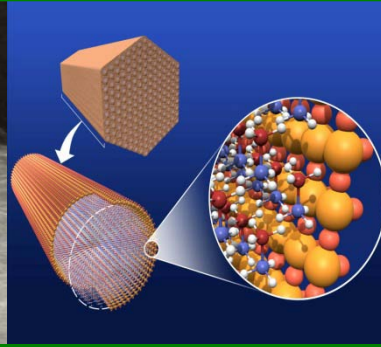
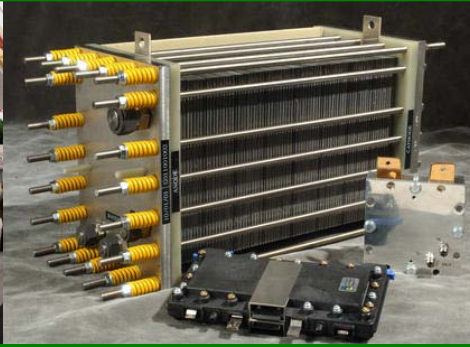




U.S. DEPARTMENT OF  
**ENERGY**



# Market Transformation & American Recovery and Reinvestment Act

*Pete Devlin*

*2011 Annual Merit Review and Peer Evaluation Meeting  
May 9, 2011*

## **GOALS**

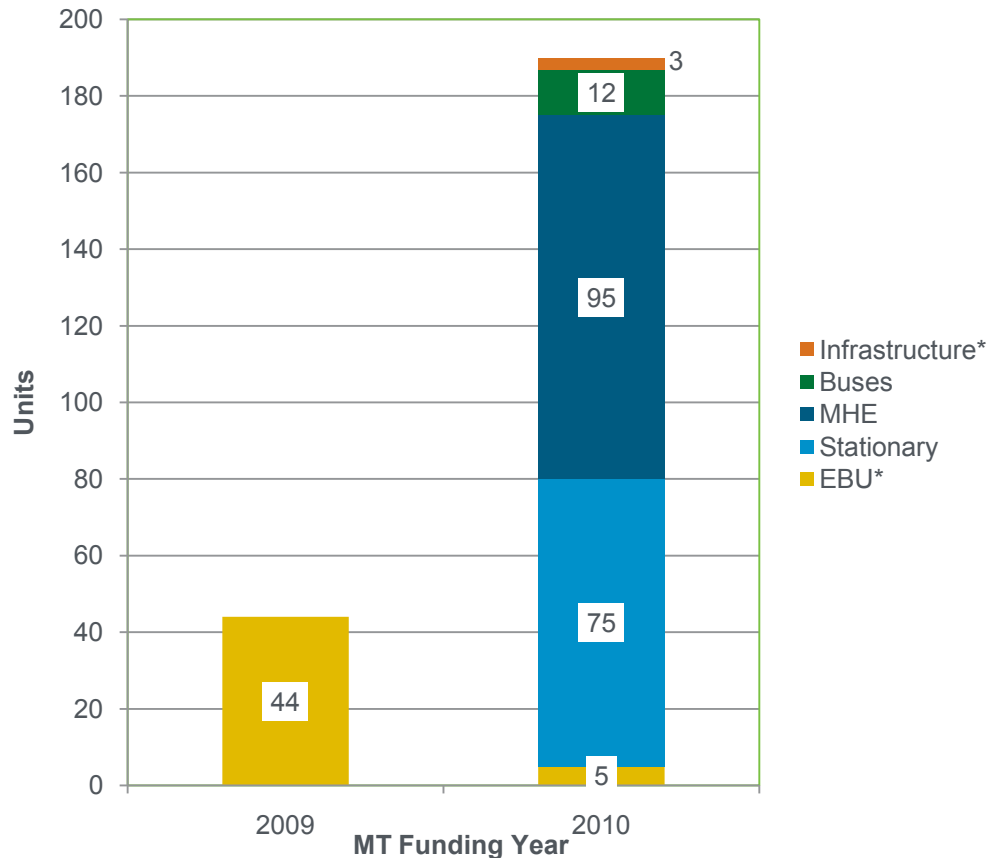
- Ensure continued technology utilization growth for domestically produced hydrogen and fuel cell systems
- Lower life cycle costs of fuel cell power by identifying and reducing non-technical barriers

## **OBJECTIVES**

- Catalyze key implementation projects and partnerships with state and local governments and other stakeholders
- Increase domestic market penetration by standardizing institutional and financial market practices
- Increase data analysis associated with siting and deployment (i.e. insurance, permitting, and installation)
- Develop and launch a transparent energy efficiency and reliability certification program

