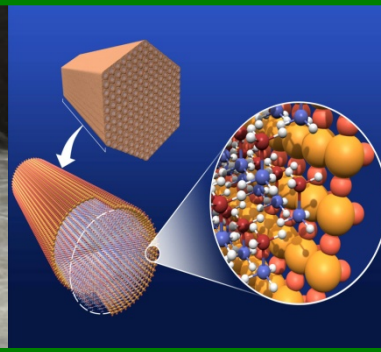
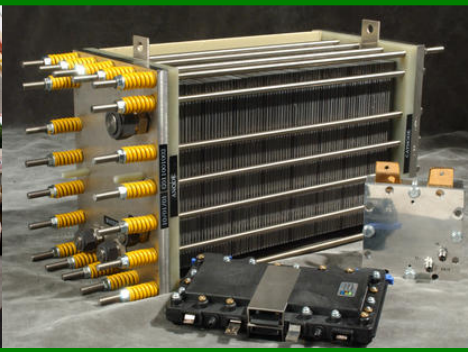




U.S. DEPARTMENT OF  
**ENERGY**



# Market Transformation & American Recovery and Reinvestment Act

*Pete Devlin*

*2012 Annual Merit Review and Peer Evaluation Meeting  
May 14, 2012*

## GOALS

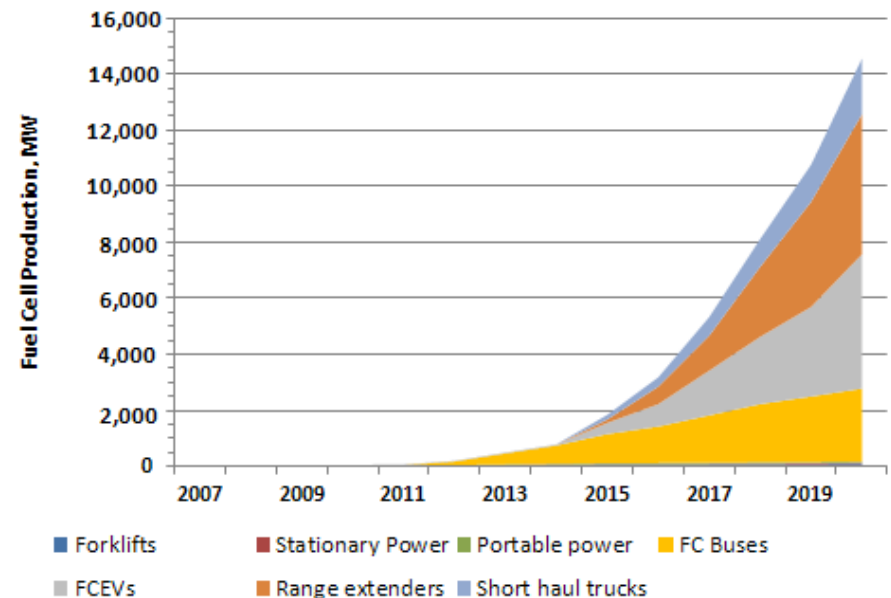
- Ensure continued technology utilization growth for domestically produced hydrogen and fuel cell systems
- Lower life cycle costs of fuel cell power by identifying and reducing non-technical barriers

## OBJECTIVES

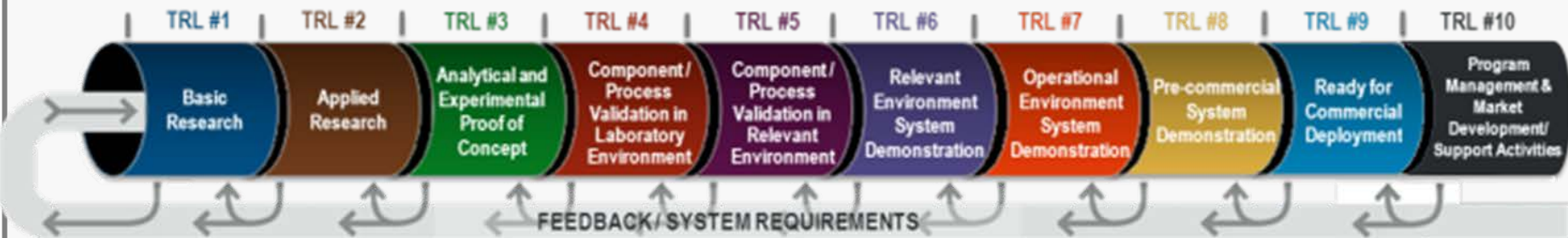
- Catalyze key implementation projects and partnerships with state and local governments and other stakeholders
- Increase domestic market penetration by standardizing and stimulating institutional and financial market practices
- Increase data analysis associated with siting and deployment (e.g., insurance, permitting, and installation)

