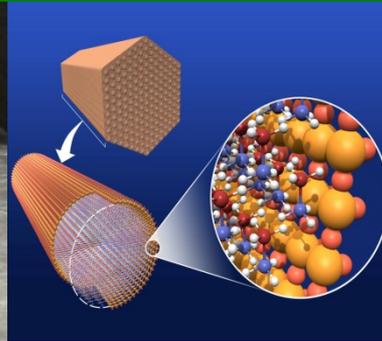




U.S. DEPARTMENT OF
ENERGY



Market Transformation

- *Session Introduction* -

Pete Devlin

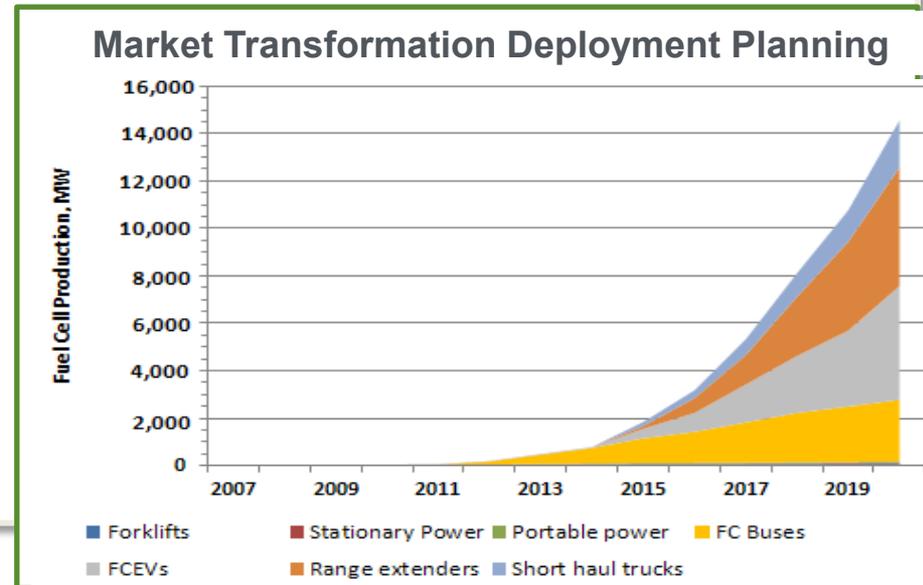
2013 Annual Merit Review and Peer Evaluation Meeting
May 15, 2013

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 deployment barriers

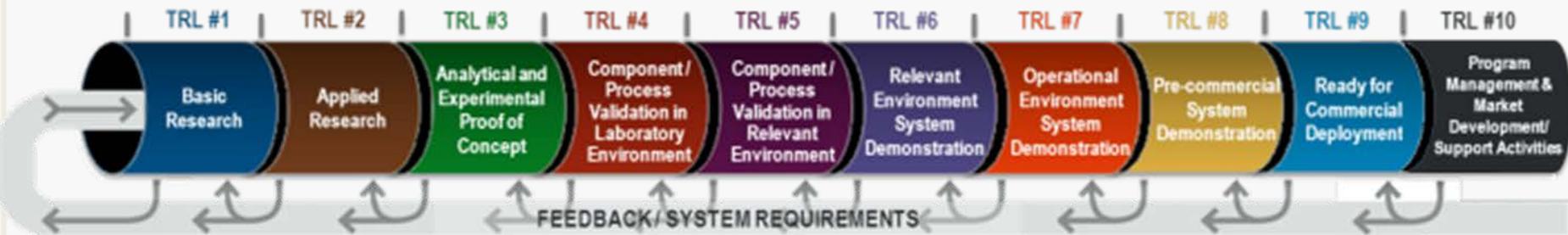
OBJECTIVES

- 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

- 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)