- To test emerging applications at the Technology Readiness Level (TRLs) 7-9 level to expand user and servicing expertise
- To test new technology applications in user operating conditions to establish baseline energy efficiency and reliability performance and determine commercial viability
- To develop strategies to mitigate commercial risks and develop new approaches to ensure high hydrogen and system utilization and reliability under mass market penetration scenarios
- To develop comprehensive standards for measuring energy efficiency to catalyze private sector financing for fuel cell systems
- To obtain data from operating experience
- To facilitate affordable insurance premiums for hydrogen and fuel cell technologies

## Fuel Cell Installations (ARRA Projects Not Included)



## Total Installations by Type\*

### 2009 Deployments (\$5 M)

- 44 EBU Units

### 2010 Deployment (\$15 M)

- 5 Mobile Light Stands
- 75 Micro CHP Units
- 95 MHE Units
- 12 HICE Buses
- 1 Electrolyzer
- 1 Mobile Refueler
- 1 Hydrogen Reformer (Landfill Gas)

\*Figures include Market Transformation funding only, ARRA and Other are excluded

*Completed the multi-site award of back-up power for DOD (CERL),  
NASA, and NPS*

## Advantages of Fuel Cells for Backup Power:

1. Longer continuous run-time and greater durability than batteries
2. Less maintenance than batteries or generators
3. Can be monitored remotely
4. Can provide substantial cost-savings over battery-generator systems\*



Plug Power units at Ft. Jackson

## Bundled DOD Multi Site Back-Up Power Project to Reduce Overall Cost of Deployment

### *Project Details*

- ✓ 9 Host Sites
- ✓ 20 Separate Buildings
- ✓ 44 Units
- ✓ ~220kW

- U.S. Army Aberdeen Proving Ground, MD
- U.S. Army Fort Bragg, NC
- U.S. Army Fort Hood TX
- U.S. Army National Guard Ohio
- U.S. Army Picatinny Arsenal , NJ
- NASA Ames Research Center, CA
- USMC AGGC 29 Palms, CA (2 Buildings)
- US Military Academy West Point, NY.
- Cheyenne Mountain Air Station

\*SOURCE: *Identification and Characterization of Near-Term Direct Hydrogen Proton Exchange Membrane Fuel*

Cell Markets, Battelle Memorial Institute, 2007  
([www.hydrogenandfuelcells.energy.gov/fc\\_publications.html](http://www.hydrogenandfuelcells.energy.gov/fc_publications.html))



*Developed a new mobile lighting technology and tested in real operations  
(Sandia National Laboratory)*

**Demonstrated fuel cells for mobile lighting - combining PEM fuel cells and high efficiency plasma lights**



*Fuel Cell Mobile Light used at 2011 Golden Globe Awards (courtesy of SNL)*

## *Benefits of Fuel Cell Mobile Lighting*

- ✓ 40 hour duration (lighting)
- ✓ 3 kW of AC power available
- ✓ Illuminates 50 yds x 75 yds
- ✓ Suitable for indoor/outdoor use
- ✓ Very quiet! 43 dB noise level at 23 ft

## **Next Steps**

- Real World deployments at SFO, State DOT (CA, CT), and the entertainment industry
- Publicize and further commercialize
- Continue to improve technology

*Continuously operated fuel cell powered lift trucks at DOD sites*

**The Defense Logistics Agency Susquehanna, PA and Warner Robins, GA have run fuel cell powered lift trucks for 1000s of hours and refills without incidents or performance problems.**



## ***Project Details***

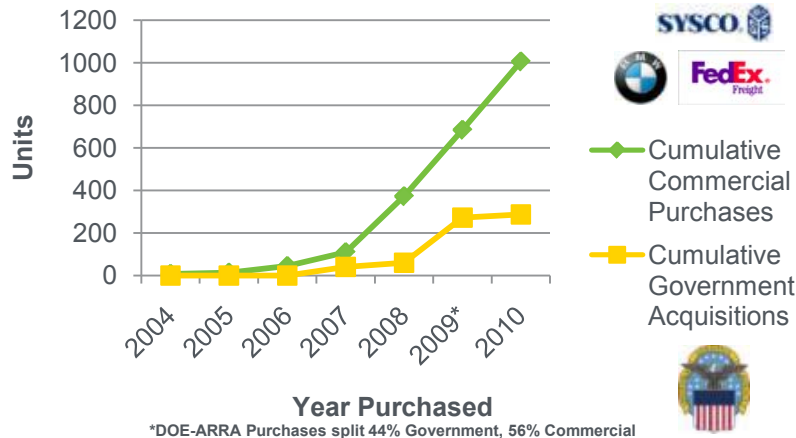
- ✓ 55 current units
- ✓ 15 units Firm Fixed Price
- ✓ Fully utilize infrastructure