Data stems from research conducted by the California Fuel Cell Partnership and Pike Research

### Market Transformation Deployment Planning



- 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

## Examples:



***A 1-kW fuel cell system providing power for this FAA radio tower near Chicago***

(Photo courtesy of ReliOn)



***Material Handling Equipment at work in U.S. airports***

(Photo courtesy of Hydrogenics)

- 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 obtain data from operating experience and develop replicable business cases

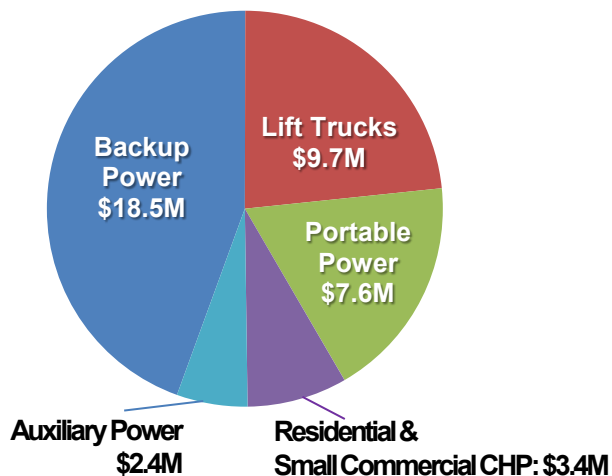
# ARRA Fuel Cell Funding & Status

DOE announced more than \$41 million from the 2009 American Recovery and Reinvestment Act to fund 12 projects. Over 1,000 fuel cells have been deployed—helping to achieve near-term impact and create jobs in fuel cell manufacturing, installation, maintenance & support services sectors.

## FROM the LABORATORY to DEPLOYMENT:

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

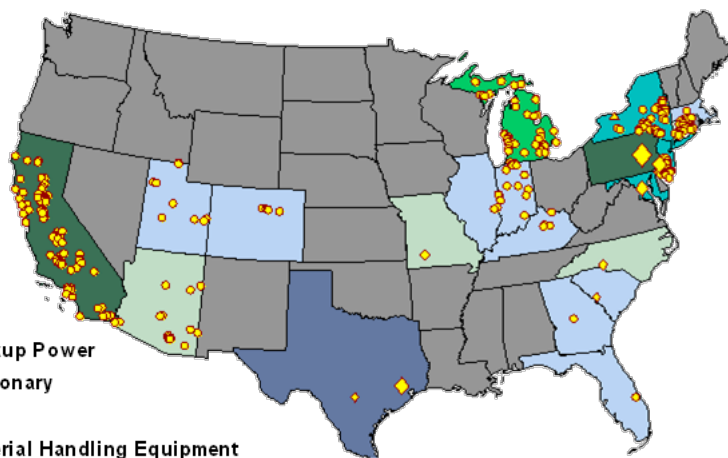
Approximately \$54 million in cost-share funding from industry participants for a total of about \$96 million



Company	Award	Application
Plug Power (6A)	\$2.7 M	Backup Power
ReliOn, Inc. <sup>1</sup>	\$8.5 M	Backup Power
Sprint Nextel	\$7.3 M	Backup Power
FedEx Freight East <sup>2</sup>	\$1.3 M	Lift Truck
GENCO <sup>2</sup>	\$6.1 M	Lift Truck
Nuvera Fuel Cells <sup>1</sup>	\$1.1 M	Lift Truck
Sysco Houston <sup>2</sup>	\$1.2 M	Lift Truck
Jadoo Power	\$2.2 M	Portable
MTI Micro Fuel Cells <sup>1</sup>	\$3.0 M	Portable
Univ. of North Florida <sup>1</sup>	\$2.4 M	Portable
Plug Power (7A)	\$3.4 M	CHP
Delphi Automotive	\$2.4 M	Auxiliary Power