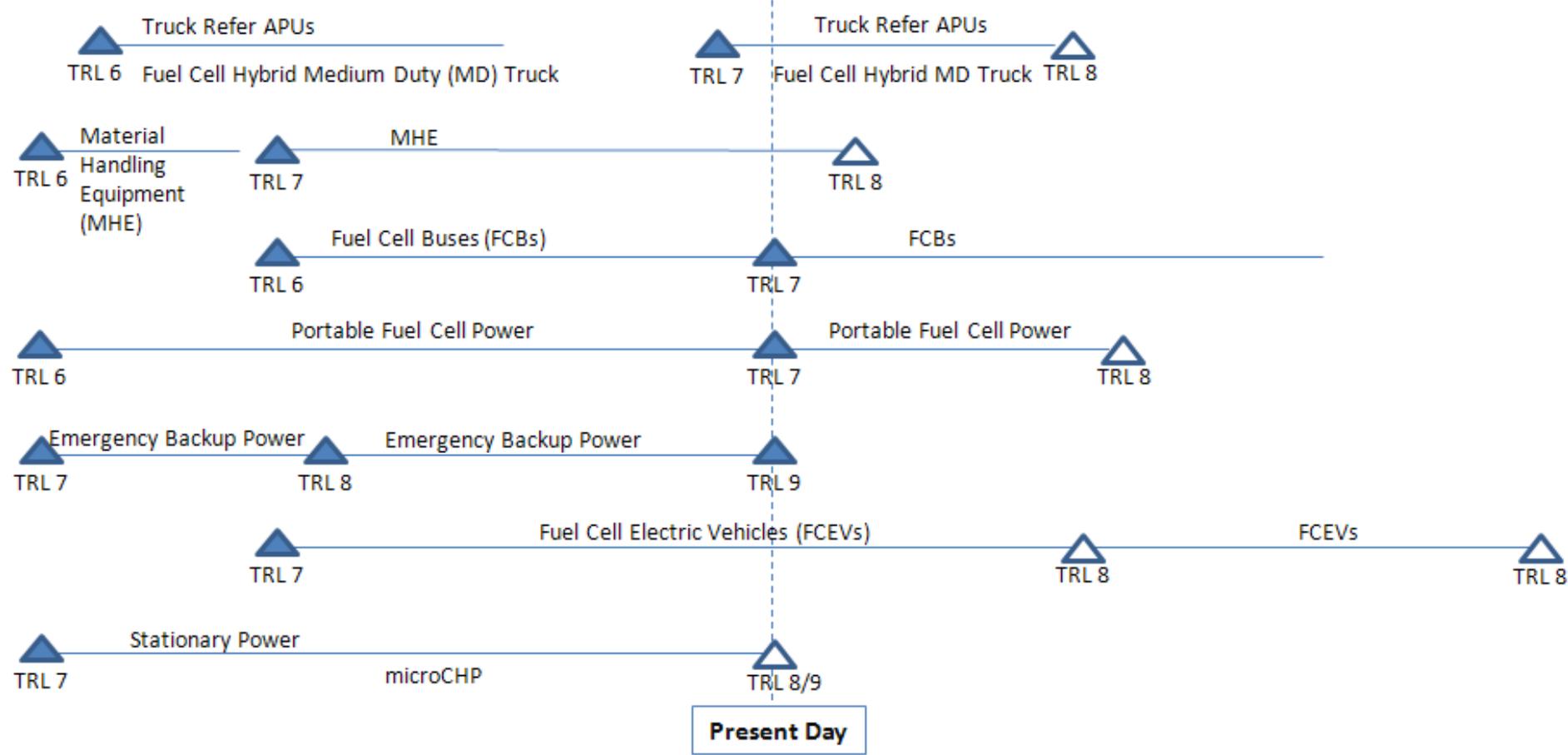


Material Handling Equipment at work in U.S. airports

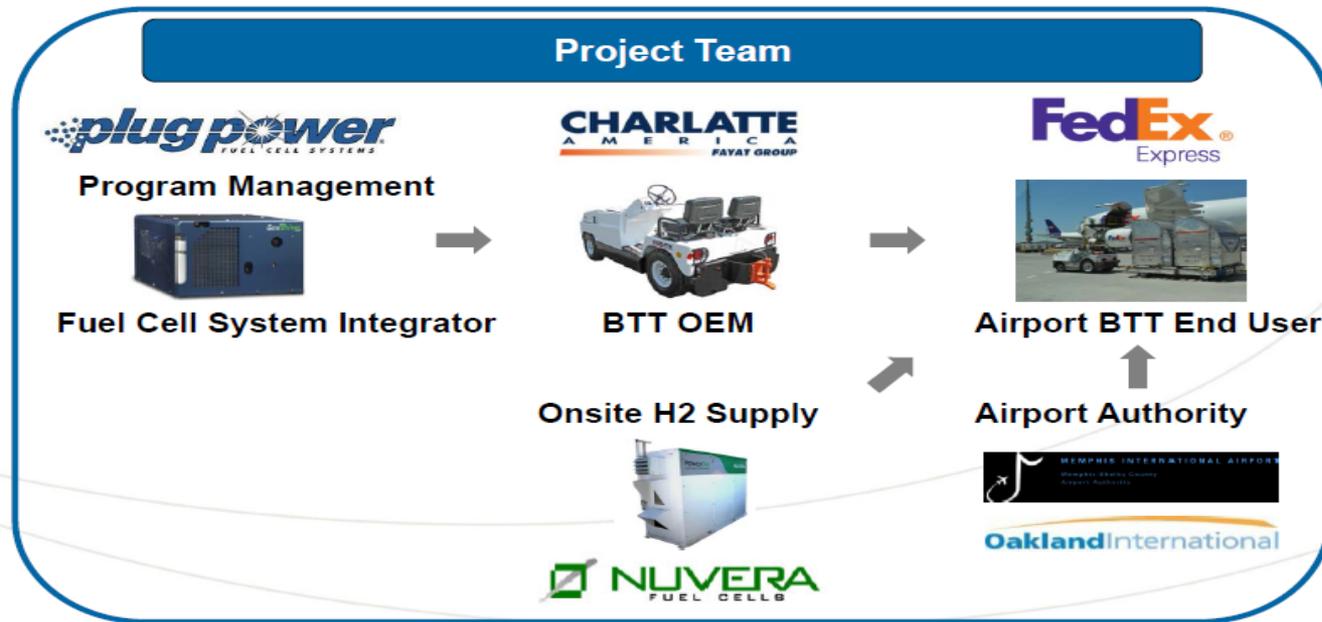
(Photo courtesy of Hydrogenics)

Commercial Industry Fuel Cell Deployments (preliminary assessment)

