U.S. DEPARTMENT OF ENERGY

Fuel Cell Technologies: FY 2010 Budget Request Briefing

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Introduction: FY2010 Budget in Brief

The FY 2010 Budget Request:

- **Funding priorities are realigned to focus on fuel cell technologies for near term applications.**
- **Renames the Hydrogen Technology Program the Fuel Cell Technologies Program.**

Creates a new sub-program for:

- **Fuel Cell Systems R&D**
  - Consolidates four sub-programs: Fuel Cell Stack Components R&D, Transportation Fuel Cell Systems, Distributed Energy Fuel Cell Systems, and Fuel Processor R&D
  - Technology neutral fuel cell systems R&D for diverse applications

Defers funding for:

- **Hydrogen Production and Delivery R&D**
- **Hydrogen Storage R&D**
- **Technology Validation** (moved back to Fuel Cell Technologies Program)
- **Safety, Codes and Standards** (moved back to Fuel Cell Technologies Program)
- **Education** (moved back to Fuel Cell Technologies Program)
- **Manufacturing**
- **Market Transformation** (funded through ARRA)

Budget — EERE Key Activities

EERE Hydrogen and Fuel Cells Budget *(in thousands)*				
Key Activity	**FY 2007** *appropriation*	**FY 2008** *appropriation*	**FY 2009** *appropriation*	**FY 2010** ***request***
Fuel Cell Systems R&D	**0**	**0**	**0**	**63,213**
Hydrogen Production & Delivery R&D	**33,702**	**38,607**	**10,000**	**0**
Hydrogen Storage R&D	**33,728**	**42,371**	**59,200**	**0**
Fuel Cell Stack Component R&D	**37,100**	**42,344**	**62,700**	**0**
Technology Validation	**39,413**	**29,612**	**14,789***	**0**
Transportation Fuel Cell Systems	**7,324**	**7,718**	**6,600**	**0**
Distributed Energy Fuel Cell Systems	**7,257**	**7,461**	**10,000**	**0**
Fuel Processor R&D	**3,952**	**2,896**	**3,000**	**0**
Safety, Codes & Standards	**13,492**	**15,442**	**12,500***	**0**
Education	**1,978**	**3,865**	**4,200***	**0**
Systems Analysis	**9,637**	**11,099**	**7,713**	**5,000**
Manufacturing R&D	**1,928**	**4,826**	**5,000**	**0**
Market Transformation	**0**	**0**	**4,747**	**0**
Total	**$189,511**	**$206,241**	**$200,449**	**$68,213**

* Under Vehicle Technologies Budget in FY 2009

Hydrogen & Fuel Cell Budgets: *FY04 – FY10*

	Funding *($ in thousands)*						
	FY 2004 Approp.	FY 2005 Approp.	FY 2006 Approp.	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Approp.	FY 2010 Request
EERE Hydrogen/Fuel Cells	144,881	166,772	153,451	189,511	206,241	200,449	68,213
Fossil Energy (FE)	4,879	16,518	21,036	21,513	24,088	25,000*	16,400*
Nuclear Energy (NE)	6,201	8,682	24,057	18,855	9,668	7,500	0
Science (SC)	0	29,183	32,500	36,388	36,509	36,509	36,509**
DOE TOTAL	**155,961**	**221,155**	**231,044**	**266,267**	**276,506**	**269,458**	**121,122**
Department of Transportation (DOT)	555	549	1,411	1,420	1,425	1,800	1,800
TOTAL	**156,516**	**221,704**	**232,455**	**267,687**	**277,931**	**271,258**	**122,922**

*** Includes funding for R&D plus program direction. Fossil Energy also plans $58M for SECA in FY10.**
**** The Office of Science also plans ~$14M for Biological and Environmental Research in FY10.**