## **Next Steps**

- Data collection and summary analysis
- Lessons learned reports

## Government adoption as a catalyst for industry adoption

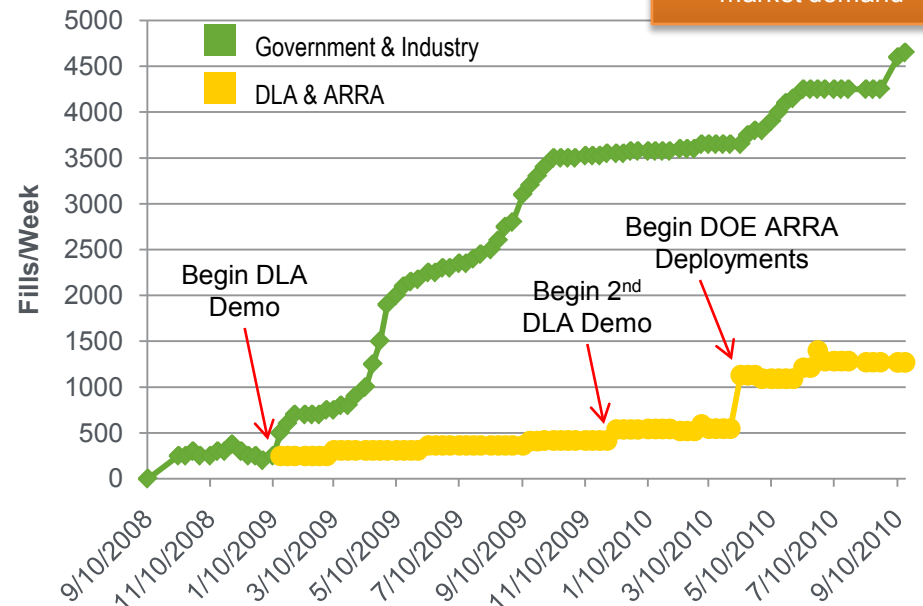
### Cumulative Fuel Cell MHE Equipment Purchases



### Fuel Cell MHE Market Example

- Early Procurement (2007-2009)
  - DLA began early fuel cell powered forklift procurements, 99 units
  - Multiple OEMs across sites in PA, GA, CA, and WA (Army)
- DOE-ARRA-funded Projects (2009)
  - Received over 50% cost share from industry
- Fully Integrated Fuel Cell Forklifts (2011)
  - Two forklift OEMs have announced plans to design a new class of forklifts around fuel cells

### H<sub>2</sub> Refuelings



Today's refueling increasingly driven by market demand

YR	Commercial Purchases	Cumulative Commercial Purchases	Government Acquisitions	Cumulative Government Acquisitions
2004	8	8	0	0
2005	6	14	0	0
2006	31	45	0	0
2007	65	110	40	40
2008	263	373	20	60
2009*	312	685	212	272
2010	321	1006	15	287



*Installed and operated hydrogen buses at 9 DOD and DOE sites*

- **Deployed Hydrogen buses used by the general public to demonstrate technical feasibility and infrastructure**
- **Each site will be hosting Outreach events to engage the general public in the benefits of Hydrogen**



## *Project Details*

- 12 Ford HICE Buses
- 8 Different Sites
- H<sub>2</sub> from Renewables
- DOD and Lab Sites, Including 1 University Site
- Emphasis on Outreach
- 1000 + Impressions since 1<sup>st</sup> deployment in June



## **Next Steps**

- More Outreach Events planned for all sites (12 Month Outreach Programs)
- Enable infrastructure and codes/standards development

## *Started a micro CHP deployment for light commercial facilities (PNNL)*

- MicroCHP costs are becoming competitive with grid power and ROIs are estimated at under 5 yrs
- Deployments will target areas where a business case can be made with pay back periods which meet industry needs



### ***Project Details***

- ✓ 50 units
- ✓ 5 kW units
- ✓ Prove business case for MicroCHP applications

### **Next Steps**

- Review proposals and make awards
- Gather material performance data
- “Real world” evaluation and testing of equipment

*Catalyzed an industry fuel cell lift truck project using LFG feedstock  
(SCRA / BMW)*

**Initiated project to compare LFG-produced hydrogen to delivered hydrogen in a “real world” evaluation of MHE equipment.**



*BMW Manufacturing site,  
courtesy of Waste Management World*

- Landfills generate landfill gas (LFG) from active microorganisms interacting with the waste
- This gas can be converted into hydrogen and used to provide energy or fuel, effectively **turning trash into power**

## *Landfill Gas to Hydrogen Benefits*

- ✓ Reduced emissions
- ✓ Additional power supply
- ✓ Additional vehicle fuel source

*Launched DMFC powered lift truck operations in 4 locations*

**Fuel Cells for MHE using bio-methanol will have lower infrastructure costs.**

## ***Project Details***

- ✓ 75 units
- ✓ 4 locations
- ✓ Engage Key Industry Stakeholders:  
Nissan



## **Next Steps**

- Gather material handling equipment (MHE) performance data.
- “Real world” evaluation and testing of equipment.