FY 08 FY09 FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18

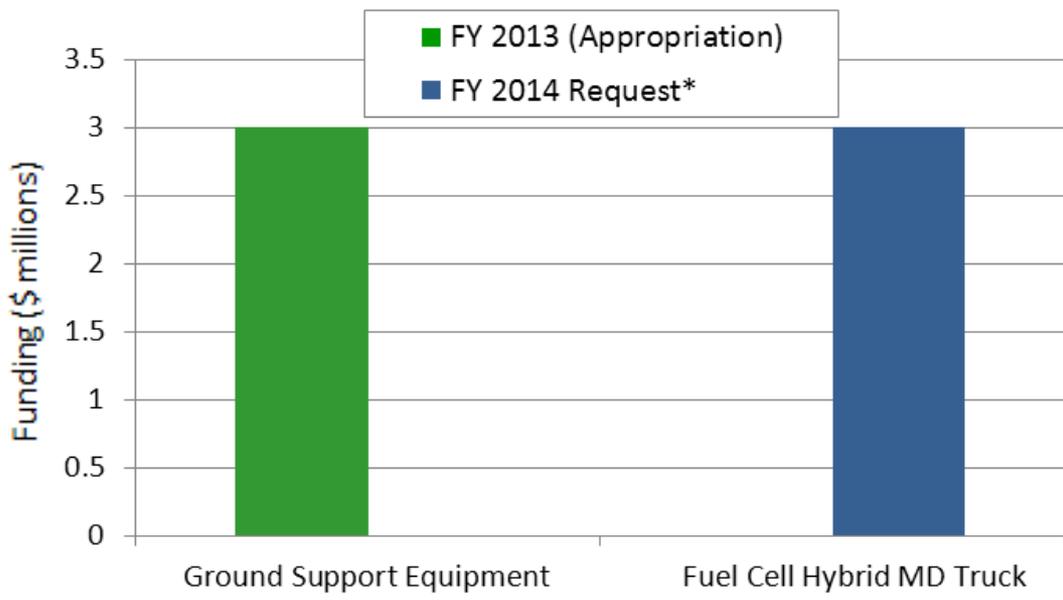


- To develop strategies to mitigate commercial risks and develop new approaches to ensure high hydrogen and system utilization and reliability under mass market penetration scenarios



- To obtain data from operating experience and develop replicable business cases

FY 2013 Appropriation = \$3M
FY 2014 Request = \$3M



* Subject to appropriations and project go/no go decisions

EMPHASIS

- New Ground Support Equipment Awards were made in January 2013
- Planning multiple FOAs over the next few FYs to enhance leveraging of deployments with DOE offices and other agencies
- Continue developing models, tools and templates for early markets

- **Collected ~172,000 hour data DMFC-powered lift truck operations in 4 locations reducing unscheduled maintenance by 36% (NREL)**
- **Developed and installed electrolyzer system for geothermal renewable hydrogen (RH2) fuel demo (HNEI)**
- **Developed and installed LFG gas clean for industry RH2 fuel cell lift truck demo (SCRA/BMW)**
- **Installed and collected data on 15 Micro-CHP systems for light commercial facilities with availability of 93.4% (PNNL)**



5 kW MicroCHP



DMFC Powered Lift Truck



- Initiated new IWG committee (Advanced Vehicles) and identified a Fed Fleet strategy
- Awarded HDV Electric Transportation Technology Projects with VTO
- Awarded Ground Support Equipment Project (Plug Power)
- Started 2 Refer APU projects (PNNL)
- Identified 4 MW of projects through a government wide procurement process
- Started Site Study with GSA and FEMP for refueling station
- Completed model and simulation analysis for on board recharging of eMDVs and eLDVs

C3-6 Delivery Truck



C8 Drayage Truck



1.86

Installed capacity
in MW

Systems are operating reliably in 19 states. Reasons for unsuccessful starts include an e-stop signal, no fuel, and other system failures.

99.6%

Successful starts

806

Systems in operation*

4-6

Average site
capacity in kW

1,796

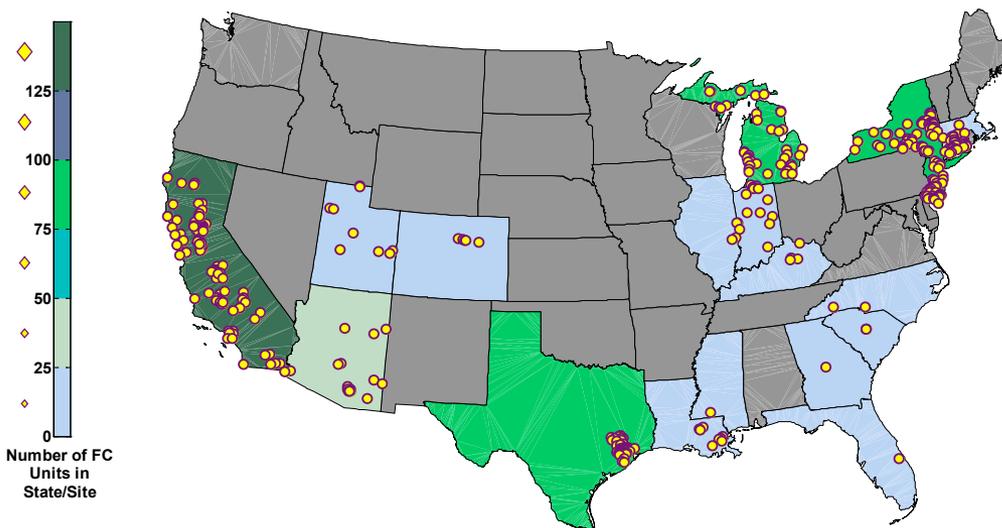
Start attempts

65

Continuous run
hours demonstrated

1,153

Operation hours



*Not all systems have detailed data reporting to NREL

Accomplishments: MHE Operation Summary 2009 Q4 – 2012 Q4



Validation of MHE is based on real-world operation data from high-use facilities.