FY2010 EERE Budget Request

ACTIVITY	FY2007 Approp ($000)	FY2008 Approp ($000)	FY2009 Approp ($000)	FY2010 Request ($000)
Biomass and Biorefinery Systems	196,277	195,633	217,000	235,000
Building Technologies	102,983	107,382	140,000	237,698
Federal Energy Management Program	19,480	19,818	22,000	32,272
Geothermal Technology	5,000	19,307	44,000	50,000
Hydrogen Technology	189,511	206,241	168,960	0
Fuel Cell Technologies	0	0	0	68,213
Water Power	0	9,654	40,000	30,000
Industrial Technologies	55,763	63,192	90,000	100,000
Solar Energy	157,028	166,320	175,000	320,000
Vehicle Technologies	183,580	208,359	273,238*	333,302
Weatherization & Intergovernmental Activities	281,731	282,217	516,000	301,000
Wind Energy	48,659	49,034	55,000	75,000
Facilities & Infrastructure	107,035	76,176	76,000	63,000
Program Support	10,930	10,801	18,157	120,000
Program Direction	99,264	104,057	127,620	238,117
Congressionally Directed Activities	0	186,664	228,803	-
RE-ENERGYSE	0	0	0	115,000
Adjustments	0	-743	-13,238	-
TOTAL EERE	**1,457,241**	**1,704,112**	**2,178,540**	**2,318,602**

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

Key Challenges

The program has identified key challenges facing widespread commercialization of fuel cells.

Technology Barriers

Fuel Cell Cost & Durability

Targets:

- ***Stationary Systems:*** **$750 per kW, 40,000-hr durability**
- ***Vehicles:*** **$30 per kW, 5000-hr durability**

Fuel Cost and Storage Capacity

Target: $2 – 3 /gge, and greater than 300-mile range for vehicles—without reducing interior space or compromising performance

Technology Validation:

Technologies must be demonstrated under real-world conditions

Economic & Institutional Barriers

- **Safety, Codes & Standards Development**
- **Domestic Manufacturing & Supplier Base**
- **Public Awareness & Acceptance**
- **Fuel Supply & Delivery Infrastructure**

Market Transformation

Assisting the growth of early markets will help to overcome many barriers, including achieving significant cost reductions through economies of scale.

EERE FY2010 Key Fuel Cell Activities

- Broaden scope to multiple fuel cell applications including combined heat and power (CHP), auxiliary power units (APUs) and portable applications.
- Improve multiple core technologies, including: catalysts, membranes, and balance of plant components for polymer electrolyte membrane (PEM) fuel cells; interconnects, catalysts, and design configurations for solid oxide fuel cells; and catalysts, improved tolerance to contaminants, and design configurations for alkaline fuel cells.
- Develop and improve key stack components, including high temperature membranes, bipolar plates and seals, and gas diffusion layers.
  - Support new approaches to increase the activities and utilization of platinum and platinum group metal catalysts, and to improve the performance of non-PGM catalysts.
  - Address key factors that affect fuel cell durability: "poisoning" of the electrodes by impurities, and freezing of the water in the fuel cell stack in cold weather.
  - Employ research data and analytical models to better understand how fuel and air impurities degrade cell performance and to help develop methods for mitigating those effects.
- Improve water management by exploring novel concepts and improved system configurations.

EERE FY2010 Key Systems Analysis Activities

- Develop analytical models and tools to identify resource limitations, options for stationary power generation from fuel cells, options for renewable fuel supply, infrastructure issues, and the environmental benefits and impacts of widespread commercialization.
- Update the Macro System Model to determine the benefits of integrating stationary power fuel cells with the electrical sector.
- Conduct market studies to assess the opportunities for early market applications of fuel cells, the resulting impacts on job growth, and the effects of a federal fuel cell acquisition program on fuel cell costs.
- Conduct risk-analysis to evaluate progress toward the program's targets and goals and assess the risk and effects of not meeting key targets.

Funding Opportunities - Other

Loan Guarantee Program

- Loan guarantees for renewable energy, energy efficiency, & electricity transmission projects.

