

Data Analysis for ARRA Early Fuel Cell Market Demonstrations



**Presented at the NHA
2010 Hydrogen
Conference and Expo**

**Long Beach,
California**

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May 5th, 2010

NREL/PR-560-48204

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Project Objective

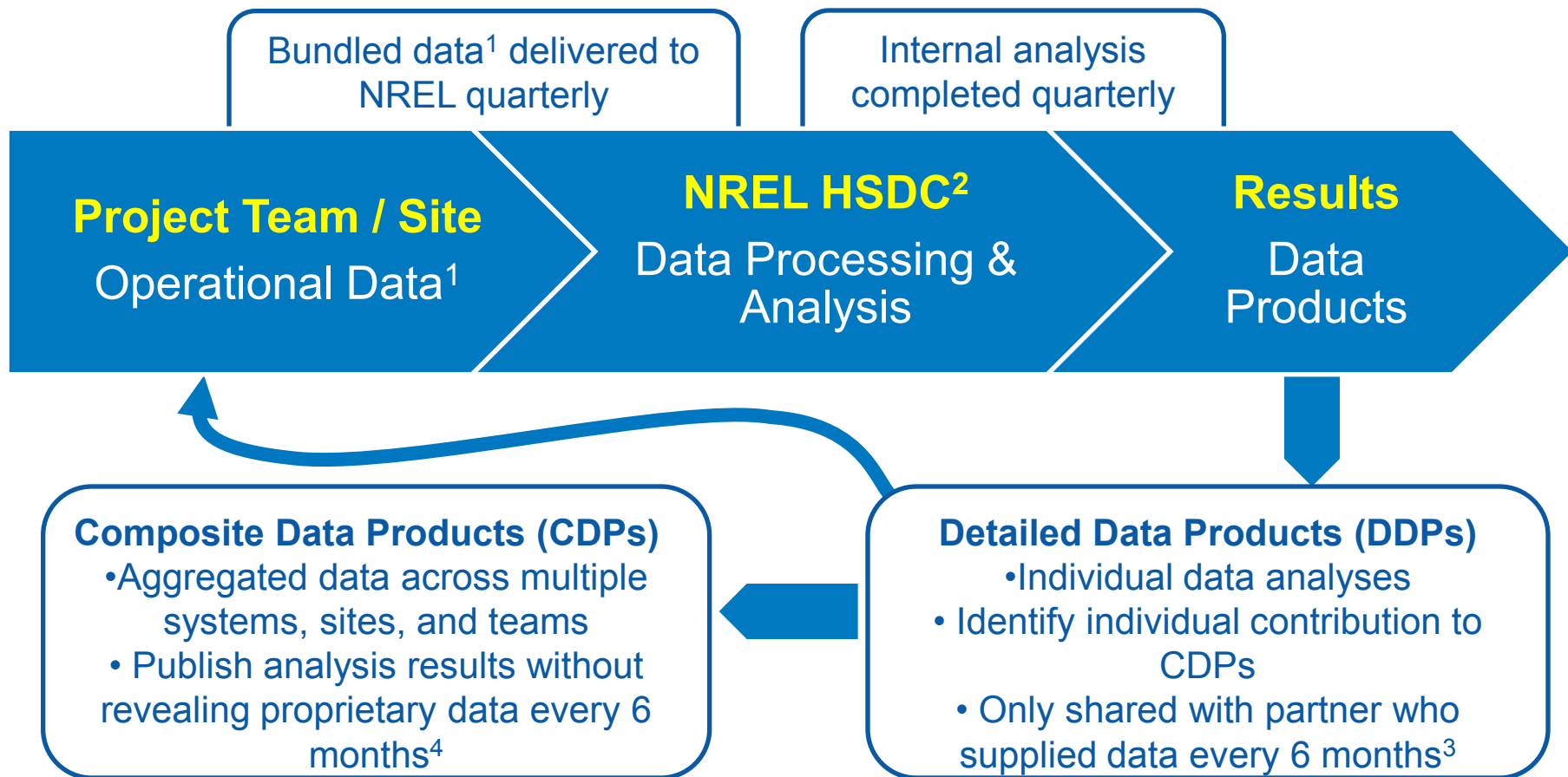
Deploy ~1,000 fuel cells to **accelerate the commercialization** and deployment of fuel cells and fuel cell manufacturing, installation, maintenance, and support services



12 awards with >\$40 million
ARRA & ~\$53 million cost share

COMPANY	AWARD	APPLICATION
Delphi Automotive	\$2.4 M	Auxiliary Power
FedEx Freight East	\$1.3 M	Specialty Vehicle
GENCO	\$6.1 M	Specialty Vehicle
Jadoo Power	\$2.2 M	Backup Power
MTI MicroFuel Cells	\$3.0 M	Portable
Nuvera Fuel Cells	\$1.1 M	Specialty Vehicle
Plug Power, Inc. (1)	\$3.4 M	CHP
Plug Power, Inc. (2)	\$2.7 M	Backup Power
Univ. of N. Florida	\$2.5 M	Portable
ReliOn Inc.	\$8.5 M	Backup Power
Sprint Comm.	\$7.3 M	Backup Power
Sysco of Houston	\$1.2 M	Specialty Vehicle

ARRA Hydrogen Fuel Cell & Infrastructure Data



Bundled data¹ delivered to NREL quarterly

Internal analysis completed quarterly

Project Team / Site

Operational Data¹

NREL HSDC²

Data Processing & Analysis

Results

Data Products

Composite Data Products (CDPs)

- Aggregated data across multiple systems, sites, and teams
- Publish analysis results without revealing proprietary data every 6 months⁴