1,445,558
Operation hours

246,997
Hydrogen fills

490

Units in operation*

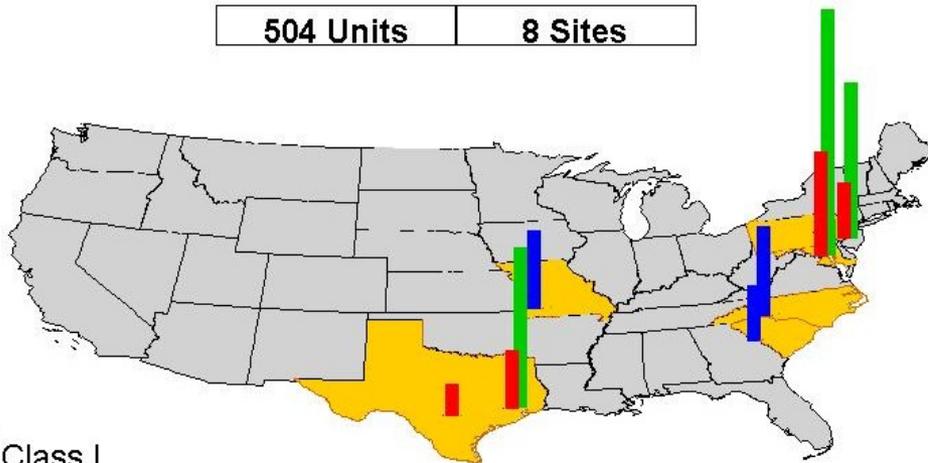
4.6

Average operation hours between fills

187,426

Hydrogen dispensed in kg

504 Units | 8 Sites



- Class I
- Class II
- Class III

Height proportional to units deployed.

