O'Connor

2:55 Production, Fossil Energy: Mark Ackiewicz

3:05 Fuel Cells: Nancy Garland

3:25 Break

4:05 Storage: Sunita Satyapal

4:25 Technology Validation: John Garbak

4:35 Manufacturing and Market Transformation: Pete Devlin

4:45 Education: Christy Cooper

4:55 Safety, Codes and Standards: Antonio Ruiz

5:05 Systems Analysis: Fred Joseck

5:20 Hydrogen Scenario Analysis: David Greene

5:45 Question and Answer period (10-15 minutes)

6:00 Reviewer Orientation Session (10 minutes in Salons I&II)

6:30 Poster Session I: Storage; Analysis; Safety, Codes & Standards; Market Transformation; Technology Validation

FY 09 Budget

FY 2009 Budget in Brief

The FY 2009 Budget Request:

Increases funding for:

- Hydrogen Storage R&D
- Fuel Cell Stack Component R&D
- Distributed Energy Fuel Cell Systems
- Basic Science

Moves / Reduces Funding for:

- **Technology Validation; Safety, Codes & Standards; and Education**
  - → *Moved to Vehicle Technologies to leverage synergies within fuel cell, plug-in hybrid, and biofuel vehicle validation efforts*
  - → *Funding for FCV Validation cut in half; impact on learning demo TBD*
- **Renewable Hydrogen Production and Manufacturing R&D**
  - →*Funding deferred; not on critical path for 2015 technology readiness*
  - →*Hydrogen from natural gas available economically; Program has met critical path target of $3.00/gge; WTW CO_2 emissions in NG → H_2 FCVs 33 – 45% less than conventional vehicles*

Results:

- Funding for EERE hydrogen technologies reduced from $211.1M in FY08 to $177.7M in FY09 Request
- A more balanced EERE portfolio of near-, mid-, and long-term solutions
- Increased focus in Hydrogen Program on 2015 critical path barriers

Hydrogen Fuel Initiative

President Bush committed ***$1.2 billion*** **over 5 years (FY04 – FY08)** to accelerate R&D to enable technology readiness in 2015.

Hydrogen Fuel Initiative Funding[1] *($ in millions)*					
FY 2004 Approp.	**FY 2005 Approp.**	**FY 2006 Approp.**	**FY 2007 Approp.**	**FY 2008 Approp.**	**TOTAL (FY04 – FY08)**
157	**222**	**232**	**268**	**281**	**1,159**

- The President's cumulative request of $1.267 B (for FY04 – FY08) is consistent with the original commitment of $1.2 B.

[1] Includes EERE, FE, NE, SC and Department of Transportation

Hydrogen Fuel Initiative Budget

FY 2004 – FY 2009

	Funding *($ in thousands)*					
	FY 2004 Approp.	FY 2005 Approp.	FY 2006 Approp.	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request
HYDROGEN FUEL INITIATIVE						
EERE Hydrogen	144,881	166,772	153,451	189,511	211,062	177,713*
Fossil Energy (FE)	4,879	16,518	21,036	21,513	21,773	11,430
Nuclear Energy (NE)	6,201	8,682	24,057	18,855	9,909	16,600
Science (SC)	0	29,183	32,500	36,388	36,388	60,400
DOE Hydrogen TOTAL	**155,961**	**221,155**	**231,044**	**266,267**	**279,132**	**266,143**
Department of Transportation	555	549	1,411	1,420	1,425	1,425
Hydrogen Fuel Initiative TOTAL	**156,516**	**221,704**	**232,455**	**267,687**	**280,557**	**267,568**