Detailed Data Products (DDPs)

- Individual data analyses
- Identify individual contribution to CDPs
- Only shared with partner who supplied data every 6 months³

- 1) Operation, Maintenance, and Safety data templates are created for each different application/report and are common to all partners in an application.
- 2) Hydrogen Secure Data Center
- 3) Data exchange may happen more frequently based on data, analysis, & collaboration
- 4) Results published via NREL Tech Val website, conferences, and reports

NREL Data Analysis Objectives – ARRA Demonstrations

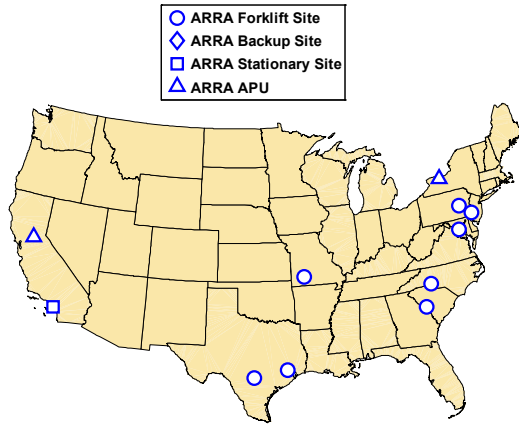
- Independent technology **assessment**; focused on fuel cell system and hydrogen infrastructure: performance, operation, and safety.
- Leverage** data processing and analysis capabilities developed from the fuel cell vehicle Learning Demonstration project and DoD Forklift Demo.
- Establish a **baseline** of real-world fuel cell operation and maintenance data and identify technical/market barriers.
- Support market growth** through analyses relevant to the **value proposition** and reporting on **technology status** to fuel cell and hydrogen communities and **stakeholders**