SBIR/STTR

- Annual solicitations on a wide variety of topics
- 2010 Solicitation subtopics to be released in the Fall
- DoD SBIR topic: "Extraction of Atmospheric CO_2 and Conversion to Liquid Hydrocarbon Fuel" (*The Army is seeking ways to produce fuel from CO_2 and water in the atmosphere. Water will be used to provide the hydrogen needed for the conversion process*). Closing date: June 17.

$16.8 billion for Energy Efficiency & Renewable Energy

$2.5 B	Research, development, demonstration and deployment ($1.2 B specified for biomass and geothermal; $50 M for IT efficiency—*$1.25 B in discretionary funds.*)
$5.0 B	Weatherization – Initial applications due MARCH 23; final applications due MAY 12
$3.1 B	State Energy Program – Closed MAY 13
$3.2 B	Energy Efficiency and Conservation Block Grants – State applications due MAY 26, all others due JUNE 25
$400 M	Transportation Electrification – Closed MAY 13
$300 M	Alternative Fueled Vehicles Pilot (Clean Cities) – Closing MAY 29
$2.0 B	Advanced Battery Manufacturing – Closing MAY 19
$300 M	Energy Efficient Appliance Rebate Program/EnergyStar

Progress: FUEL CELLS

Steady and significant progress seen in past 5 years in reducing cost and increasing durability of automotive fuel cell systems.

