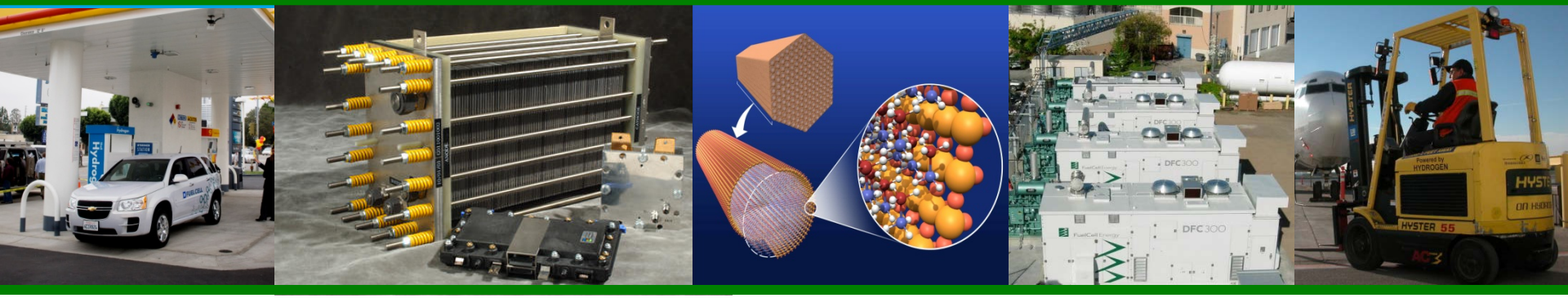
U.S. DEPARTMENT OF ENERGY



Market Transformation

Pete Devlin

2013 Annual Merit Review and Peer Evaluation Meeting

May 13, 2013

Goals and Objectives

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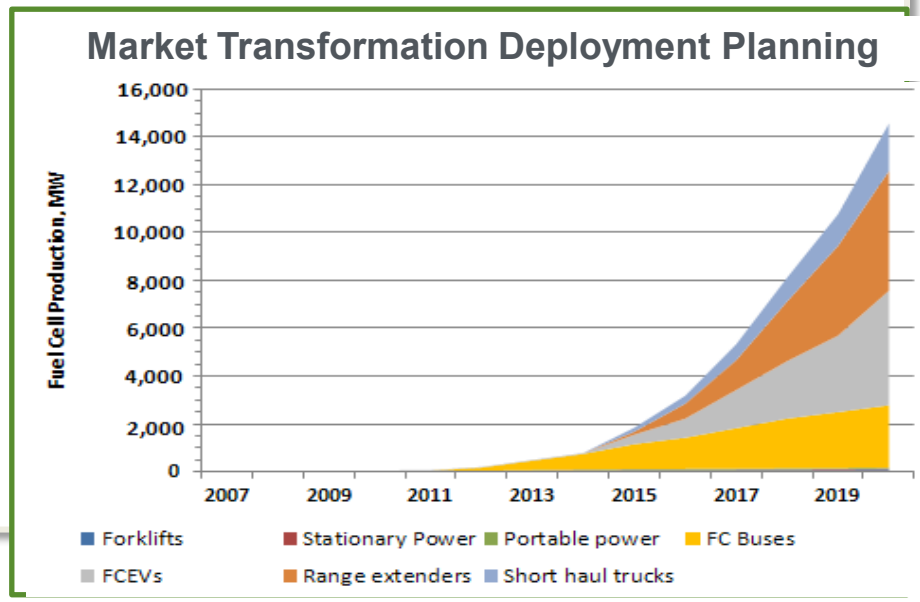
GOALS

- 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

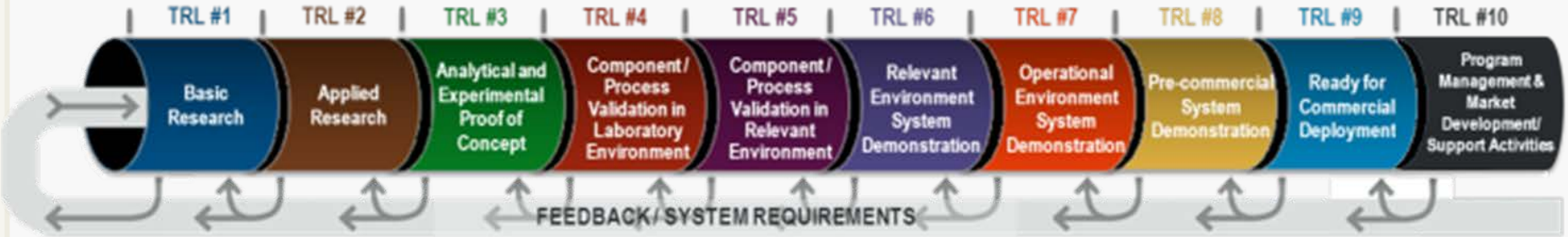
- Catalyze key implementation projects and partnerships with state and local governments and other stakeholders
- Increase domestic market penetration by standardizing and stimulating institutional and financial market practices
- Increase data analysis associated with siting and deployment (e.g., insurance,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