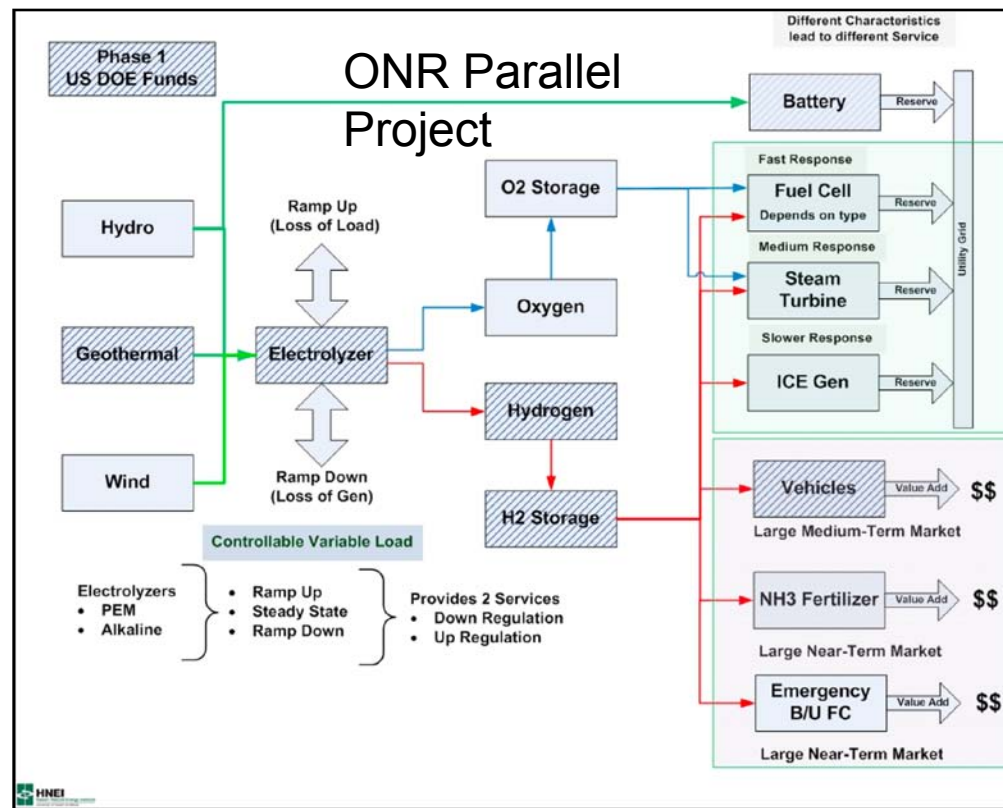


# Progress – Hydrogen from Renewables

*Started first-of-its-kind application to generate hydrogen from renewable energy for transportations fuel and grid management (NRL and HNEI)*

## Grid Integrated Hydrogen Energy System

To help combat large amounts of variable generation from renewable sources a grid integrated hydrogen system is proposed to use hydrogen for energy storage.



## Grid Integrated H<sub>2</sub> Energy System Benefits

- Provide hydrogen fuel to bus companies.
- Demonstrate electrolyzers as a grid management tool.
- Ability to respond quickly to increased and decreased loads.



*Worked with DOD to investigate 3 new uses of fuel cells – aircraft and shipboard APUs and waste-to-energy (WTE) fuel cells*

## Enhance Energy Security MOU

Purpose: Strengthen coordination of DOE and DOD efforts to enhance national energy security, and demonstrate Government leadership in transitioning America to a low carbon economy.



## Aviation APUs Workshop

### Purpose:

- To begin discussing collaboration across DOD and DOE in keeping with the MOU
- To motivate RD&D for APU applications

### Next Steps

- Identify specific POCs for DOD activities (RED DOTS)

## Waste-to-Energy Workshop

### Purpose:

- To identify DOD-DOE waste-to-energy and fuel cells opportunities
- To identify challenge and determine actions to address them