HSDC

NREL's Hydrogen Secure Data Center

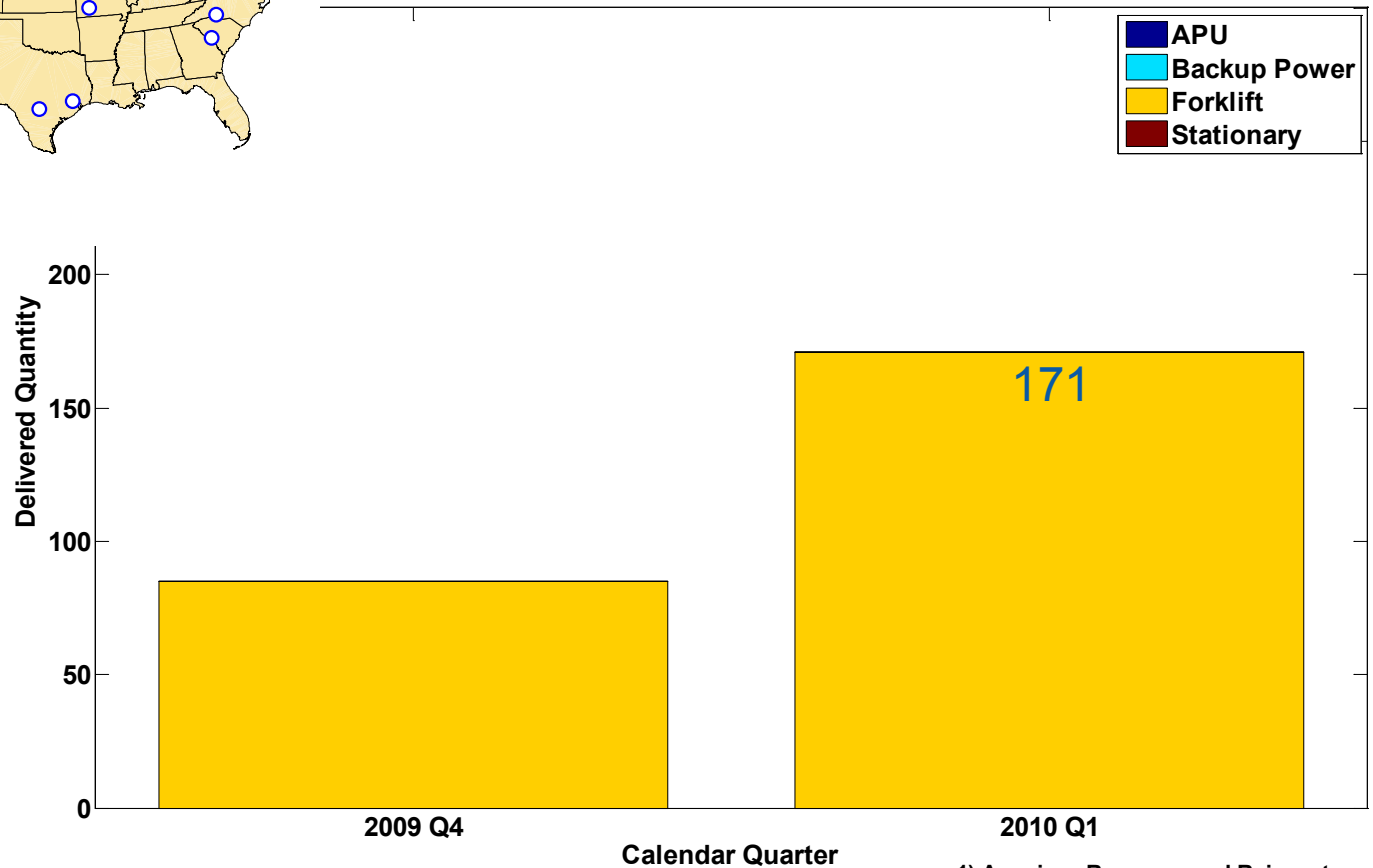


Delivered Fuel Cell Units & Deployment Sites



Some site locations TBD

DOE ARRA¹ Funded Early Fuel Cell Markets: Delivered Units



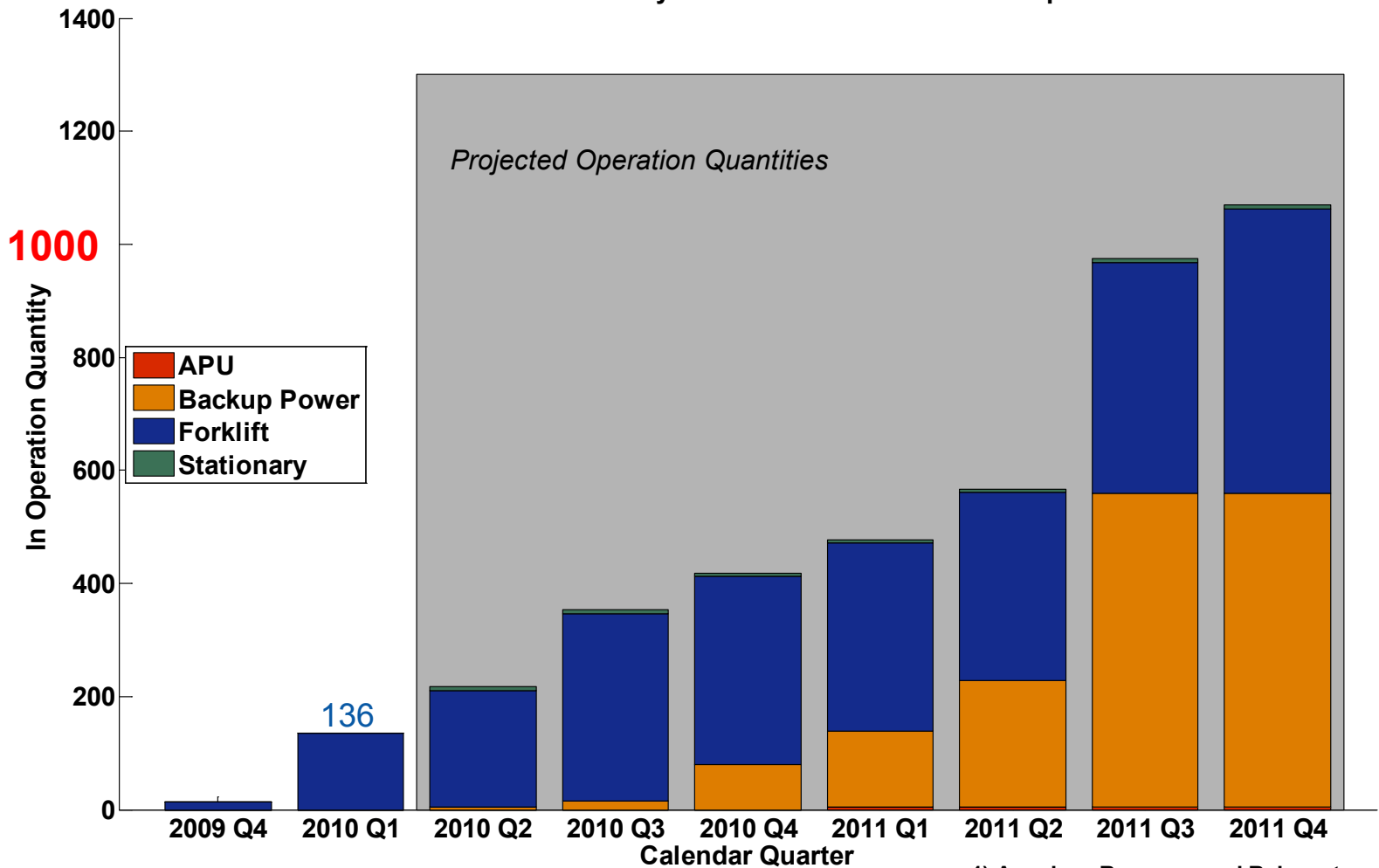
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1) American Recovery and Reinvestment Act