*** Includes $146,213,000 in Hydrogen Technology and $31,500,000 in Vehicle Technologies**

EERE Hydrogen Technologies Budget

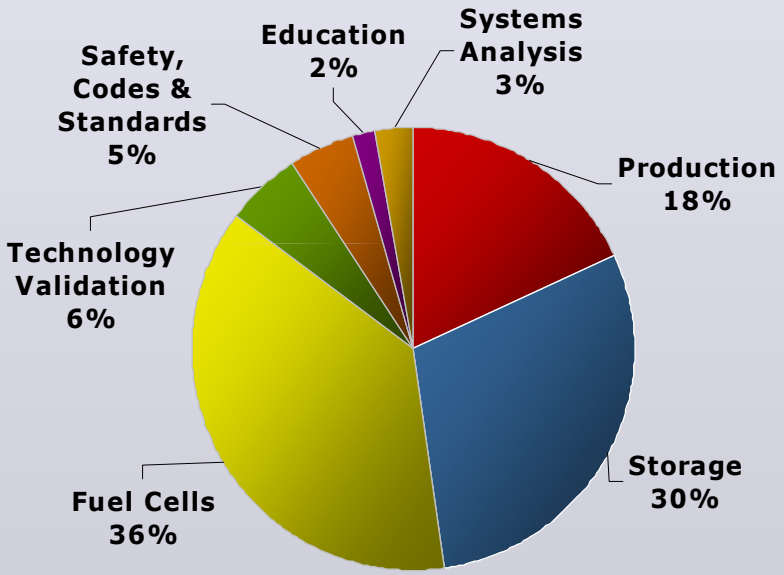
FY 2004 – FY 2009

Activity	Funding *($ in thousands)*					
	FY 2004 Approp.	FY 2005 Approp.	FY 2006 Approp.	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Request
Hydrogen Production & Delivery	10,083	13,303	8,391	33,702	39,636	0
Hydrogen Storage R&D	13,628	22,418	26,040	33,728	43,501	59,200
Fuel Cell Stack Component R&D	24,551	31,702	30,710	37,100	43,600	62,700
Technology Validation	15,648	26,098	33,301	39,413	29,727	15,000*
Transportation Fuel Cell Systems	7,317	7,300	1,050	7,324	7,927	6,600
Distributed Energy Fuel Cell Systems	7,249	6,753	939	7,257	7,630	10,000
Fuel Processor R&D	14,442	9,469	637	3,952	2,973	0
Safety, Codes & Standards	5,755	5,801	4,595	13,492	15,854	12,500*
Education	2,417	0	481	1,978	3,865	4,000*
Systems Analysis	1,429	3,157	4,787	9,637	11,395	7,713
Manufacturing R&D	0	0	0	1,928	4,954	0
Technical/Program Mgt. Support	395	535	0	0	0	0
Congressionally Directed Activities	41,967	40,236	42,520	0	0	0
TOTAL	**144,881**	**166,772**	**153,451**	**189,511**	**211,062**	**177,713**

*** Transferred to Vehicle Technologies in FY 2009**

DOE FY 2009 Budget Request for Hydrogen Technologies *(includes EERE, FE, NE, SC)*

Activity	Funding *($ in thousands)*					
	EERE (HFCIT)	EERE (VT)	FE (coal)	NE (nuclear)	BES (science)	TOTAL
Hydrogen Production			11,430	16,600	20,133	48,163
Hydrogen Storage	59,200				20,134	79,334
Fuel Cells	79,300				20,133	99,433
Technology Validation		15,000				15,000
Safety, Codes & Standards		12,500				12,500
Education		4,000				4,000
Systems Analysis	7,713					7,713
TOTAL	**146,213**	**31,500**	**11,430**	**16,600**	**60,400**	**266,143**