### Next Steps

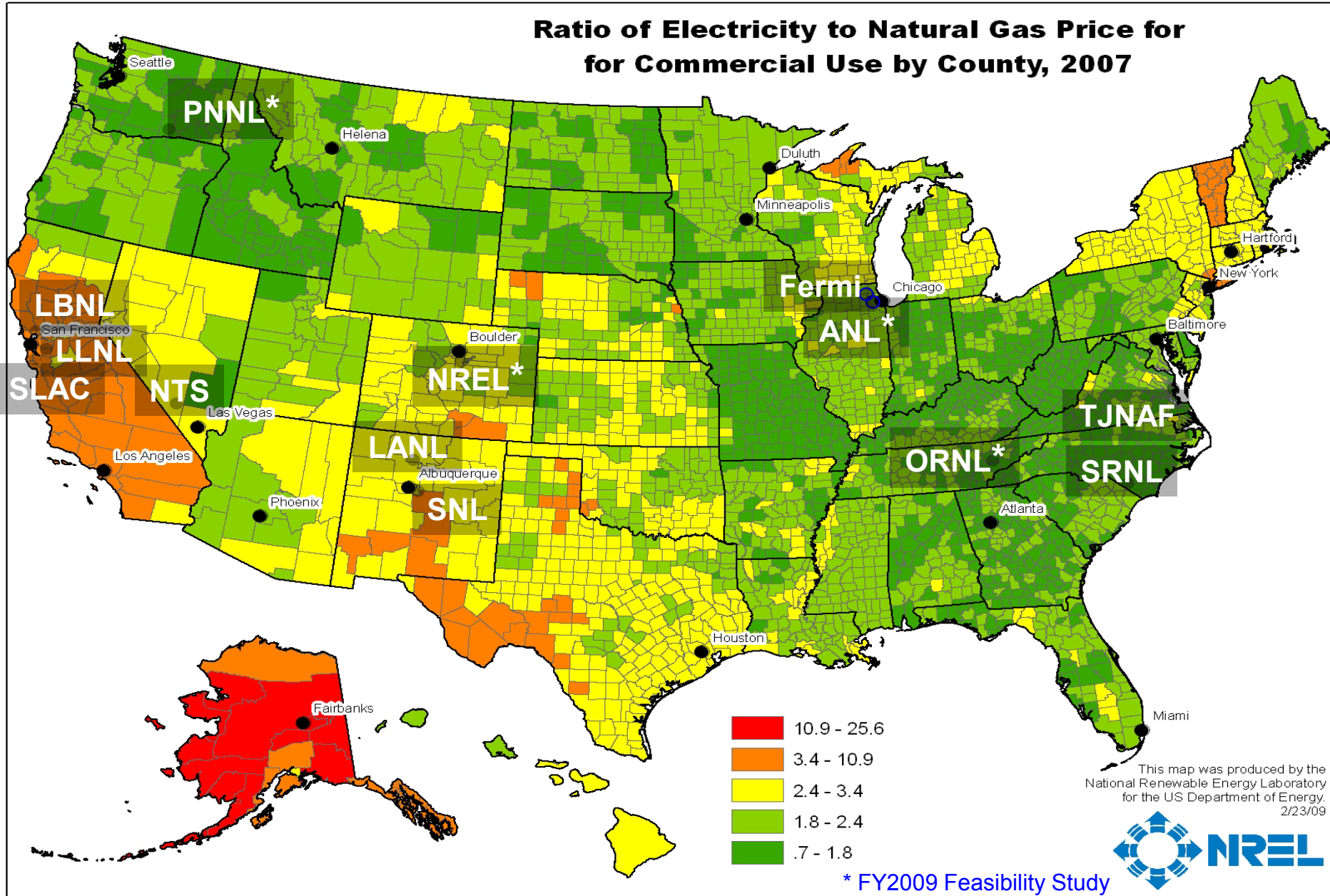
- Set up an on-going WG to begin coordination, collaboration, assistance
- Develop a guidance document for Feds using third party financing

## Shipboard APUs Workshop

- Organized by ONR

# Power Purchase Agreement Feasibility Study

## Ratio of Electricity to Natural Gas Price for for Commercial Use by County, 2007



This map was produced by the  
National Renewable Energy Laboratory  
for the US Department of Energy.  
2/23/09



\* FY2009 Feasibility Study

- “**Green Communities**”

- Residential, mixed-use, light commercial, municipal or state sites that have committed to mitigating their environmental impact.



- Identify communities that have adopted energy efficiency and conservation plans that are capable of leveraging their existing or planned investments with the deployment of hydrogen and fuel cells systems.

## Potential Projects

Community requires system capable of integrating with existing renewable energy generators to produce hydrogen to fuel new fuel cell bus fleet.

Fuel cell co-generation plant could provide sufficient electric power and heat to meet community's requirements and help achieve energy efficiency and GHG emissions goals adopted by community.

Installation of electrolyzer would allow community to store and sell excess renewable energy production, generating a new revenue stream and fully utilizing renewable resources.