Fuel Cell Units in Operation

Current and Projected Quantities

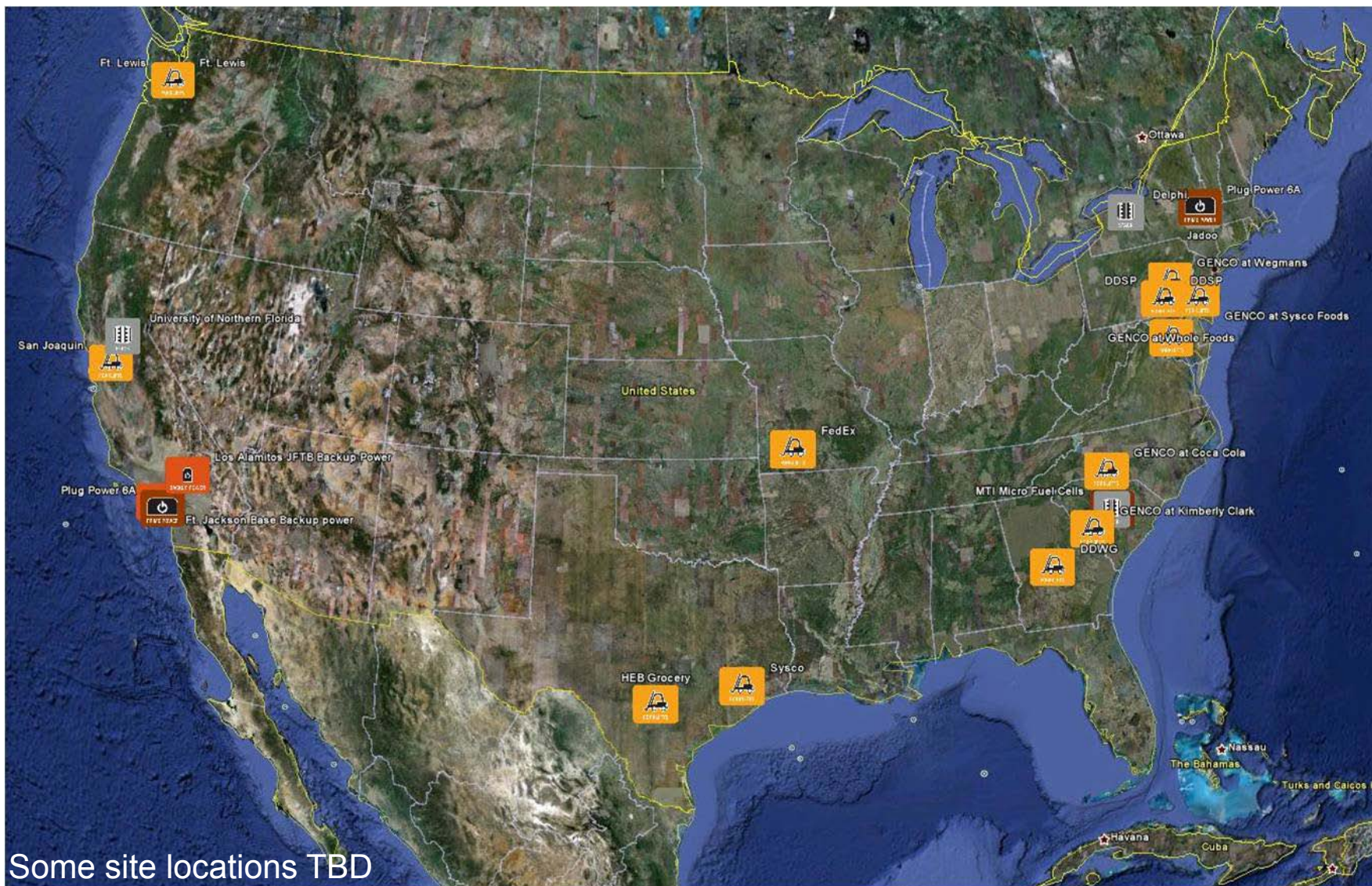
DOE ARRA¹ Funded Early Fuel Cell Markets: Units in Operation



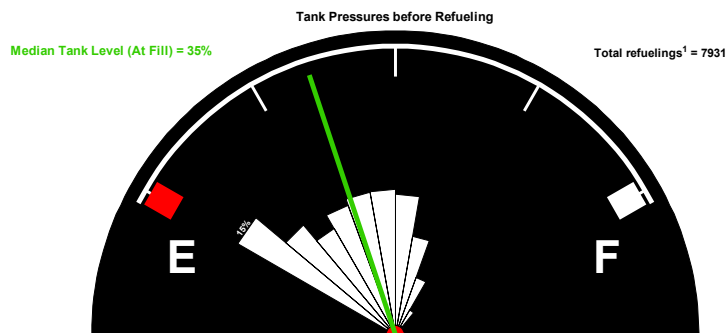
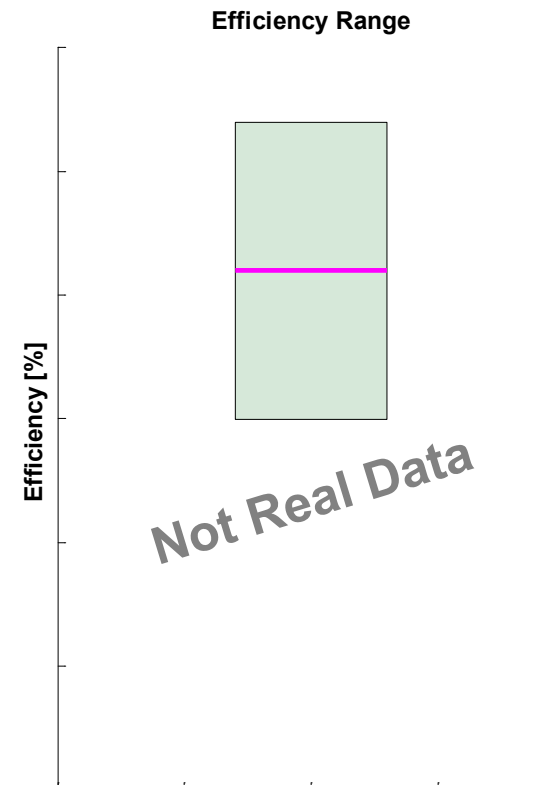
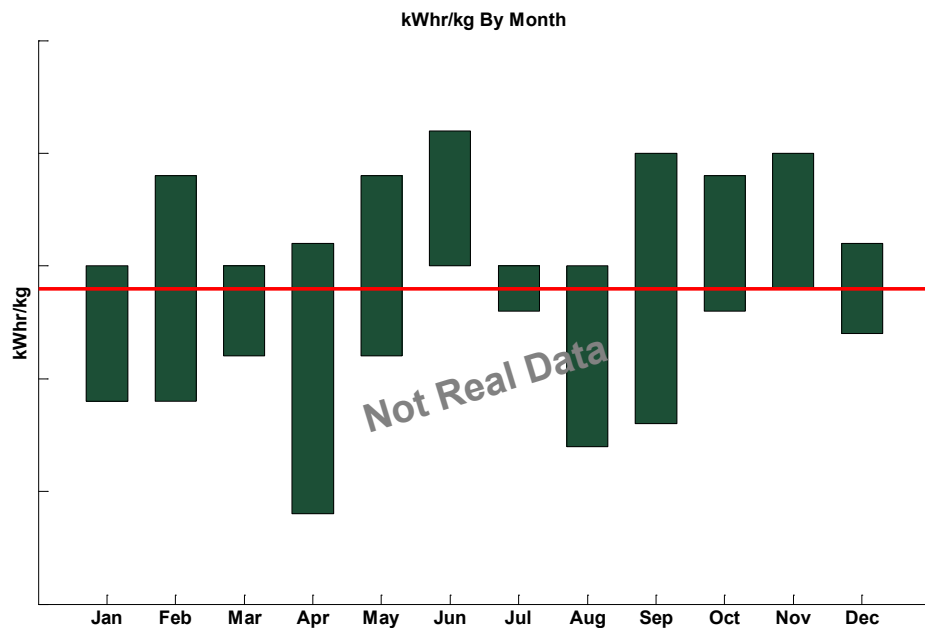
1) American Recovery and Reinvestment Act