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

Challenges

- 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

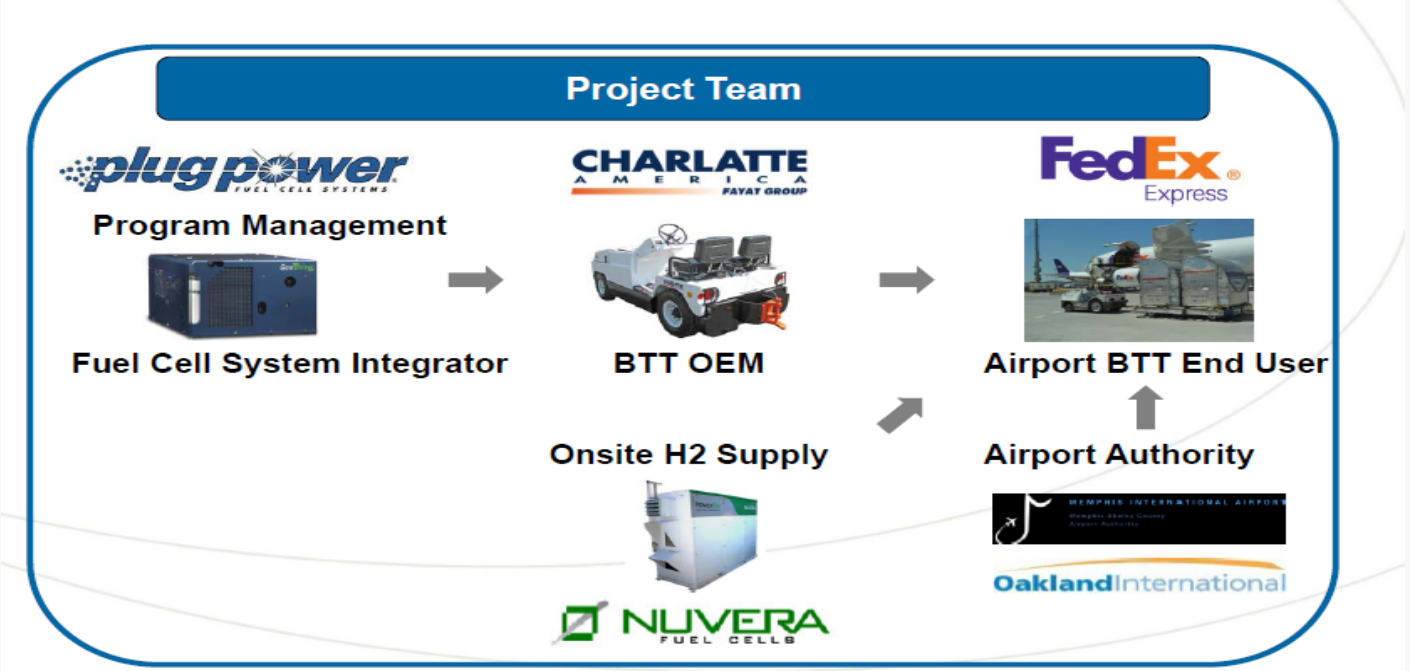
(Photo courtesy of ReliOn)

Material Handling Equipment at work in U.S. airports

(Photo courtesy of Hydrogenics)

Challenges

- 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

Market Transformation Budget

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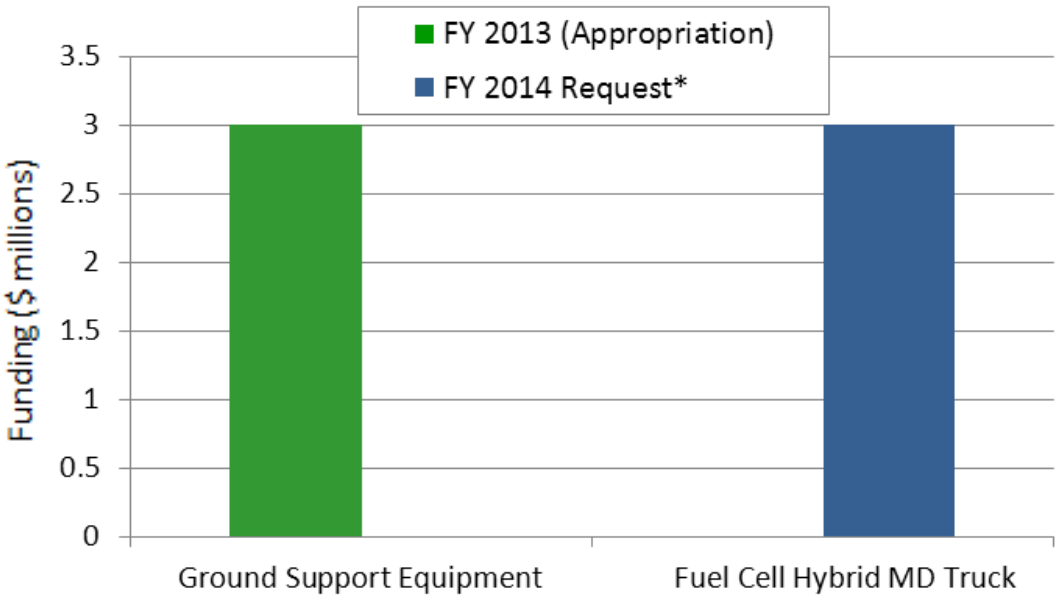
FY 2013 Appropriation = $3M