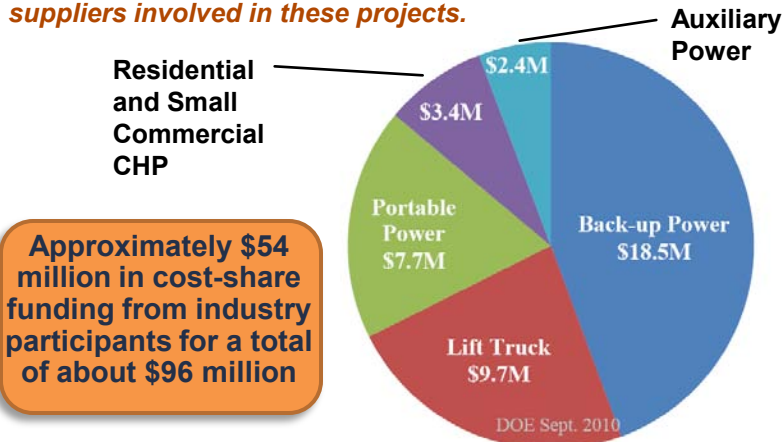


# ARRA Fuel Cell Funding & Budget

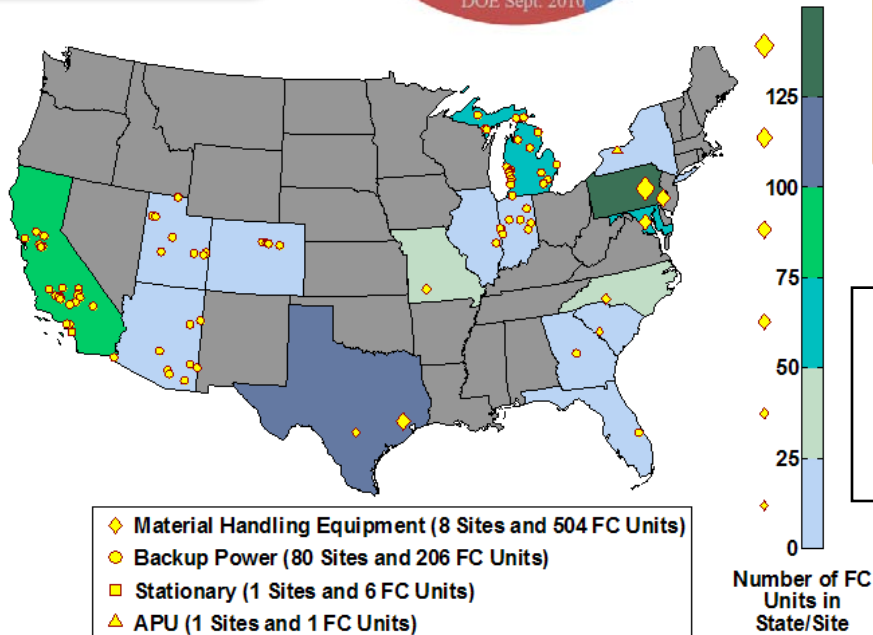
DOE announced more than \$41 million from the 2009 American Recovery and Reinvestment Act to fund 12 projects, which are deploying up to 1,000 fuel cells—to help achieve near-term impact and create jobs in fuel cell manufacturing, installation, maintenance & support services.

## FROM the LABORATORY to DEPLOYMENT:

DOE funding has supported R&D by all of the fuel cell suppliers involved in these projects.



Approximately \$54 million in cost-share funding from industry participants for a total of about \$96 million



COMPANY	AWARD	COST SHARE	APPLICATION
Delphi Automotive	\$2.4 M	\$2.4 M	Auxiliary Power
FedEx Freight East	\$1.3 M	\$1.5 M	Lift Truck
GENCO	\$6.1 M	\$6.1 M	Lift Truck
Jadoo Power	\$2.2 M	\$2.6 M	Portable
MTI MicroFuel Cells	\$3.0 M	\$3.6 M	Portable
Nuvera Fuel Cells	\$1.1 M	\$2.2 M	Lift Truck
Plug Power, Inc.	\$3.4 M	\$3.4 M	CHP
Plug Power, Inc.	\$2.7 M	\$2.7 M	Back-up Power
Univ of N Florida	\$2.5 M	\$0.6 M	Portable
ReliOn, Inc.	\$8.5 M	\$9.6 M	Back-up Power
Sprint - Nextel	\$7.3 M	\$17.2 M	Back-up Power
Sysco Houston	\$1.2 M	\$2.0 M	Lift Truck

## Deployment Status – April 2011

Fuel Cell Application	Operational Fuel Cells	Total Fuel Cells Planned
APU	0	3
Backup Power	267	539
Material Handling	369	504
Stationary	0	6
<b>Total</b>	<b>636</b>	<b>&gt; 1,000</b>