Fuel Cells (Auto) - Cost

- Target (2010): $45/kW
- Target (2015): $30/kW
  - *Status (2008): $73/kW**

Fuel Cells (Auto) Status in 2008

FC System Durability

- 1,977 hrs (59,310 miles) projected
- 1,700 hrs (51,000 miles) observed

Vehicle Range ≈ 196 – 254 miles

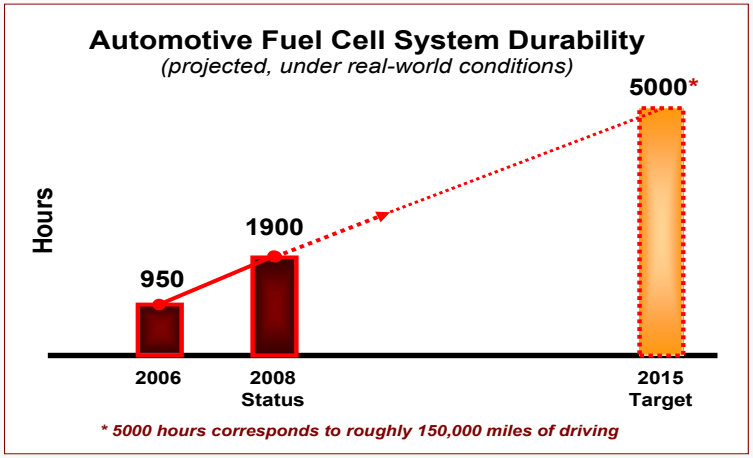
Average Refueling Rate = 0.8kg/min

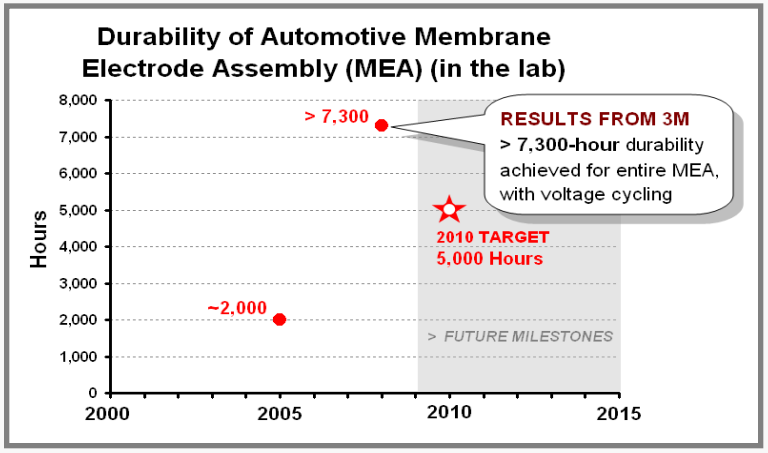
Efficiency ≈ 53-58%

*** Modeled cost for 500,000 units/year. Cost validated by independent panel ($60/kW - $80/kW).**

Fuel Cells (Auto) - Durability

- **Target (2010 & 2015): 5,000 hrs**

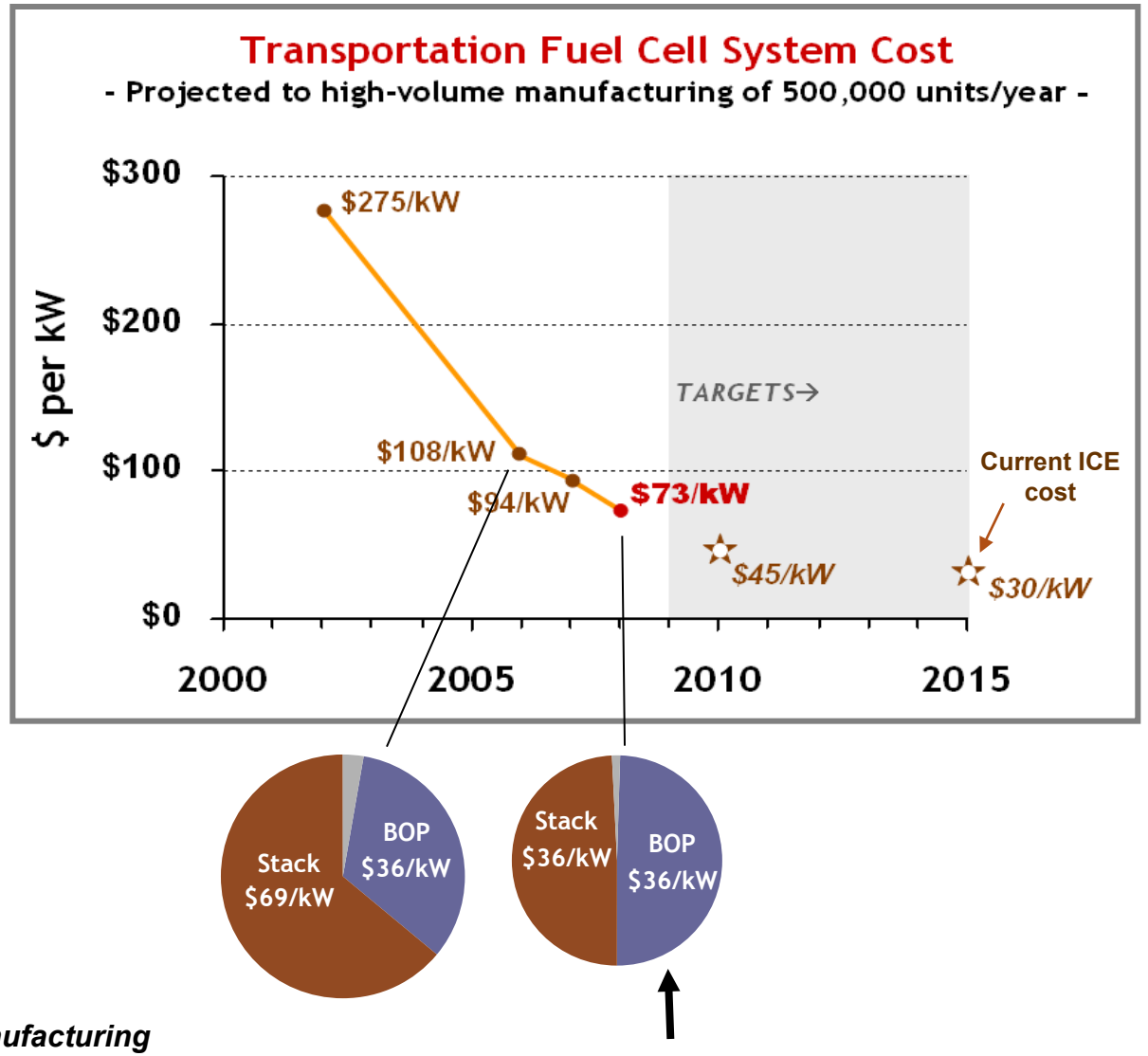