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

MicroCHP Market Potential

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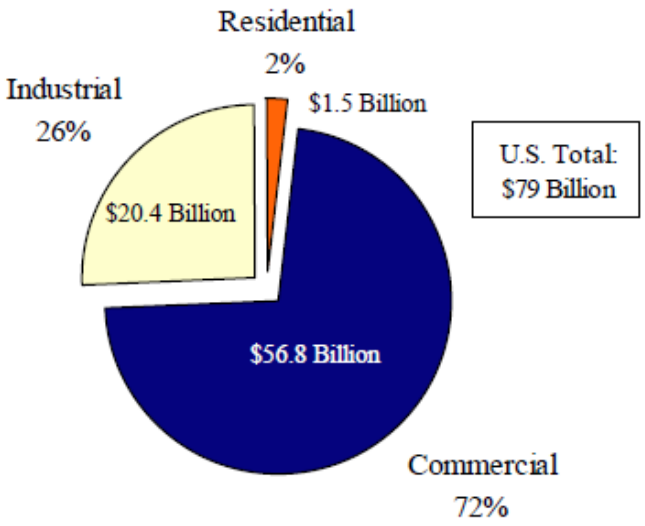
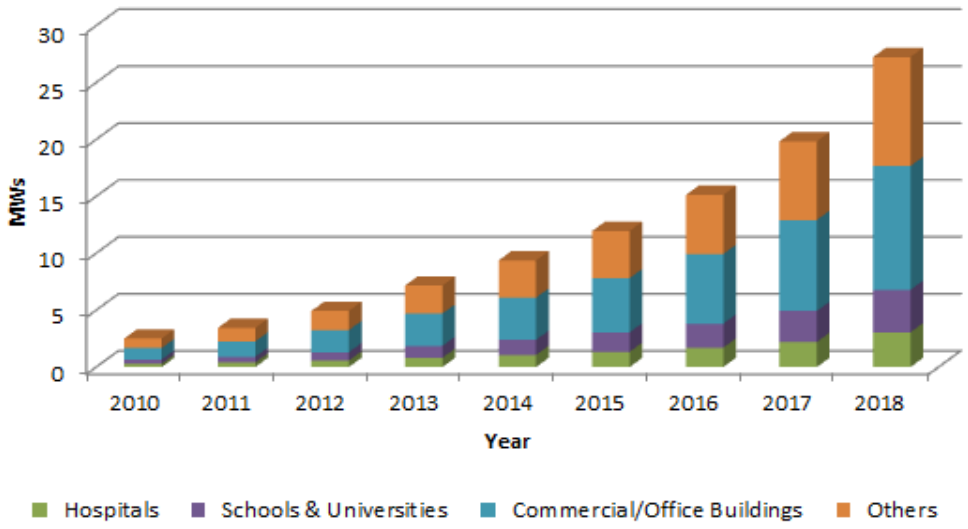
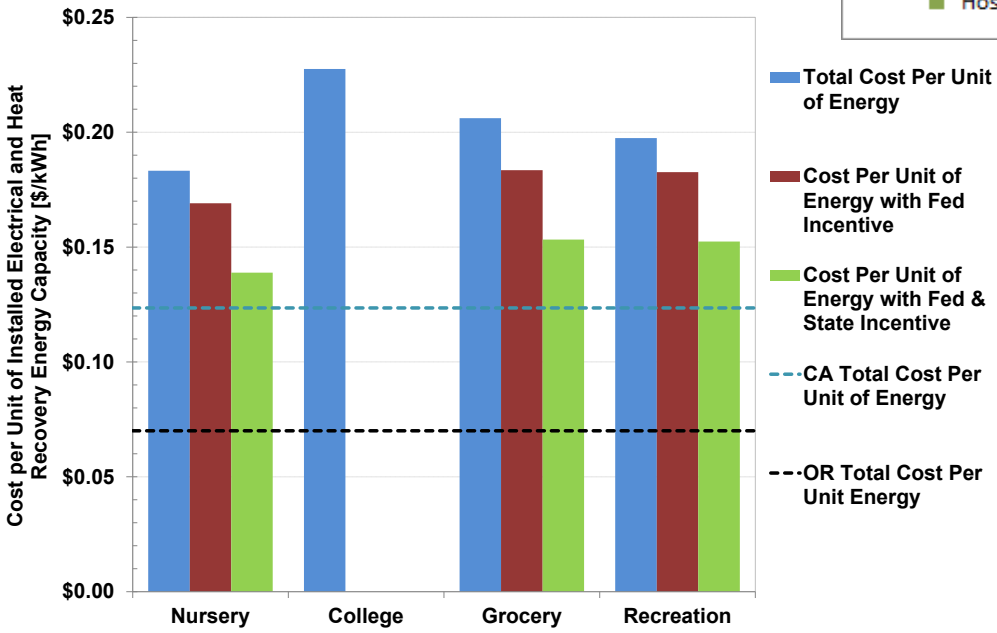
The Costs of Grid Outages



Stationary PEMFC CHP Commerical Market





Site	LCC Cost ($K)	Payback* (Yrs)	Total Savings* ($)	Payback** (Yrs)	Total Savings ** ($)
College	188	8.36	(75,731)	8.36	(75,731)
Nursery	228	6.56	(54,142)	4.97	943
Recreation	409	6.94	(122,682)	5.36	(21,061)
Grocery	427	7.02	(114,215)	5.22	(13,350)

*Without incentives

**With Incentives

Preliminary analysis by PNNL

Project Progress

- **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

Other FY12-13 Accomplishments

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- 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 Refrigerated 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