<sup>1</sup> Project completed

<sup>2</sup> Fully deployed



Fuel Cell Deployment Status – April 2012		
Application	Currently Operational	Operational as of April 2011
APU	1	0
Backup Power	668	267
Material Handling	504	369
<b>Total</b>	<b>1,173</b>	<b>637</b>

*NREL estimates over 1 million operating hours and 150,000 H<sub>2</sub> fills for material handling equipment was reached in the first quarter of 2012.*



## NREL ARRA Data Collection Snapshot

ARRA Material Handling Equipment Data	As of 12/31/2011	As of 12/31/2010
Hydrogen Dispensed	99,650 kg	18,597 kg
Hydrogen Fills	>148,250	38,863
Hours Accumulated	>959,880 hrs	307,433 hrs

### Examples of Leveraged & Future Deployments:

- Sysco (Corporation) plans to convert an additional 900+ battery powered lift trucks to fuel cell power over the next 24 months at seven sites nationwide
- By June 2012, Sysco will complete fuel cell fleet conversions at four of the seven sites
- FedEx Freight East purchased an additional 5 fuel cell powered lift trucks to bring their fleet to a total of 40 lift trucks
- Other examples being compiled

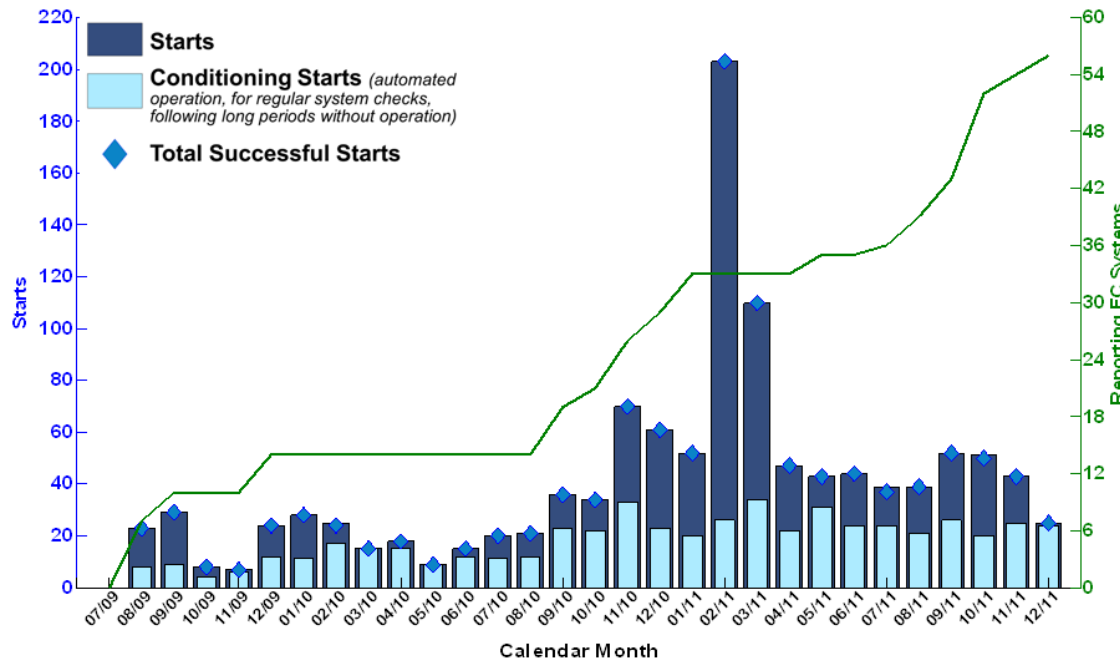
# Summary of Backup Power System Operation