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Government Funded Early Fuel Cell Market Deployment Sites (DOE ARRA, DOE IAA, DoD)



Planned Analyses Examples - Forklifts



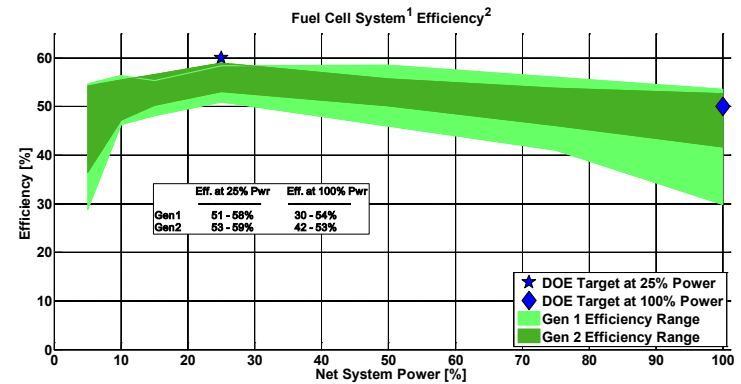
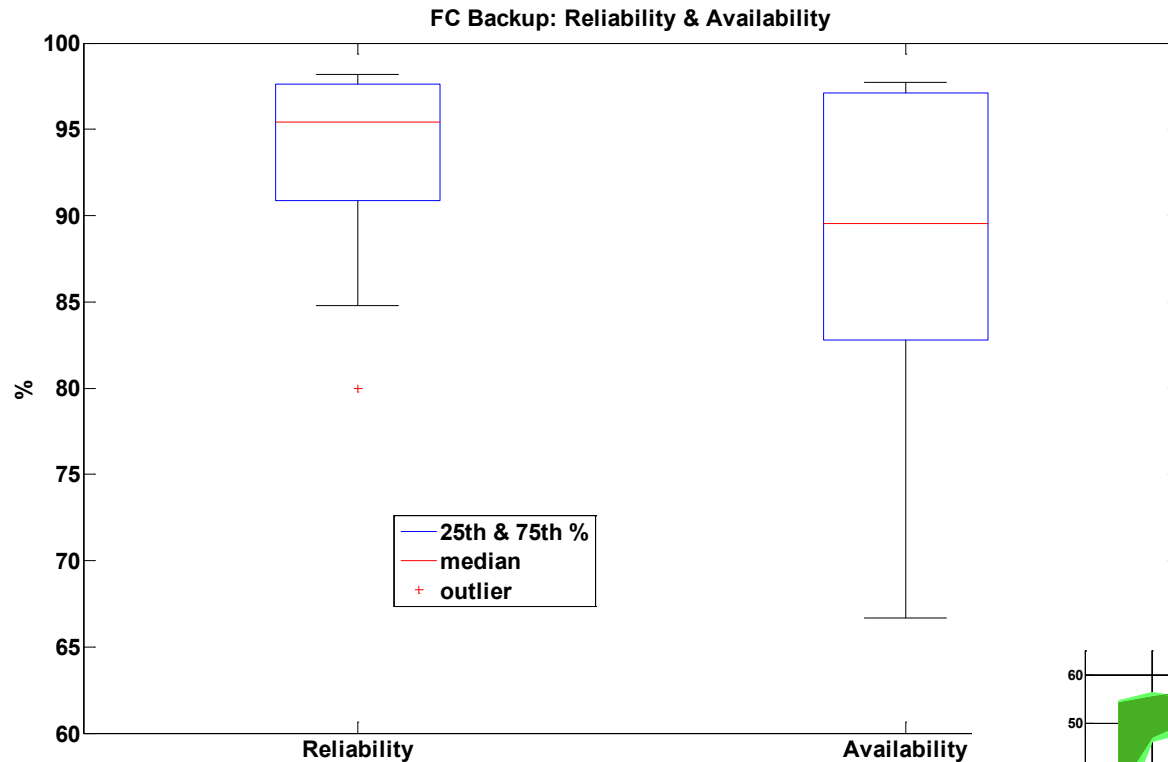
1. Some refueling events not recorded/detected due to data noise or incompleteness.
 2. The outer arc is set at 25% total refuelings.
 3. Full = 5000 psi.