Accomplishments: Deployment Update

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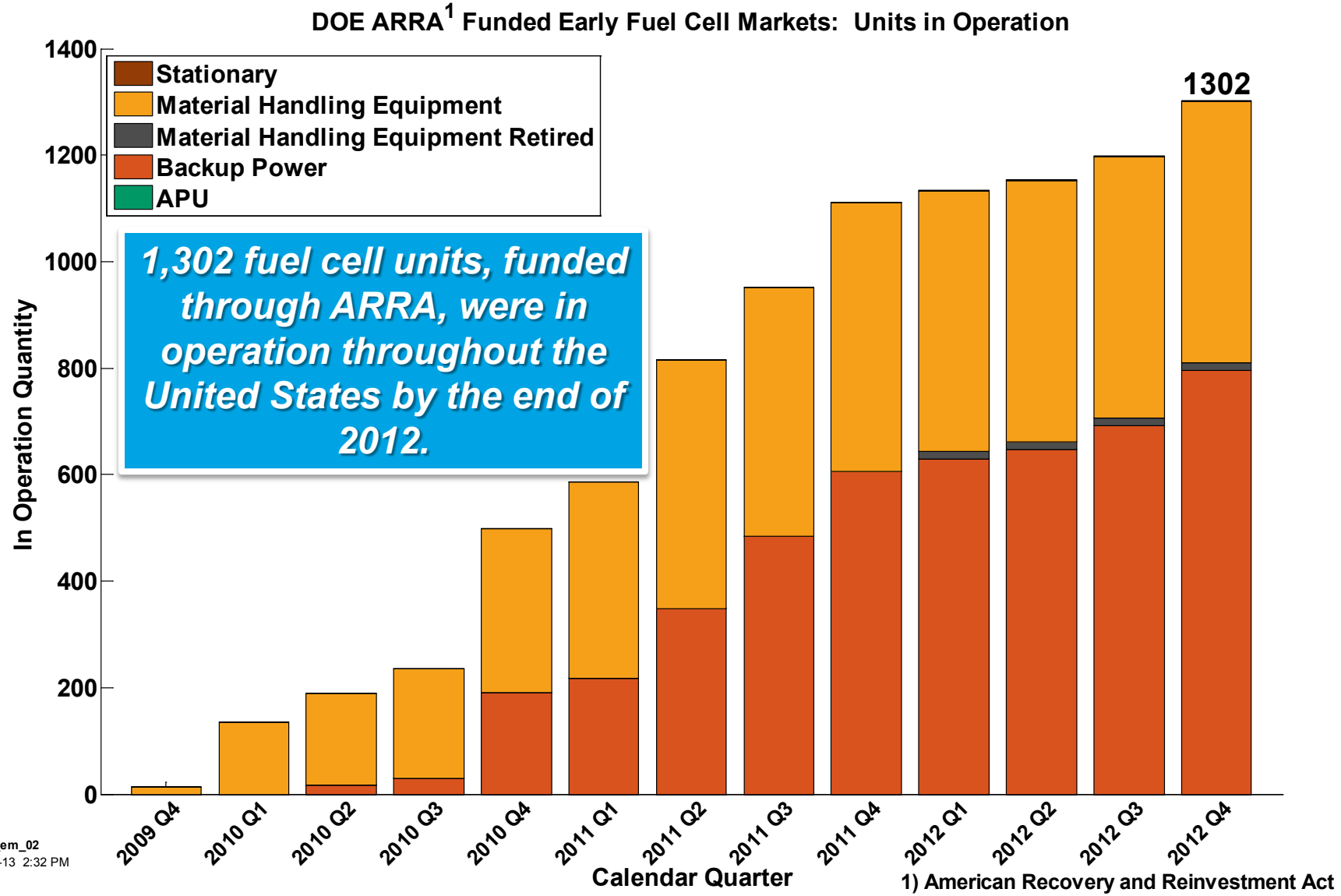

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Accomplishments: Backup Power Operation Summary 2009 Q1 – 2012 Q4

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BACKUP POWER

1.86
Installed capacity in MW

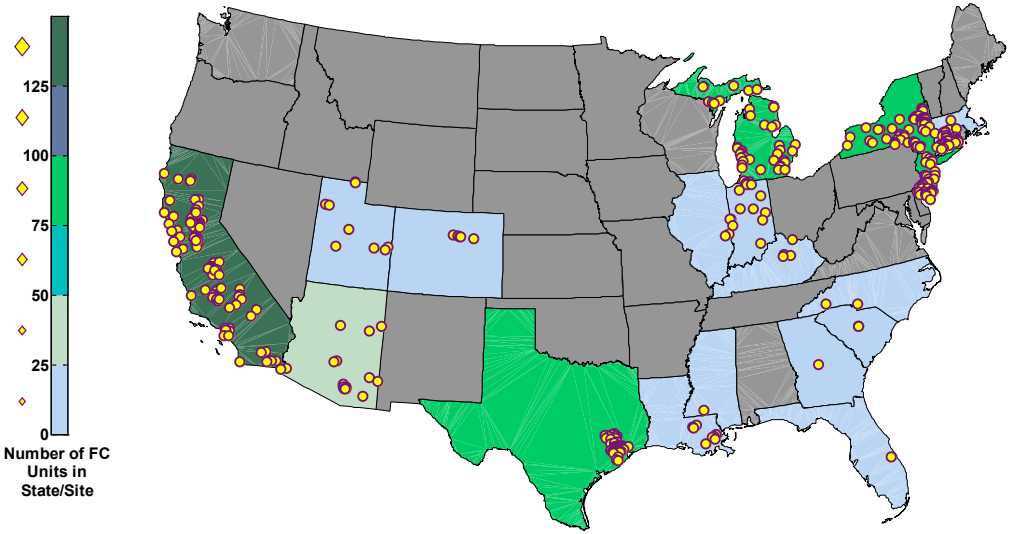
Systems are operating reliably in 19 states. Reasons for unsuccessful starts include an e-stop signal, no fuel, and other system failures.