<b>Deployed Systems</b>	<b>625*</b>
Total Successful Starts	1187 (99.7%)*
Total Run Time	611 hours*
Total Hydrogen	70.7 kg*

\* through December 2011

## Starts by Month

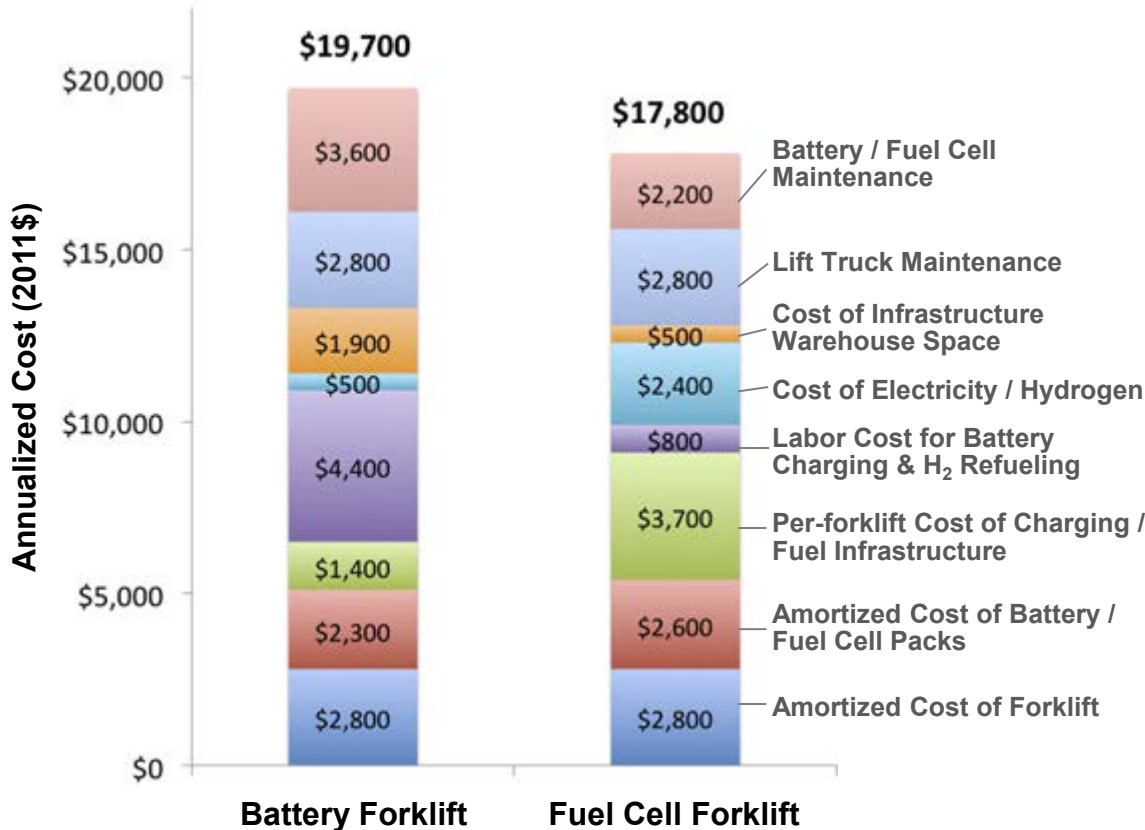


Systems are operating reliably in 15 states with 99.7% successful starts. (Reasons for unsuccessful starts include an e-stop signal and system failures.)

Source: Jennifer Kurtz, Project ID H2RA-013, presented at 1:45 on Wednesday in Crystal City Marriott, Salon F

Annualized *total cost of ownership per unit* indicates that key cost advantages are dependent on deployment size.