Progress: FUEL CELLS

We've reduced the cost of fuel cells to $73/kW*

- ***Cost projection validated by independent panel*****
- ***More than 20% reduction in one year***
- ***Nearly 75% reduction since 2002***



As stack costs are reduced, balance-of-plant components are responsible for a larger % of costs.

**Based on projection to high-volume manufacturing (500,000 units/year).*

***Panel found $60 – $80/kW to be a "valid estimate":* http://hydrogendoedev.nrel.gov/peer_reviews.html

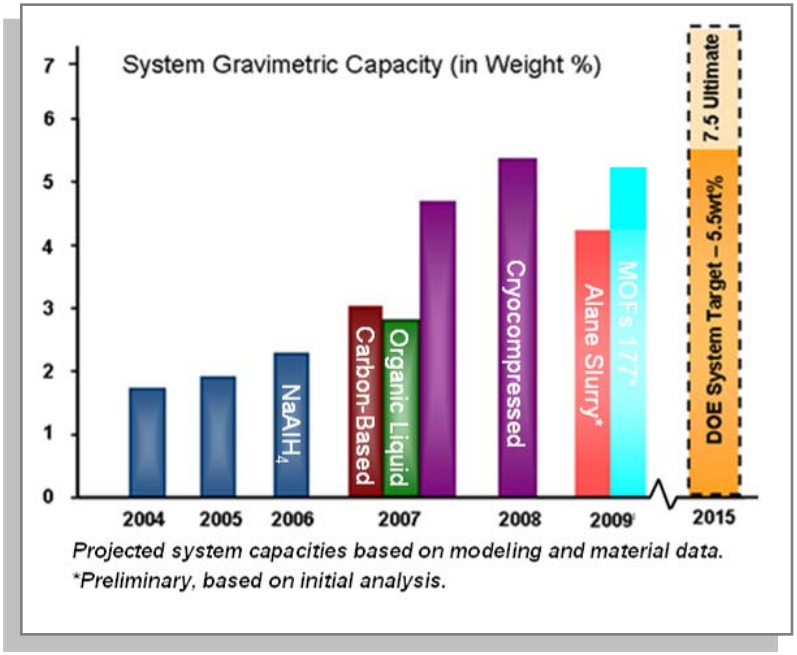
Progress: PRODUCTION, DELIVERY and STORAGE

Reduced the cost of hydrogen from multiple sources:

... from natural gas (distributed): *$3.00/gge*

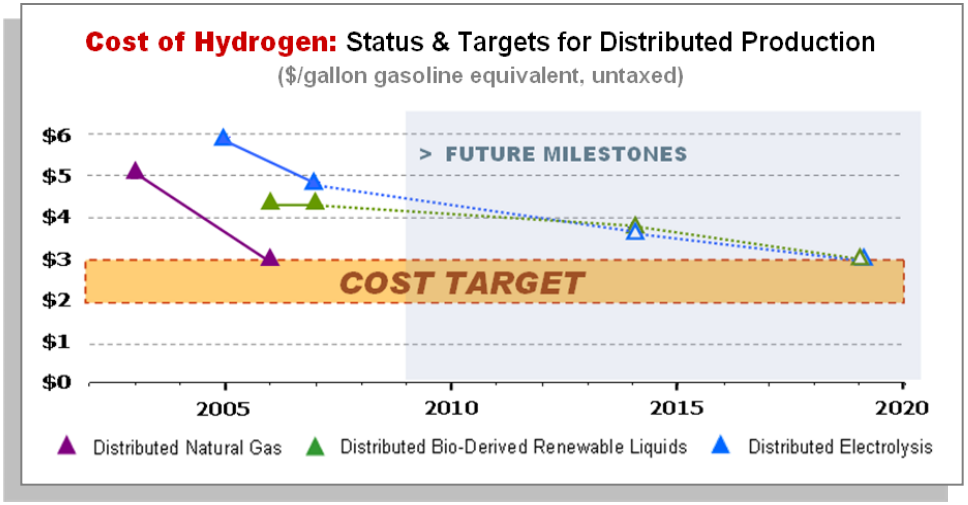
... from renewable resources (distributed): *$4.50/gge – $5.00/gge*

... from centralized production: *$5.00/gge – $9.00/gge (including delivery costs)*

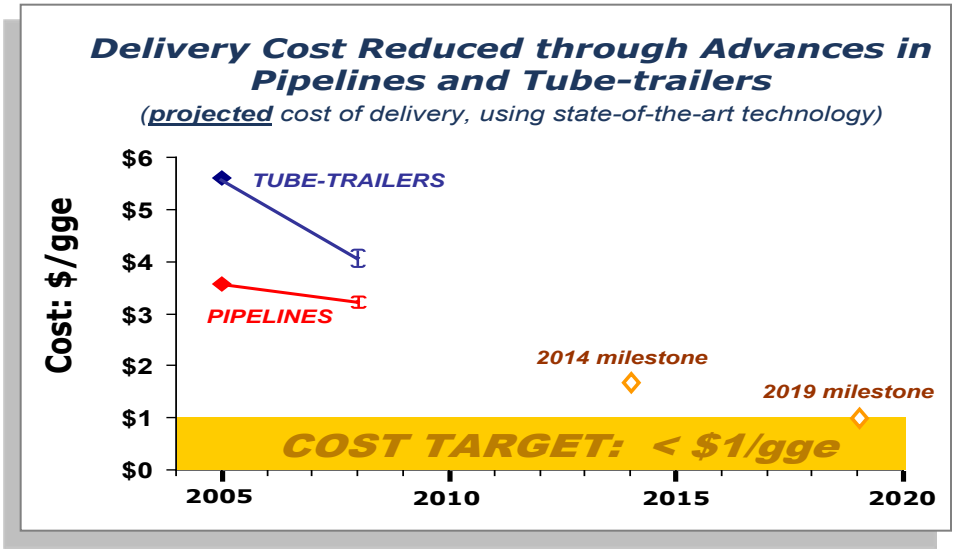


Multiple advances in hydrogen storage technologies.

- Subscale prototype developed for NaAlH4.
- Full scale prototype developed for cryocompressed tank.