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

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FORKLIFTS

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

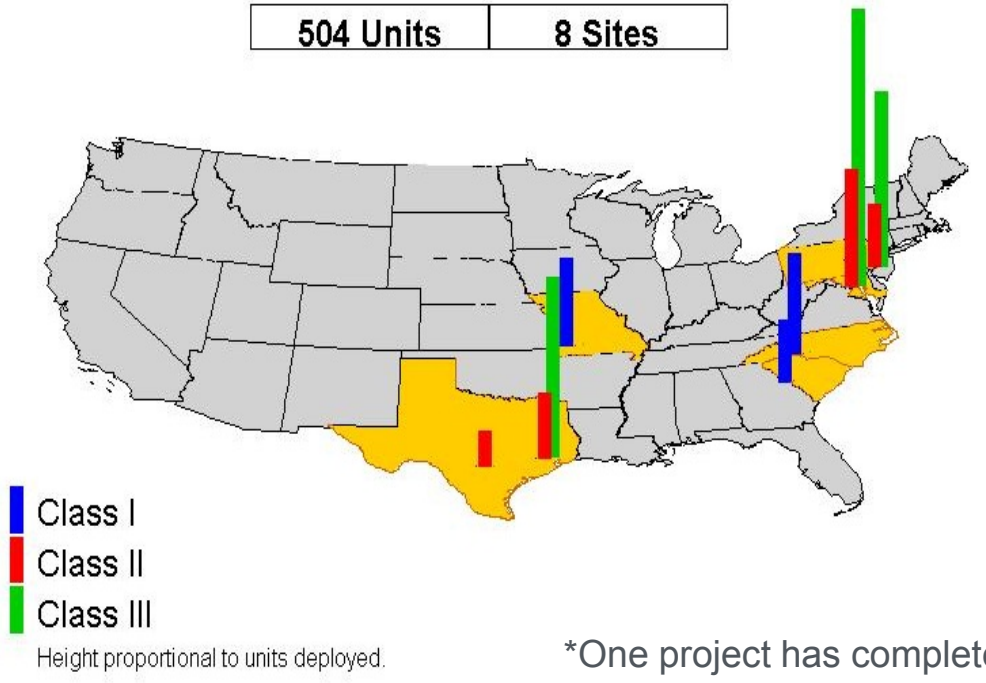
1,445,558
Operation hours

246,997
Hydrogen fills

490
Units in operation*

4.6
Average operation hours between fills

187,426
Hydrogen dispensed in kg



0.6
Average fill amount in kg

2.3
Average fill time in minutes

*One project has completed

Accomplishments: Completed MHE Cost of Ownership Report*

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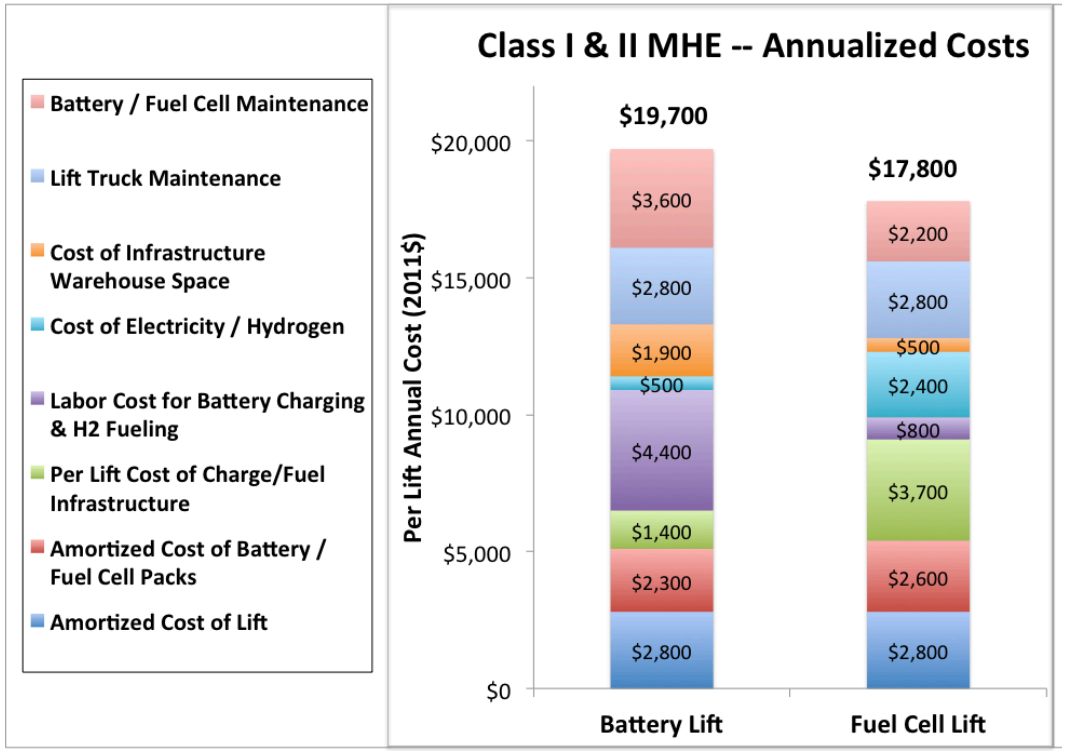
Cost advantage per unit is ~$2,000/ year for the average high-use facility with Class I and II fuel cell lift trucks analyzed by NREL.