**JOBS STATUS**  
 (April 2011)  
 48.7 jobs reported on Recovery.gov

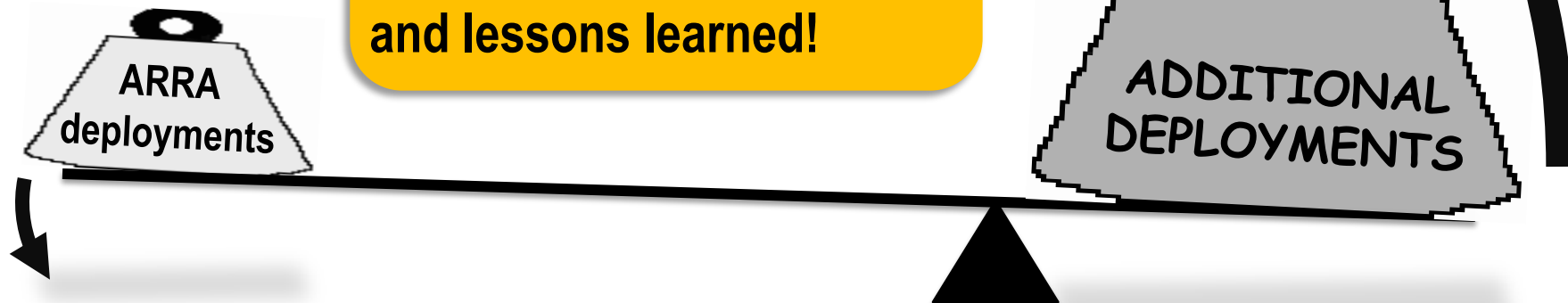
## LEVERAGING ADDITIONAL FUEL CELLS DEPLOYMENTS

- Sysco (Corporation) plans to convert an additional 500+ battery powered lift trucks to fuel cell power
- H-E-B Grocery, with Nuvera Fuel Cells, plans to expand their current fleet of fuel cell powered lift trucks by 28 additional lift trucks

### NREL ARRA Data Collection Snapshot

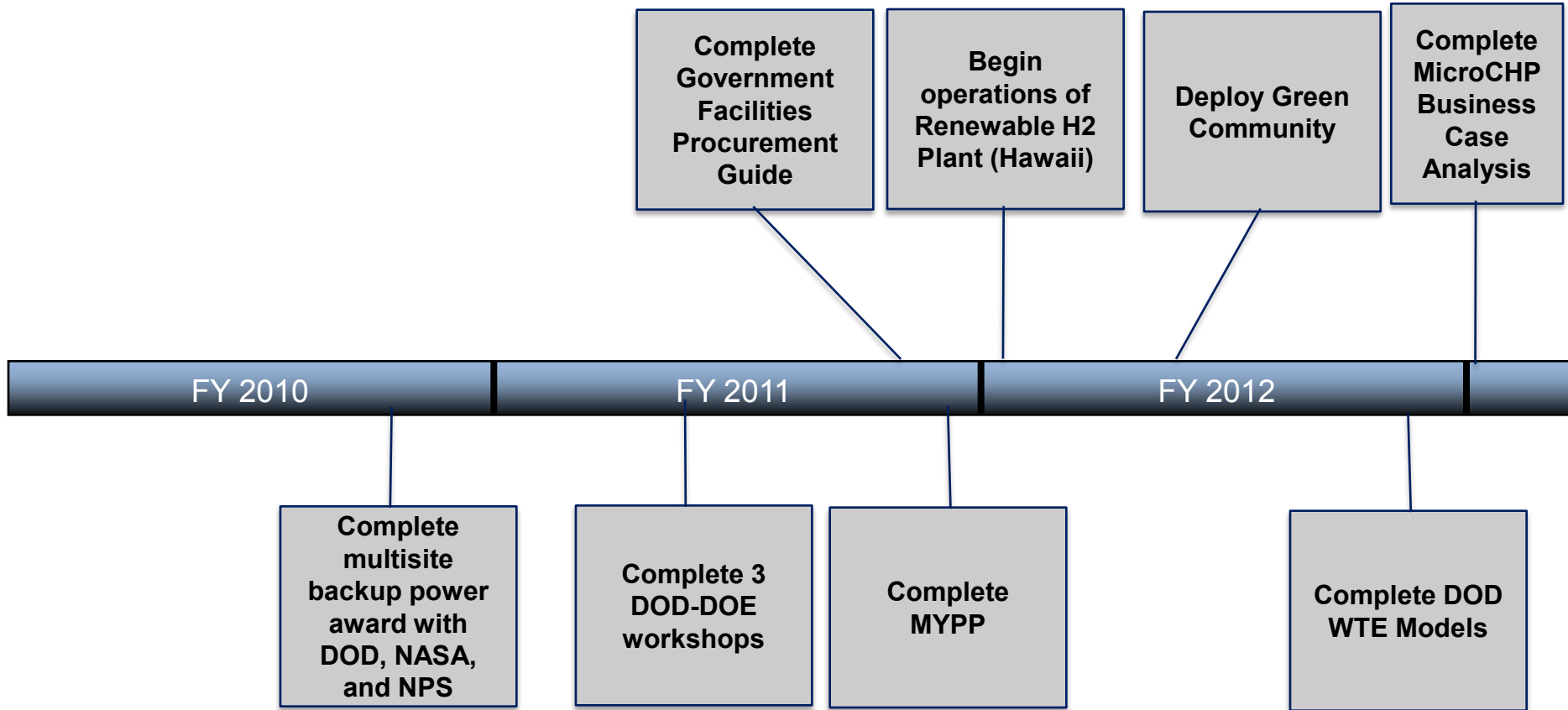
ARRA Material Handling Equipment Data	As of 12/31/2010
Hydrogen Dispensed	> 18,500 kg
Hydrogen Fills	> 38,800
Hours Accumulated	> 307,400 hrs