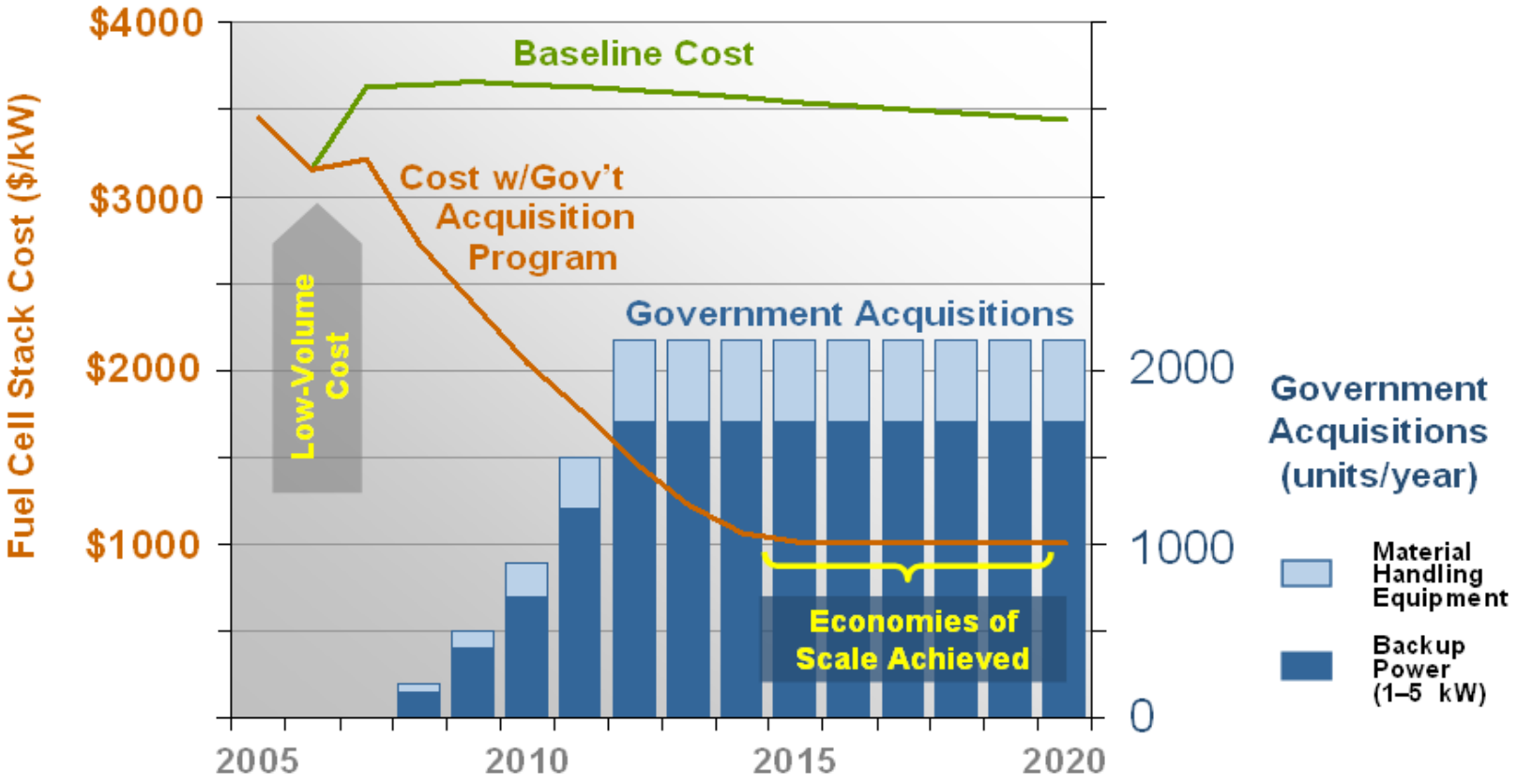
Reduced the cost of hydrogen delivery technologies.



Market Transformation

Government acquisitions could significantly reduce the cost of fuel cells through economies of scale, and help to support a growing supplier base.

Impact of Government Acquisitions on Fuel Cell Stack Costs (for non-automotive fuel cells)



Source: David Greene, ORNL; K.G. Duleep, Energy and Environmental Analysis, Inc., *Bootstrapping a Sustainable North American PEM Fuel Cell Industry: Could a Federal Acquisition Program Make a Difference?,* 2008.