Key Findings

- Cost advantages dependent on deployment size and use (i.e., multi-shift operation per day)
- H_2 fuel cell cost advantages in maintenance, warehouse infrastructure space, and refueling labor cost
- H_2 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

Accomplishments: Study of FC Voltage Degradation Against 10,000 Hours

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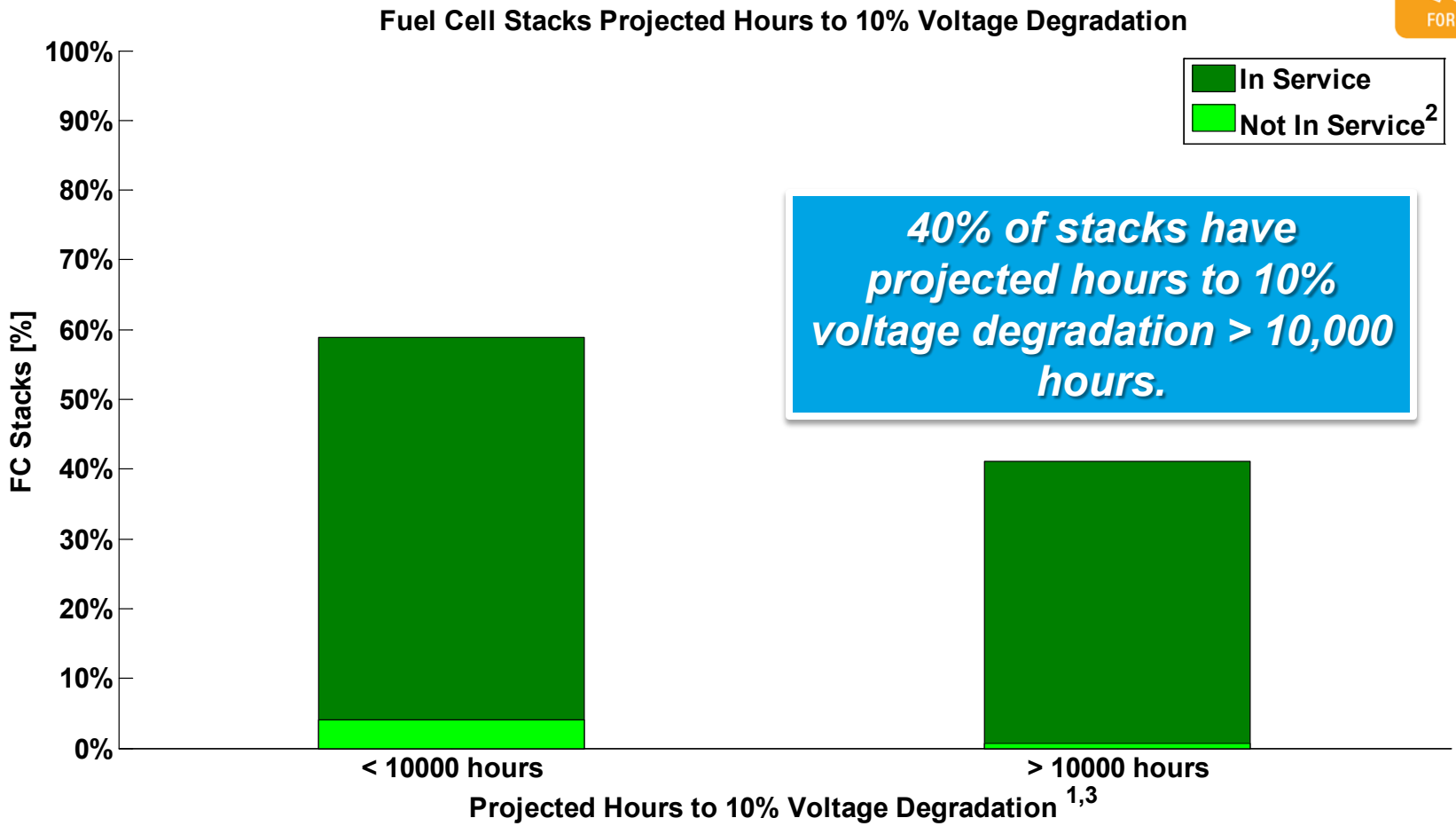

40% of stacks have projected hours to 10% voltage degradation > 10,000 hours.

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 demonstrated hours.

NREL cdp_mhe_97

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Accomplishments: Infrastructure Reliability Analysis