**Additional fuel cell lift truck deployments taking place based on ARRA experience and lessons learned!**





## Key milestones & future plans



## Market Transformation

### DOE Headquarters

Pete Devlin  
*Market Transformation and  
Intergovernmental Coordination Manager*  
202-586-4905  
[peter.devlin@ee.doe.gov](mailto:peter.devlin@ee.doe.gov)

Nancy Garland  
202-586-5673  
[nancy.garland@ee.doe.gov](mailto:nancy.garland@ee.doe.gov)

Carole Read  
202-586-3152  
[carole.read@ee.doe.gov](mailto:carole.read@ee.doe.gov)

### National Renewable Energy Laboratory Support:

*John Christensen*  
703-391-2075  
[jchrste1@comcast.net](mailto:jchrste1@comcast.net)

### Technical Support:

*Greg Moreland*  
240-499-4434  
[greg\\_moreland@sra.com](mailto:greg_moreland@sra.com)

*Kristen Nawoj*  
202-287-6319  
[kristen.nawoj@ee.doe.gov](mailto:kristen.nawoj@ee.doe.gov)

Market Transformation presentations in salon E – Crystal City Marriott Hotel  
Tuesday, May 10th at 2:30 PM – 5:45 PM

## ARRA Contacts

### DOE Headquarters:

*Sara Dillich*  
202-586-7925  
[sara.dillich@ee.doe.gov](mailto:sara.dillich@ee.doe.gov)

*Donna Ho*

*Jason Marcinkoski*

*Dimitrios Papageorgopoulos*

*Ned Stetson*

### Technical Support:

*Matthew Simon (Energetics, Inc.)*

### Golden Field Office:

*James Alkire*

*Gregory Kleen*

*David Peterson*

*Katie Randolph*

*Reginald Tyler*

### Technical Support:

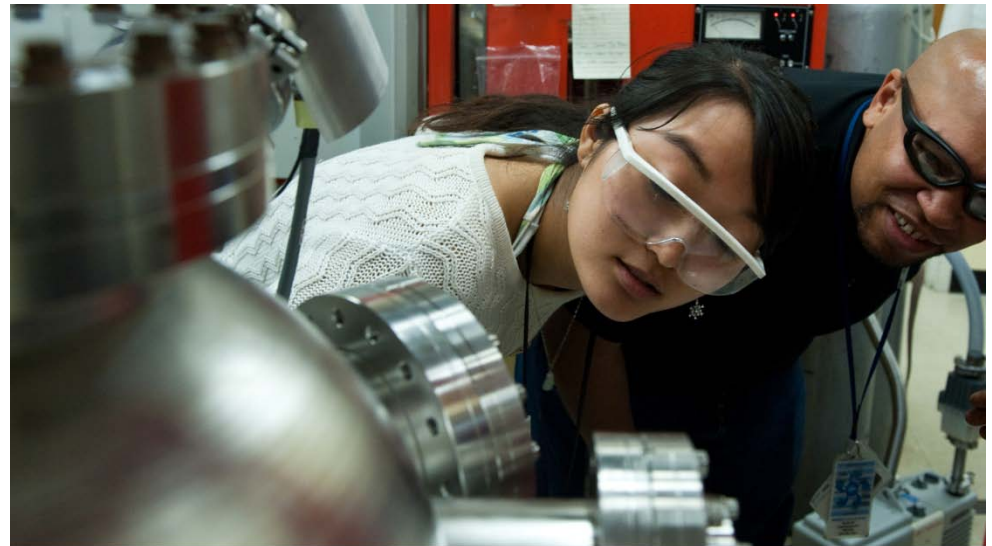
*Shaun Onorato (Cas-Navarro Joint Venture LLC)*

### NREL Data Collection and Analysis:

*Jennifer Kurtz*

**ARRA presentations in track F – Crystal City Marriott Hotel**  
**Thursday, May 12<sup>th</sup> at 1:30 PM – 5:45 PM**  
**Friday, May 13<sup>th</sup> at 8:30 AM – 12:00 PM**

- Fuel Cell Technologies Program Opportunities Available
  - Conduct applied research at universities, national laboratories, and other research facilities
  - Up to five positions are available in the areas of hydrogen production, hydrogen delivery, hydrogen storage, and fuel cells
- Applications are due June 30, 2011
- Winners will be announced mid-August
- Fellowships will begin in mid-November 2011



[www.eere.energy.gov/education/postdoctoral\\_fellowships/](http://www.eere.energy.gov/education/postdoctoral_fellowships/)

Postdoctoral fellowships in hydrogen and fuel cell research ▶