## Class I & II Forklifts—Annualized Costs



- Analysis inputs are averages per category

- Key inputs include:

- 333 days per year, 2.5 shifts per day (2,100 hours per year)
- 3 min per hydrogen fill & 10 min per battery change out

### Class III Forklift Annualized Cost

- \$11,700 FC
- \$12,400 Battery

### Other results include

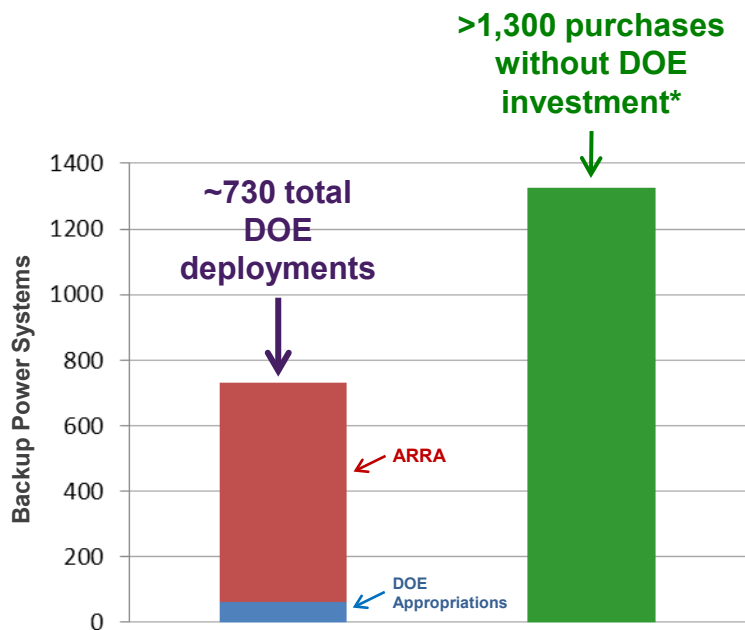
- Sensitivity analysis of costs (CDP #59)
- Cost analysis based on intensive deployment scenario—100 lift trucks and 3,000 pedal hours per year (CDP #60)

Results assume replacements as needed and do not reflect technology generation improvements or other productivity improvements such as constant power, emissions, and cold environment. FC costs include current tax credit of \$3,000/kW or 30% of purchase price. Data source: ARRA & DLA project partner questionnaire & fuel cell performance d:



Early market deployments of approximately 1,400 fuel cells have led to more than 5,000 additional purchases by industry—*with no further DOE funding.*