New Recovery Act Projects

Deploying Fuel Cells for Specialty Vehicles

Anheuser-Busch (St. Louis, MO)	**$1.1 million**	***23 fuel cells in class-1 lift trucks***
FedEx Freight East (Harrison, AR)	**$1.3 million**	***35 fuel cells in class-1 lift trucks***
GENCO (Pittsburgh, PA)	**$6.1 million**	***156 fuel cells in 6 fleets of class-1 and -3 lift trucks***
Nuvera Fuel Cells (Billerica, MA)	**$1.1 million**	***Supplement a fuel cell forklift fleet with 10 fuel cell power packs and a hydrogen fueling system***
Sysco of Houston (West Houston, TX)	**$1.2 million**	***90 fuel cells in class-3 pallet trucks***

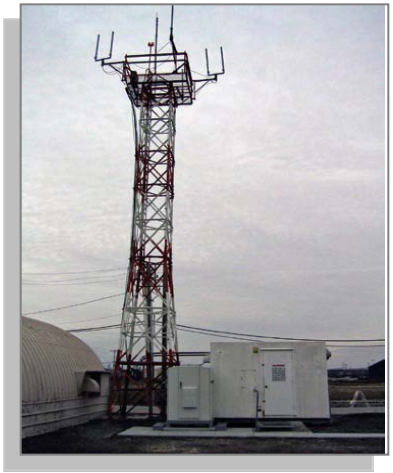
TOTAL: $10.8 million

Advantages of Fuel Cells for Specialty Vehicles:

- Allow for rapid refueling — much faster than changing-out or recharging batteries
- Provide constant power without voltage drop
- Eliminate space requirements of batteries & chargers
- *May provide substantial cost-savings* over battery-powered forklifts

New Recovery Act Projects

Deploying Fuel Cells for Back-up Power



Plug Power Inc. (Latham, NY)	**$2.7 million**	• *Up to 275 kW of backup power at government sites*
ReliOn Inc. (Spokane, WA)	**$8.6 million**	• *Backup power for 25 sites in utility communications network* • *180 backup power installations for telecommunications network*
Sprint Communications (Reston, VA)	**$7.3 million**	• *1-kW to 10-kW fuel cell systems for backup power to state/local first responders*
Jadoo Power (Folsom, CA)	**$1.8 million**	• *Evaluation of environmental and cost benefits of using 1-kW fuel cell power system, as opposed to gas/diesel generators and lead acid batteries*

TOTAL: $20.4 million

Advantages of Fuel Cells for Backup Power:

- Provide longer continuous run-time, greater durability than batteries
- Require less maintenance than batteries or generators
- Can be remotely monitored

New Recovery Act Projects

Demonstrating PEM Fuel Cells for Residential and Small Commercial CHP

ADVANTAGES of FUEL CELLS for CHP…

- Up to 85% overall efficiency
- 25 – 35% reduction in emissions from household energy use
- Zero emissions
- Low noise and vibration
- Low O&M requirements, less down-time
  - 100x more reliable than the average power supply for data centers—three seconds of down time per year versus an average of five minutes.
- Less variation in efficiency across variable loads

Plug Power, Inc. (Latham, NY)	$3.4 million	*5-kW stationary CHP systems*

Plug Power's GenSys Blue, for residential and small commercial applications

New Recovery Act Projects

Deploying Fuel Cells for Portable Power

MTI MicroFuel Cells (Albany, NY)	$2.4 million	• *1 W consumer electronics power pack*
PolyFuel, Inc. (Mountain View, CA)	$2.5 million	• *Portable power system for mobile computing*
TOTAL:	$4.9 million	

Deploying Fuel Cells for Auxiliary Power

Delphi Automotive (Troy, MI)	$2.4 million	• *3 – 5 kW SOFC APU for heavy-duty class 8 trucks*

2009 Annual Merit Review and Peer Evaluation

May 18-22, 2009

Arlington, VA

http://www.hydrogen.energy.gov/annual_review.html

For more information ...

Hydrogen Program Plan

Outlines a coordinated plan for hydrogen activities across the Department of Energy

→ ***Replacement for current Posture Plan***

→ ***To be released in 2009***

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 2009***

www.hydrogen.energy.gov/annual_review08_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 2009***

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_review08_proceedings.html