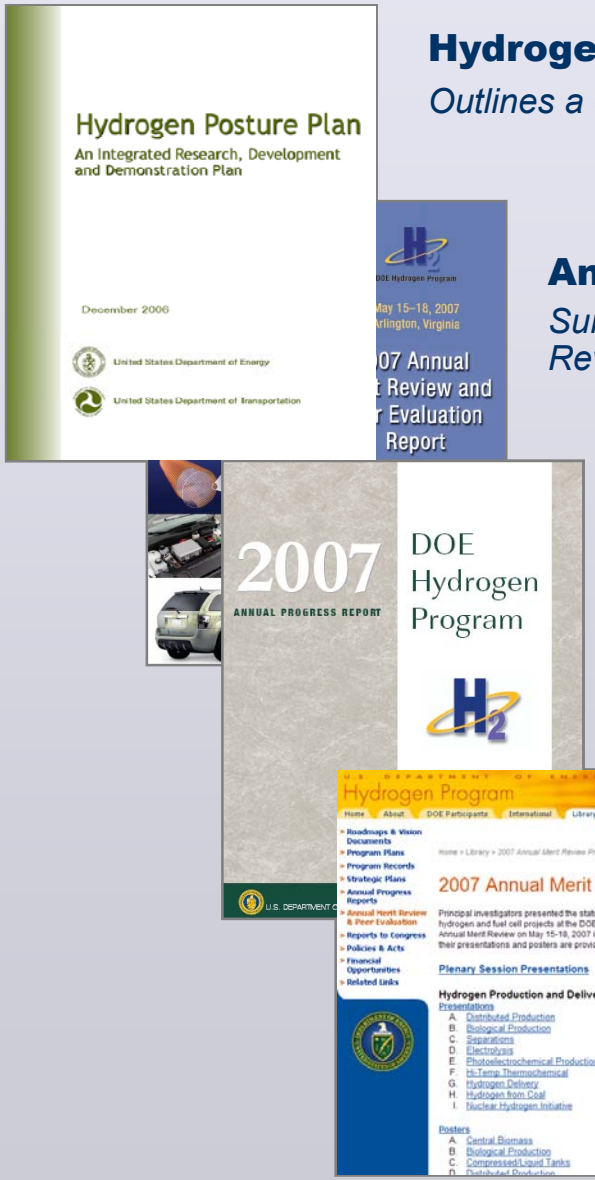
EERE FY 2009 Budget Request

— Hydrogen remains a high EERE priority —

ACTIVITY	FY2007 Approp. ($000)	FY2008 Approp. ($000)	FY2009 Request ($000)
Biomass and Biorefinery Systems	196,277	198,180	225,000
Vehicle Technologies	183,580	213,043	221,086*
Solar Energy	157,028	168,453	156,120
Hydrogen Technology	189,511	211,062	146,213
Building Technologies	102,983	108,999	123,765
Industrial Technologies	55,763	64,408	62,119
Weatherization & Intergovernmental Activities	281,731	282,217	58,500
Wind Energy	48,659	49,545	52,500
Geothermal Technology	5,000	19,818	30,000
Federal Energy Management Program	19,480	19,818	22,000
Hydropower	0	9,909	3,000
Congressionally Directed Activities	0	186,664	0
Program Direction	99,264	104,057	121,846
Program Support	10,930	10,801	20,000
Facilities & Infrastructure	107,035	76,176	13,982
Adjustments	0	-743	-738
TOTAL EERE	**1,457,241**	**1,722,407**	**1,255,393**

** Includes $31.5M for hydrogen activities in Technology Validation; Safety, Codes & Standards; and Education*

For more information …



Hydrogen Posture Plan

Outlines a coordinated plan for activities under the Hydrogen Fuel Initiative

→ ***Will be updated in 2008***

www.hydrogen.energy.gov/pdfs/hydrogen_posture_plan_dec06.pdf

Annual Merit Review & Peer Evaluation Report

Summarizes the comments of the Peer Review Panel at the Annual Merit Review and Peer Evaluation Meeting

→ ***Next edition to be published in Fall 2008***

www.hydrogen.energy.gov/annual_review07_report.html

Annual Progress Report

Summarizes activities and accomplishments within the Program over the preceding year, with reports on individual projects

→ ***Next edition to be published in Fall 2008***

www.hydrogen.energy.gov/annual_progress.html

Annual Merit Review Proceedings

Includes downloadable versions of all presentations at the Annual Merit Review

→ ***To be released following the Annual Merit Review***

www.hydrogen.energy.gov/annual_review07_proceedings.html