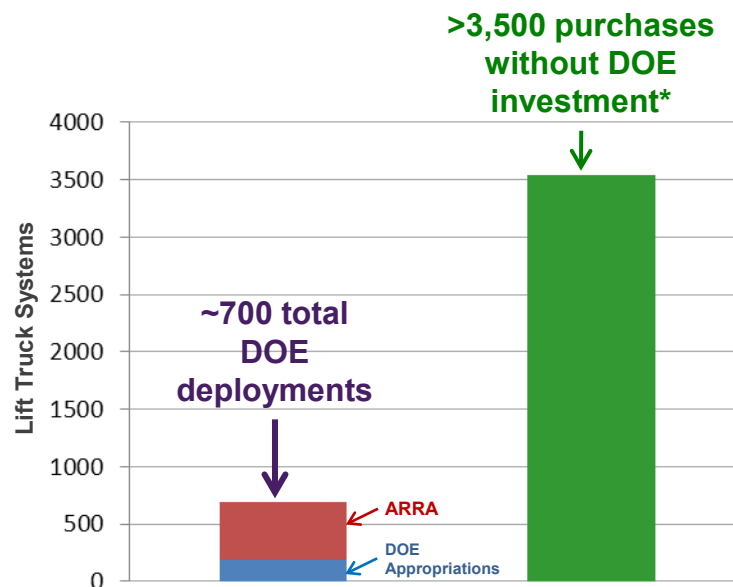
## Backup Power Units



**Leveraging DOE funds:**

***DOE deployments led to almost 2X additional purchases by industry.***

## Lift Truck Deployments



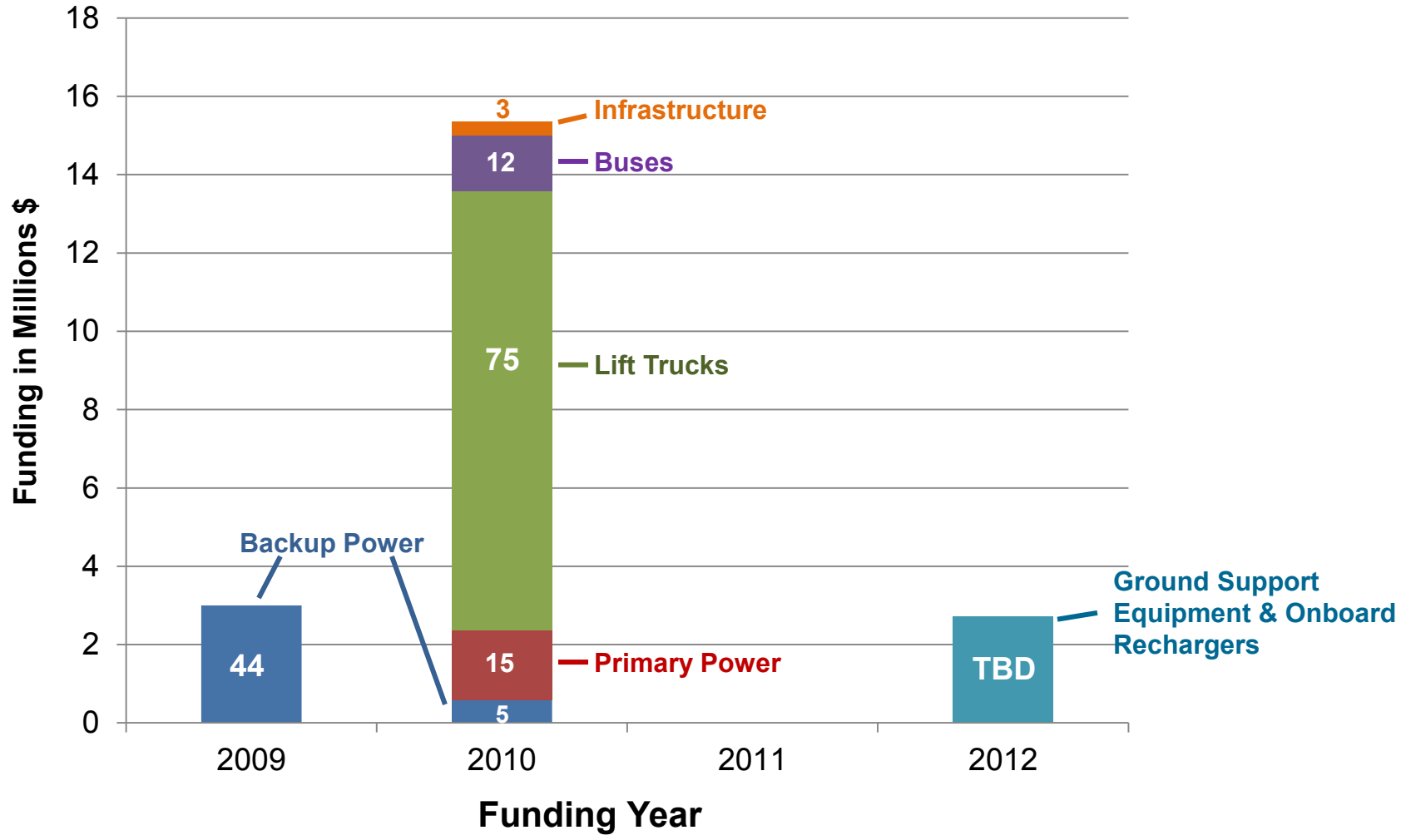
**Leveraging DOE funds:**

***DOE deployments led to >5X additional purchases by industry.***

\*industry purchases include units on order

## Market Transformation Funding and Demonstrations

*(numbers denote fuel cell units deployed)*



- **Deployed and collected data on 75 DMFC-powered lift truck operations in 4 locations** (see Lift Truck fact sheet)
- **With US Army CERL, installed 102 kW (out of 217 kW total) back up power systems at DOD, NASA and NPS sites** (see Backup Power fact sheet)
- **Installed and collected data on 15 Micro-CHP systems for light commercial facilities (PNNL)**
- **Determined technical and cost feasibility of using Landfill Gas (LFG) as feed stock for HFC lift trucks**