0.6

Average fill amount in kg

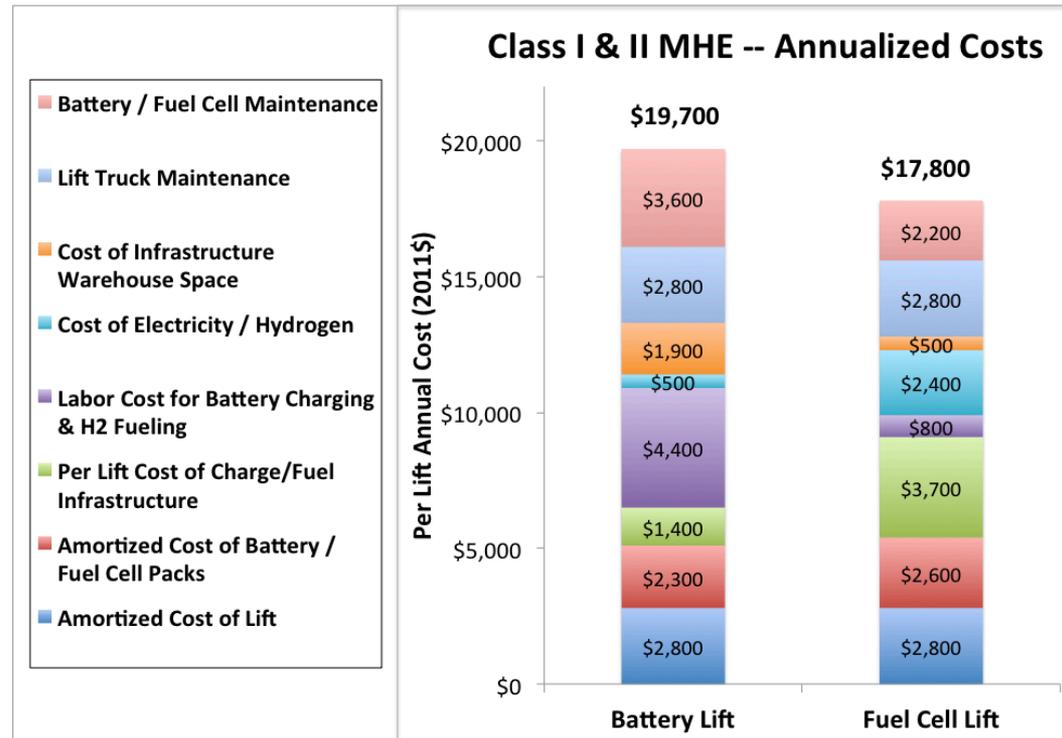
2.3

Average fill time in minutes

*One project has completed



Cost advantage per unit is ~\$2,000/year for the average high-use facility with Class I and II fuel cell lift trucks analyzed by NREL.



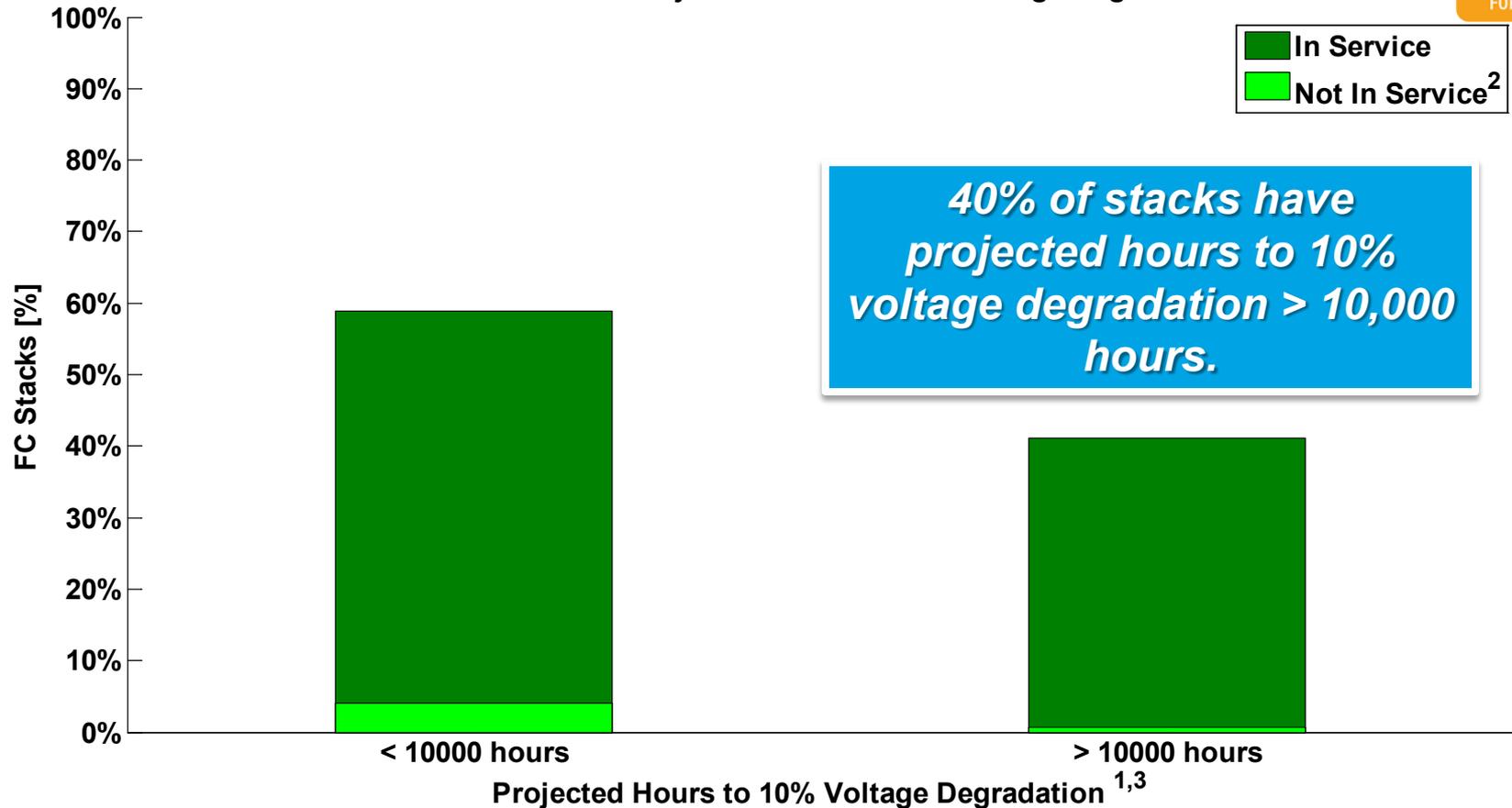
- ### Key Findings
- Cost advantages dependent on deployment size and use (i.e., multi-shift operation per day)
 - H₂ fuel cell cost advantages in maintenance, warehouse infrastructure space, and refueling labor cost
 - H₂ fuel cell cost disadvantages in infrastructure and fuel cell cost and hydrogen cost