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Planned Analyses Examples - Stationary



¹ Gross stack power minus fuel cell system auxiliaries, per DRAFT SAE J2615. Excludes power electronics and electric drive.

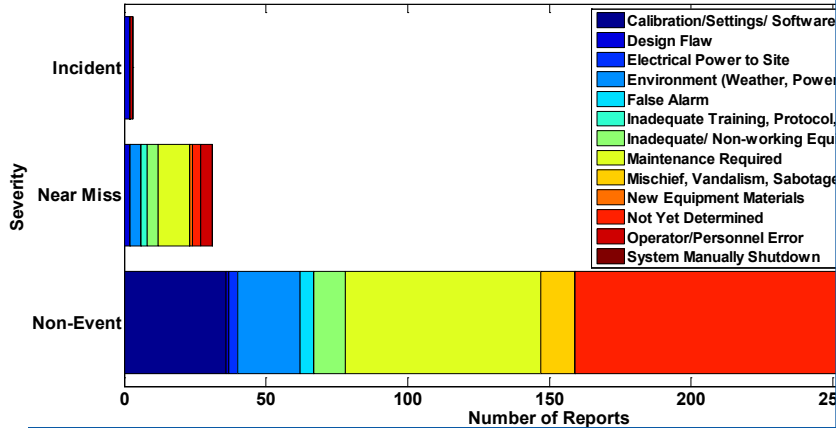
² Ratio of DC output energy to the lower heating value of the input fuel (hydrogen).

³ Individual test data linearly interpolated at 5,10,15,25,50,75, and 100% of max net power. Values at high power linearly extrapolated due to steady state dynamometer cooling limitations.

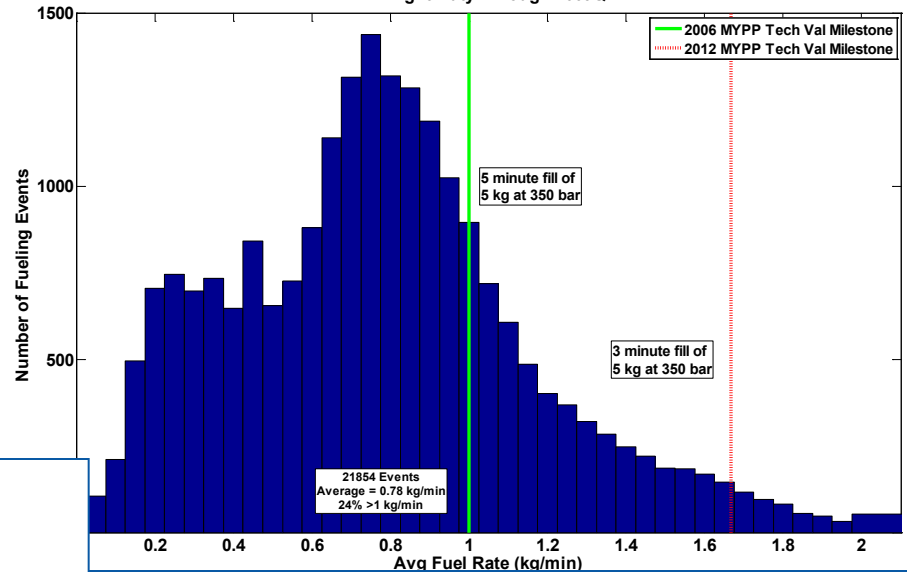


Planned Analysis Activities – Leverage Experience and Analysis from FCV

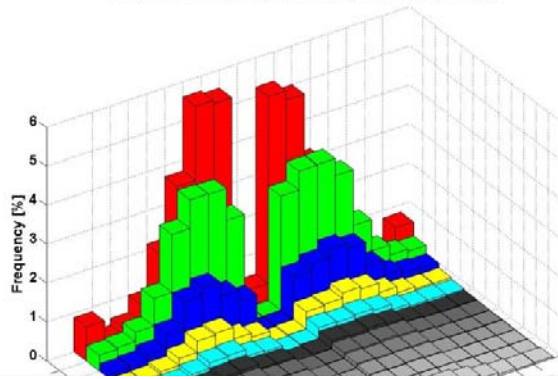
Primary Factors of Infrastructure Safety Reports Through 2009 Q2



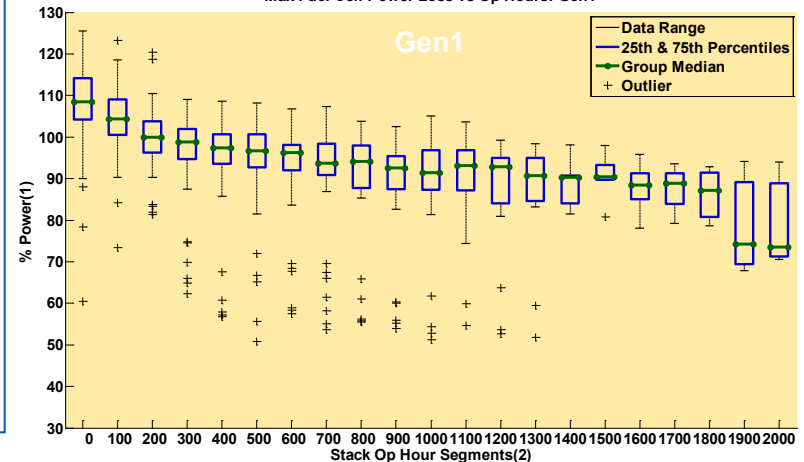
Histogram of Fueling Rates All Light Duty Through 2009 Q2