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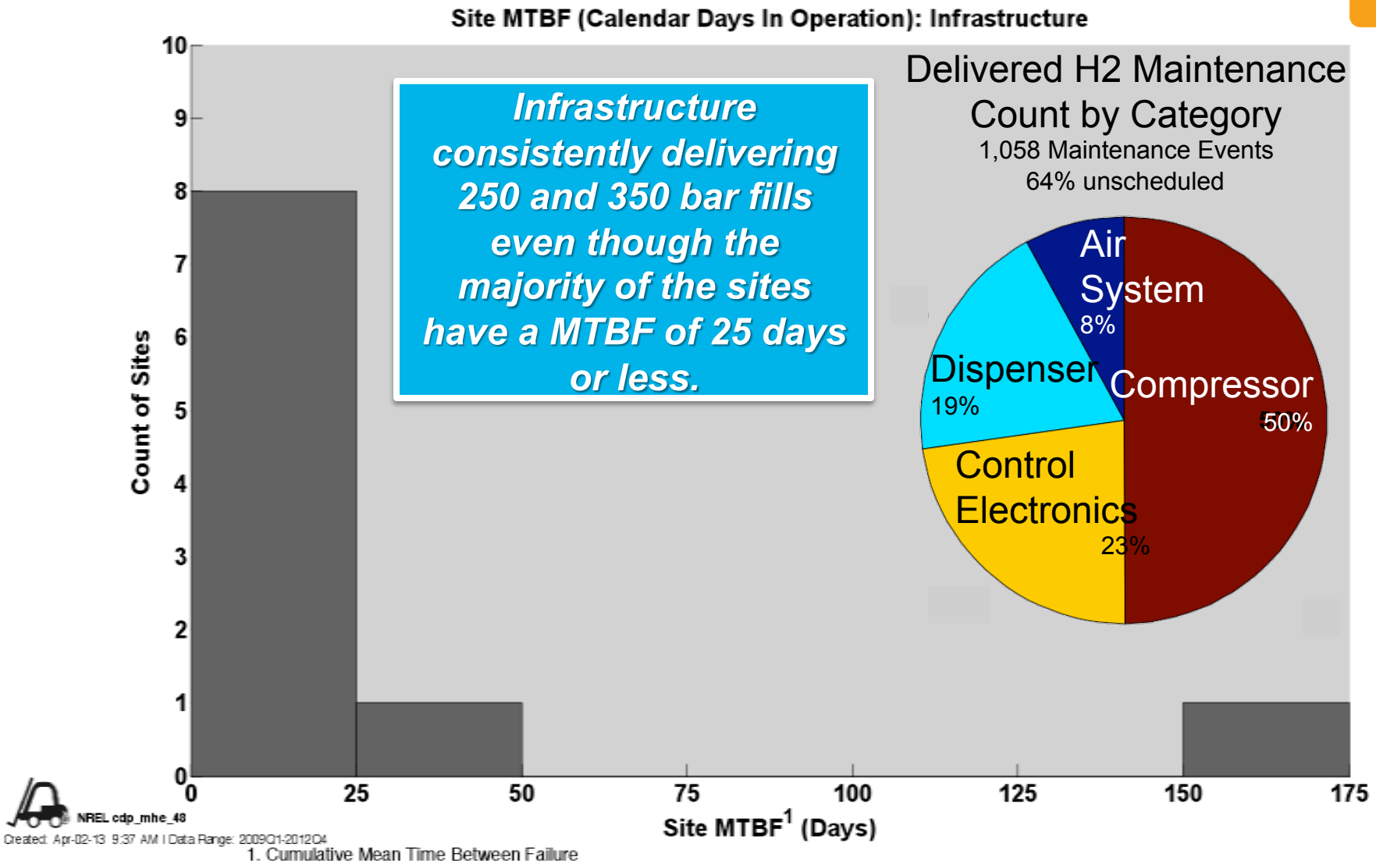

Accomplishments: Breakdown of MTBF by Key Delivered Hydrogen Infrastructure Categories

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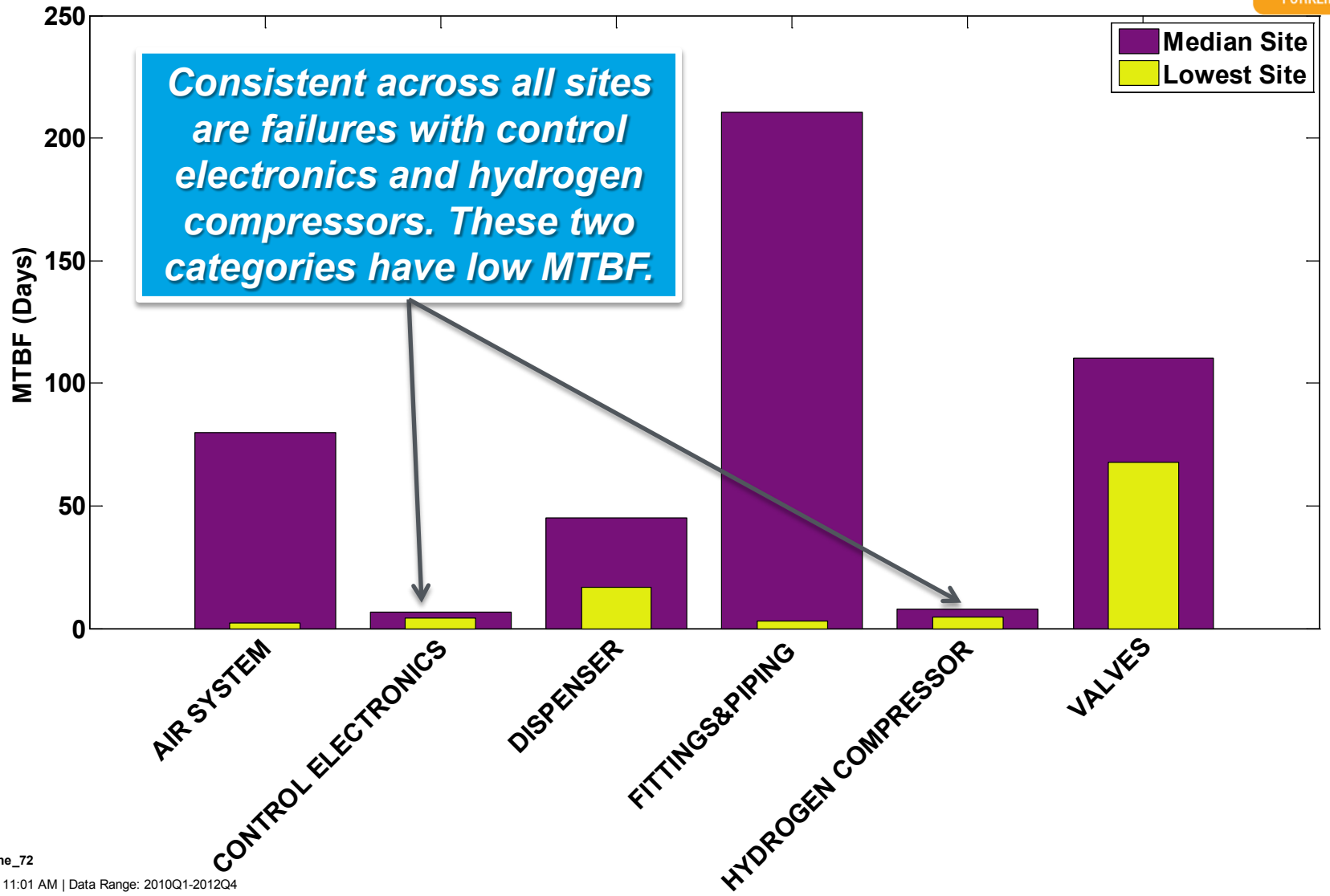
FORKLIFTS