- ### Report Sections
- Inputs, assumptions, and results for Class I/II and Class III
 - Sensitivity study
 - Intensive deployment scenario

*Publication expected 04/2013



Fuel Cell Stacks Projected Hours to 10% Voltage Degradation



1) Projection using field data, calculated at high stack current, from operation hour 0.

Projected hours may differ from an OEM's end-of-life criterion and does not address "catastrophic" failure modes.

2) Indicates stacks that are no longer accumulating hours either a) temporarily or b) have been retired for non-stack performance related issues or c) removed from DOE program.

3) Projected hours limited based on NREL demonstrated hours.



Key milestones and 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&D Plan</p>	<p>Installed and tested Renewable H₂ Plant (Hawaii)</p> <p>Awarded with VTO¹ ETT Projects</p> <p>Awarded GSE Project</p> <p>Started eHDVx Demos with VTO</p>	<p>Complete MicroCHP Business Case Analysis</p> <p>Data Collection & Assessment of DMFC Powered Lift Trucks</p> <p>Publish MHE and Backup Power Business Cases</p> <p>Award eMDVx demo project (s)</p>	<p>GSE Deployment and Business Case Analysis</p> <p>eHDVx – 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 1st Gen FCEVs</p> <p>Deployment Test for LDVs in Fed fleets</p> <p>Deployment Test for Renewable H₂ Refueling</p>

¹Vehicle Tech Office

Industry:

- Plug Power
- Gas Technology Institute
- Clear Edge
- Oorja Protonics
- BMW
- Nuvera

Laboratory:

- Pacific Northwest National Laboratory
- National Renewable Energy Laboratory
- Lawrence Livermore National Laboratory
- Sandia National Laboratory
- Argonne National Lab
- Los Alamos National Laboratory

Government:

- Office of Naval Research
- Army CERL
- SCRA
- DOT
- FAA
- NASA
- NPS
- CCAT
- GSA

University:

- Hawaii Natural Energy Institute

Market Transformation Team

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- This is a review, not a conference.
- Presentations will begin precisely at scheduled times.
- Talks will be 20 minutes and Q&A 10 minutes.
- Reviewers have priority for questions over the general audience.
- Reviewers should be seated in front of the room for convenient access by the microphone attendants during the Q&A.
- Please mute all cell phones and other portable devices.
- Photography and audio and video recording are not permitted.

- Deadline to submit your reviews is Friday, **May 24th at 5:00 pm EDT.**
- ORISE personnel are available on-site for assistance.
 - **Reviewer Lab Hours:**
 - Monday, 5:00 pm – 8:00 pm (Gateway ONLY)
 - Tuesday – Wednesday, 7:00 am – 8:00 pm (Gateway)
 - Thursday, 7:00 am – 6:00 pm (Gateway)
 - Tuesday – Thursday, 7:00 am – 6:00 pm (City)
 - **Reviewer Lab Locations:**
 - Crystal Gateway Hotel—*Rosslyn Room* (downstairs, on Lobby level)
 - Crystal City Hotel—*Roosevelt Boardroom* (next to Salon A)