Fuel Cell Transient Cycle¹ Voltage and Time Change



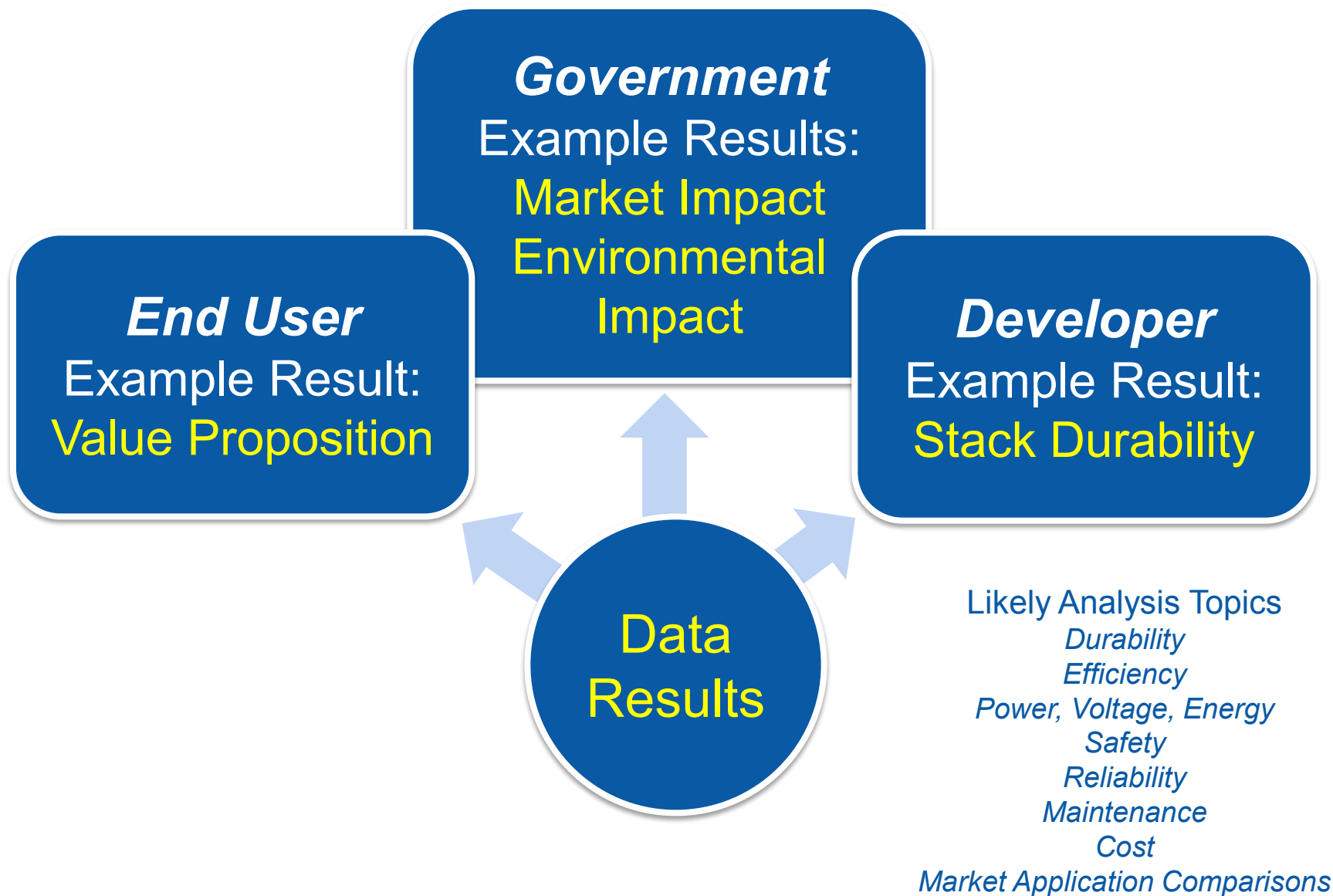
Max Fuel Cell Power Loss vs Op Hours: Gen1



Application specific analysis
 Analysis based on FCV:
 FCV Learning Demo has
80 Data Results