*Oorja Protonics Lift Truck*

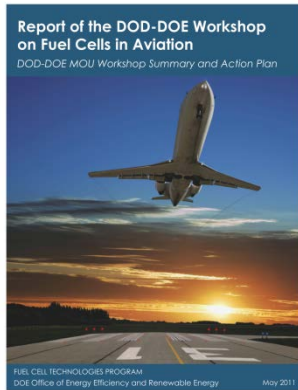


*ClearEdge MicroCHP*



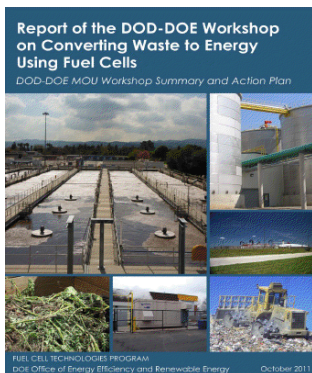
*BMW manufacturing plant in S. Carolina*

**Conducted with DOD workshops and detailed analyses on using fuel cells as auxiliary power for aviation or ship operations and converting bio-waste to hydrogen**



## **Aviation Workshop Proposed Next Steps:**

- ✓ Multisite mobile fuel cell plasma lighting demonstration
- ✓ Fuel cell battery range extender demonstration
- ✓ Collaborative ground support equipment deployment



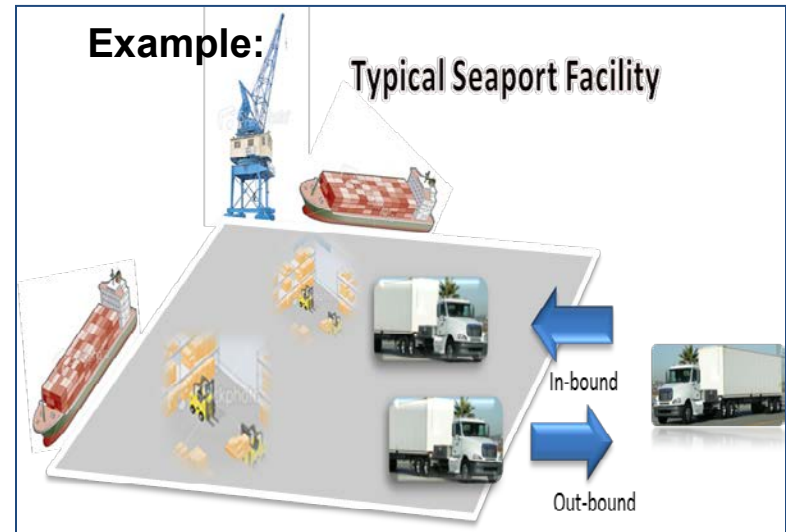
## **Bio-waste Workshop Proposed Next Steps**

- ✓ Develop project planning tool
- ✓ Develop Federal guide including external financing methods
- ✓ Identify appropriate candidate sites for WTE projects

## Electric Transportation Technologies FOA (1–2 awards\*)

- Closed May 4, 2012—selected applicants will be notified by mid-August 2012
- Collaborative effort with VTP to review and select highest-quality applications for deployment into the cargo transport sector
- Vehicle Technologies Program FY2012 Appropriations Text:

*“...up to \$10,000,000 is made available to fund section 131 of the 2007 Energy Independence and Security Act to promote zero emission cargo transport in areas of severe nonattainment and severe traffic congestion. Eligible recipients must provide 1-to-1 matching funds.”*



## Fuel Cell Hybrid Ground Support Equipment FOA (1–3 awards\*)

- Closes June 11, 2012—selections announced by mid-Sept. 2012
- Deploy fuel cell powered GSE into commercial airport operations.
- Fuel Cell Technologies Program FY2012 Appropriations Text:

*“Within the available funds, the Committee recommends funding is provided for Technology Validation focused on passenger vehicle and hydrogen infrastructure applications, hydrogen fuels R&D, and for Market Transformation in early markets.”*