NREL cdparra_mhe_72

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Accomplishments: MHE and Infrastructure Safety Report Analyses

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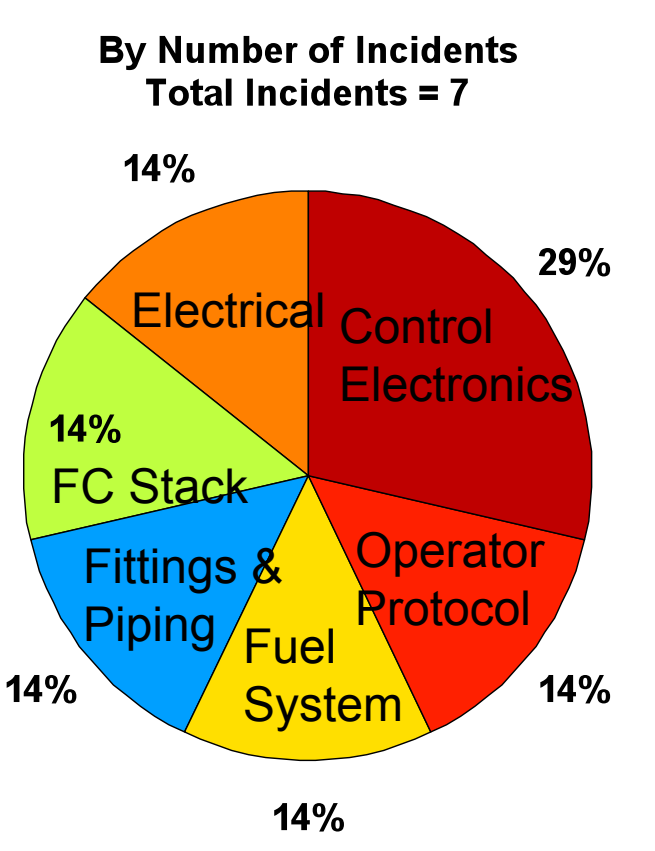
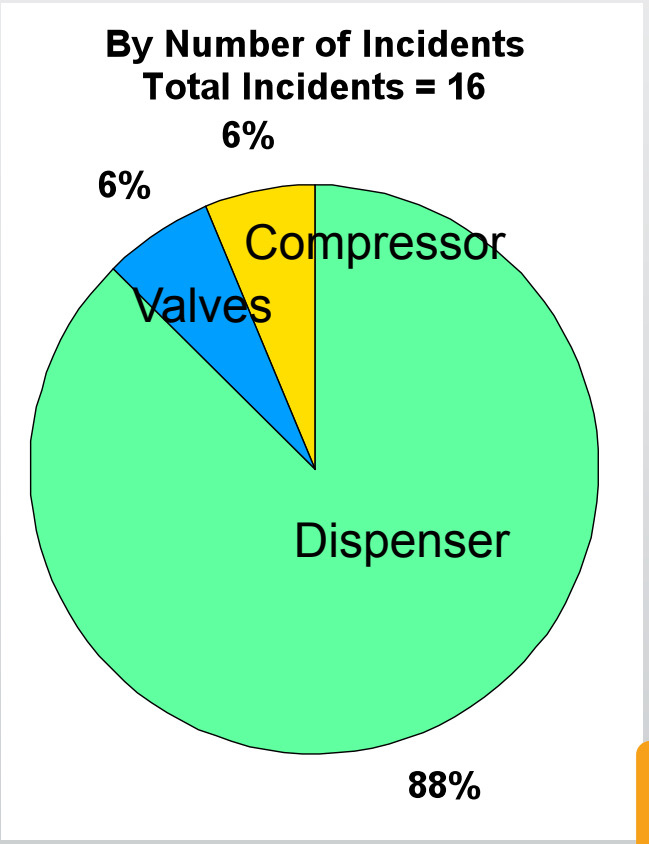
Majority of MHE safety reports (217) are minor hydrogen leaks
(4,480 stack hours per report)



Majority of infrastructure safety reports (82) are hydrogen leaks primarily from the hydrogen compressor and plumbing
(3,587 kg dispensed per report)



FORKLIFTS

Summary

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Key milestones and future plans

FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016 - 2020
Complete multi-site backup power award with DOD, NASA, and NPS	Complete Government Facilities Procurement Guide	Installed and tested Renewable H_2 Plant (Hawaii)	Complete MicroCHP Business Case Analysis	GSE Deployment and Business Case Analysis	Deploy Test and Business Case for BEVx	Deployment and Finance Test for 1st Gen FCEVs
	Complete 3 DOD-DOE Workshops	Awarded with VTO[1] ETT Projects	Data Collection & Assessment of DMFC Powered Lift Trucks	eHDVx – Business Case Analysis	Financing Methods Test for Mobile Power / Lighting	Deployment Test for LDVs in Fed fleets
	Complete MYRD&D Plan	Awarded GSE Project	Publish MHE and Backup Power Business Cases	MHE Refueling Case Study		Deployment Test for Renewable H_2 Refueling
		Started eHDVx Demos with VTO	Award eMDVx demo project (s)			

[1]Vehicle Tech Office

For More Information

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