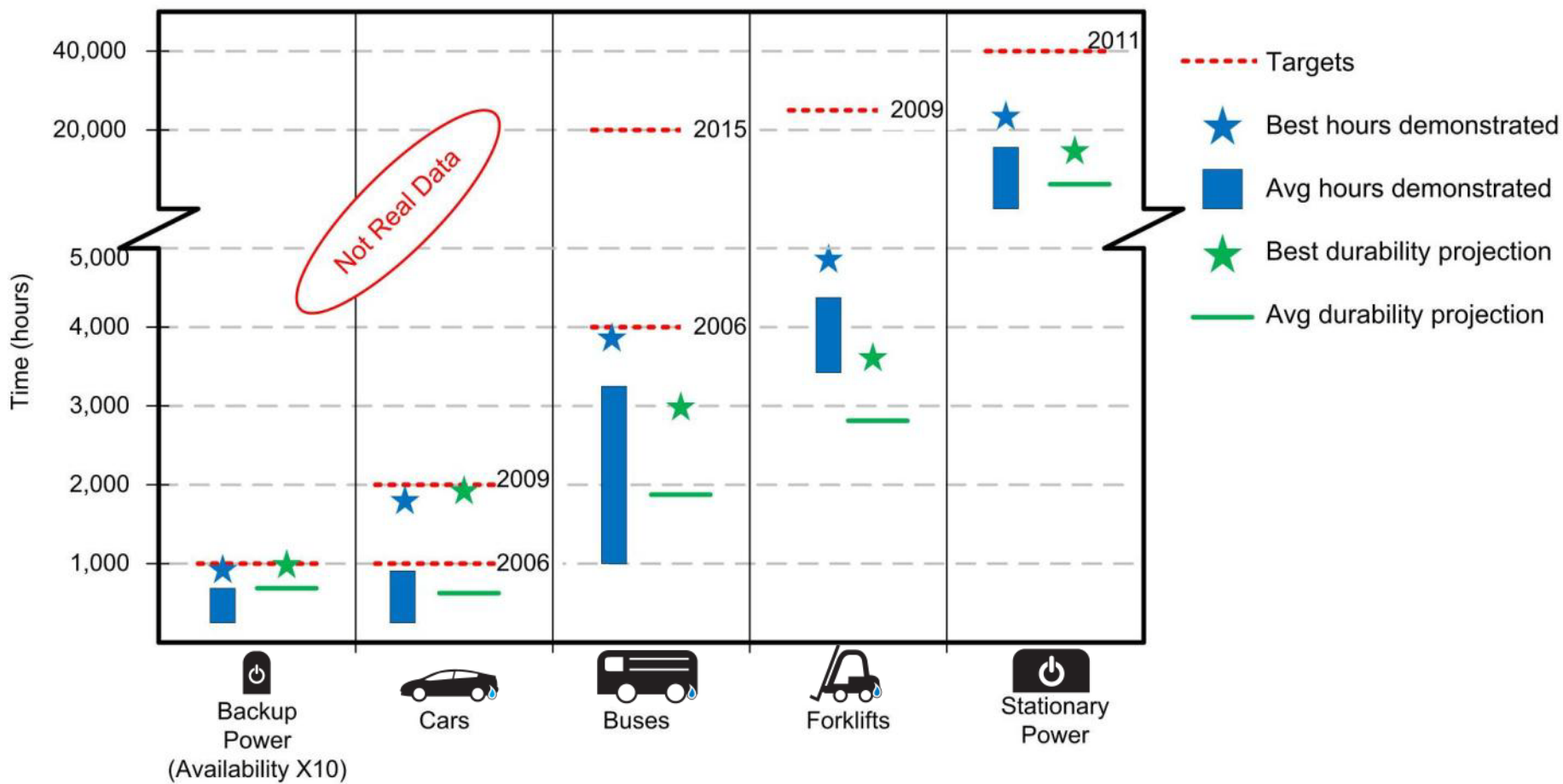
1) Normalized by fleet median value at 200 hours.
 2) Each segment point is median FC power (+50 hrs).
 Box not drawn if fewer than 3 points in segment.

Data Results Reported to Multiple Stakeholders

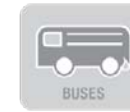


Planned Analysis – FC Application & Competing Technology Comparisons

Status of Fuel Cell Technology for a Spectrum of Applications



Summary



ARRA project expected to deploy ~ 1,000 fuel cell units.

Diverse group of project partners that includes fuel cell developers, hydrogen producers, and end users with sites across the United States.

Forklift sites are first to begin operation

First round of technical results expected later this year

Technical results reported to end users (e.g. Value Proposition), developer (e.g. Stack Durability), and government (e.g. Market Impact)

Contact Information & Website

http://www.nrel.gov/hydrogen/proj_fc_market_demo.html

- Hydrogen & Fuel Cells Research Home
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 - Hydrogen Storage
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 - Fuel Cell Vehicle Learning Demonstration
 - Fuel Cell Bus Evaluations
 - Early Fuel Cell Market Demonstrations**
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Early Fuel Cell Market Demonstrations

Early fuel cell market demonstrations are focused primarily on using fuel cell technologies for material handling, backup power, and prime-power applications. The Department of Energy-sponsored demonstration projects support fuel cell market transformation activities and help foster the growth of fuel cell markets. In addition, the Department of Defense funds early fuel cell demonstration projects.

NREL receives operational data from these early market fuel cell demonstrations, analyzes, and reports on these data. By aggregating data across numerous industry teams and sites, NREL develops composite data products (CDPs), which provide relevant data results on the technology status and fuel cell performance without revealing proprietary data. These publicly available CDPs will help the development community understand the state of fuel cell technologies, identify areas for continued improvement, and provide data metrics that are important to the business case for these fuel cell markets.



Hydrogen PEM fuel cells are leading candidates for use in fuel cell vehicles. Today's commercially available PEM fuel cells are particularly appropriate for low-power applications requiring intermittent backup.

This page provides the following resources:

- [Composite Data Products](#)
- [Presentations and Publications](#)
- [Presentations Containing All CDPs](#)

Composite Data Products

The public technical analysis results are generated in the form of composite data products. The following CDPs can be sorted by title, category, CDP number, and date updated. Download the CDPs as PowerPoint or JPG files using the links in the two columns on the right. Download the current presentation containing all CDPs ([PowerPoint 2.7 MB](#)) or see the archived [presentations containing all CDPs](#).

Sort by Title ▼	Sort by Category ▼	Sort by CDP No. ▼	Sort by Date Updated ▼	PowerPoint	JPG
Operating Hours between Fueling	Fuel Cell Fuel Economy Range and Efficiency	FL08	2009-11-06		JPG
Accumulated Forklift Operating Hours	Fuel Cell Usage and Operation Behavior	FL02	2009-11-06		JPG
Forklifts Deployed by Quarter	Fuel Cell Usage and Operation Behavior	FL01	2009-11-06		JPG
Fuel Cell Units Delivered to Site	Fuel Cell Usage and Operation Behavior	ARRA01	2010-02-19		JPG
Fuel Cell Units in Operation—Current and Projected Quantities	Fuel Cell Usage and Operation Behavior	ARRA02	2010-02-19		JPG

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