Ground support equipment at Hawaii Center for Advanced Transportation Technologies

## *Enabling distributed generation power and heat purchases by the kWhr*

- Federal Power Purchase Agreements (PPAs) exist for Solar PV, Wind, Biomass, and Geothermal
- Third-party financing of fuel cell power eliminates up-front CAPEX outlays and enables investors to take advantage of the Investment Tax Credit.
- Cost economies of scale can be realized by bundling power needs on a Federal-government-wide basis



### ***Approach: Develop and implement a Fuel Cell Power Federal wide Indefinite Quantity, Indefinite Delivery (IDIQ)***

- Partners: Army Corps, DOE FEMP, DOE Golden
- PPAs for bundles of government sites
- Potential Pilot Project: Ord Military and Presidio base Monterey (CA)

### **Next Steps:**

- Finalize and review draft document via the Fuel Cell and Hydrogen Interagency Working Group
- Develop work scope for first phase of Pilot Project
- Review draft IDIQ with potential hosting contracting offices
- Select contracting offices and post IDIQ solicitation

*Fuel Purchasing Agreements (FPAs) are currently used in Federal Agencies for petroleum and alternative fuels.*

## Hydrogen refueling systems are expensive

- Starting a Hydrogen FPA solicitation process would eliminate most up-front CAPEX outlays and enable more hydrogen to be available in the Federal government
- Leveraging buying power of Federal government to compete for best per kilogram price will enable more use of fuel cells

**Partners:** Army Corps and Defense Logistics Agency (DLA) Energy Office; the Hydrogen and Fuel Cells Interagency Working Group (IWG) will help generate requirements

## Next Steps:

- **IWG Review and Revise Draft FPA**
- **Announce via DLA Energy FPA solicitation**



- Complete DMFC MHE data collection and analysis
- Complete installations and collect data on 15 micro CHPs
- Begin operations of Renewable H<sub>2</sub> Plant (Puna, Hawaii)
- Award (VTO) Electric Transportation Technology Projects
- Initiate 2 ad hoc IWG committees (Advanced Vehicles and Waste-to-Energy)
- Award Ground Support Equipment Projects
- Complete Landfill Gas SCRA project startup and two-month deployment
- Launch Federal government-wide IDIQ PPA FPA procurement process and identify 4 MW of projects
- Develop revolving loan program for mobile lighting
- Complete model and simulation of BEV range extenders





## Key milestones & future plans

FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016 - 2020
<p>Complete multi-site backup power award with DOD, NASA, and NPS</p>	<p>Complete Government Facilities Procurement Guide</p> <p>Complete 3 DOD-DOE Workshops</p> <p>Complete MYRD&amp;D Plan</p>	<p>Begin operations of Renewable H<sub>2</sub> Plant (Hawaii)</p> <p>Award with VTP ETT Projects*</p> <p>Award GSE Projects*</p>	<p>Complete MicroCHP Business Case Analysis</p> <p>Operate Interagency Renewable H<sub>2</sub> Grid Management Project</p> <p>Data Collection &amp; Assessment of DMFC Powered Lift Trucks</p> <p>Publish MHE and Backup Power Business Cases</p>	<p>GSE Deployment and Business Case Analysis</p> <p>REx Electric Trucks for Short Haul – Business Case Analysis</p> <p>MHE Refueling Case Study</p>	<p>Deploy Test and Business Case for BEVx</p> <p>Financing Methods Test for Mobile Power / Lighting</p>	<p>Deployment and Finance Test for 1<sup>st</sup> Gen FCEVs</p> <p>Deployment Test for HDV APUs</p> <p>Deployment Test for Renewable H<sub>2</sub> Refueling</p>

*\*Subject to appropriations*

## *Market Transformation Team*

### **DOE**

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**Market Transformation presentations in salon F – Crystal City Marriott Hotel  
Wednesday, May 16th at 8:15 AM – 11:00 AM**

# Save the Date!

**2013 Annual Merit Review  
and Peer Evaluation Meeting**  
of the DOE *Hydrogen and Fuel Cells Program*  
and *Vehicle Technologies Program*

**May 13–17, 2013**