



Fuel Cell-Powered Lift Truck Sysco Houston Fleet Deployment

Project ID: H2RA010
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Project Overview

■ Timeline

- Start: September 15, 2009
- Finish: September 14, 2013
- 35% complete (Feb 28, 2011)

■ Budget

Total Project Funding

- DOE: \$1,201,918
- Sysco: \$2,046,710
- The project is fully funded

■ Barriers

- Safe hydrogen use in high-throughput distribution center
- Full fleet conversion of greenfield center
- Operator productivity improvements
- Fuel cell use in freezer setting
- GenDrive fuel cell lifetime and reliability

■ Partners

- Plug Power – GenDrive system and service provider
- Air Products – Hydrogen and hydrogen infrastructure provider
- Big-D Construction – Site preparation provider for hydrogen infrastructure

Relevance

OBJECTIVES

- Support American Recovery and Reinvestment Act goals of long-term economic growth by successfully demonstrating a new technology
- Establish a proving ground for expanded use of hydrogen fueling technology at Sysco, thereby promoting future adoption of fuel cells in other applications to help drive their use in the U.S.
- Promote the economic and environmental benefits of hydrogen fuel cell technology

TACTICS

- Convert the entire class-2 and class-3 lift truck fleet at Sysco Houston's greenfield distribution center to fuel cell use
- Demonstrate the economic benefits of large fleet conversions of lift trucks from lead-acid batteries to fuel cell power units by measuring, analyzing and reporting on the performance, operability and safety of the systems
- Demonstrate freezer operation
- Obtain affordable and reliable hydrogen



Plan and Approach

- **Fueling Station Installation**
 - Install hydrogen handling and dispensing equipment consistent with merchant liquid hydrogen supply
- **GenDrive Power Unit Construction**
 - Complete build of 26 class-2 and 79 class-3 GenDrive power units (including 7 temporary rental units)
- **Startup, Training and Safety**
 - Commission and start up of the fueling station and power units and train Sysco Houston personnel in their use and maintenance
 - Complete NEPA environmental forms
- **Lift Truck Operation and Evaluation**
 - Receive operational and maintenance support for the power units and the hydrogen handling and dispensing equipment and evaluate their performance over the duration of the project
- **Program Management and Reporting**
 - Provide overall project management and reporting to the DOE over the course of the project, including quarterly reports, annual assessments and the submission of data to NREL

Milestones

Milestones	Progress	% Complete
Fueling Station Installation	Big-D completed preparatory work for hydrogen infrastructure installation Air Products completed installation of hydrogen fueling system	100%
GenDrive Build	Plug Power completed build of 26 class-2 and 79 class-3 power units (including 7 temporary rental units)	100%
► Go/No Go	<ol style="list-style-type: none"> 1. Fuel station was fully tested and deemed operational 2. Fuel cells passed factory acceptance testing 	100%
Annual Assessments Month 18, 30 and 48	<p>Assess reliability of the fuel cells by measuring the time between failures and examining the cause of failure</p> <p>Assess cost to maintain and operate the fuel cells, as well as overall operator experience</p>	35%

Progress and Technical Accomplishments

PROGRESS

- Sysco Houston is successfully using hydrogen fuel cell technology for the first time in a total fleet environment
- Facility has proper safety, backup and operational procedures in place
- Close monitoring and return on investment calculations have increased Sysco's involvement in fuel cell powered lift truck operations
- Fully implemented hydrogen safety plan

ACCOMPLISHMENTS

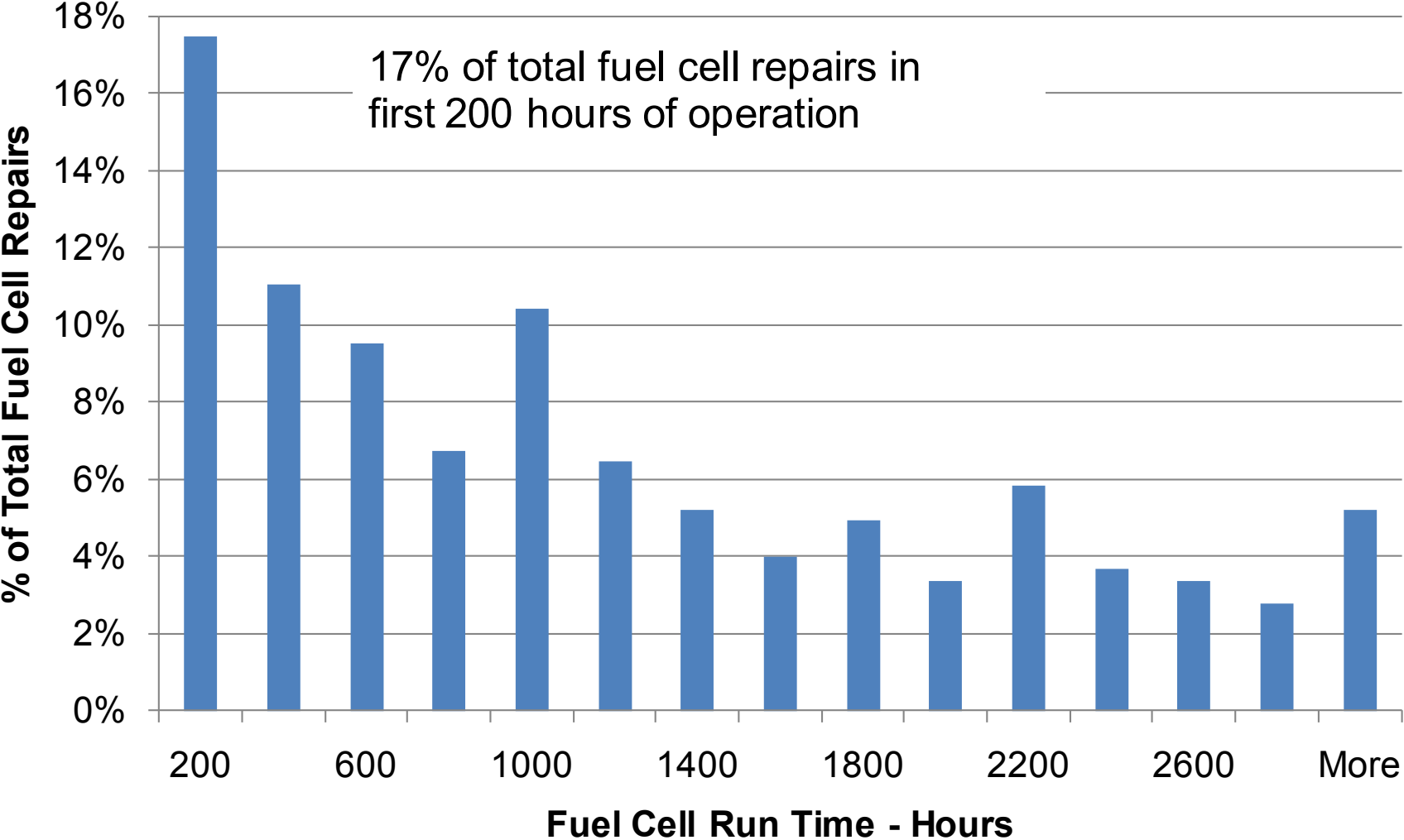
- Converted the entire class-2 and class-3 lift truck fleet in a greenfield distribution center to fuel cell use
- Built permanent hydrogen fueling infrastructure
- Trained over 100 employees on operation and safety of hydrogen use
- Improved operator productivity due to elimination of battery degradation and charging time
- Through life of project 5.5 jobs have been created



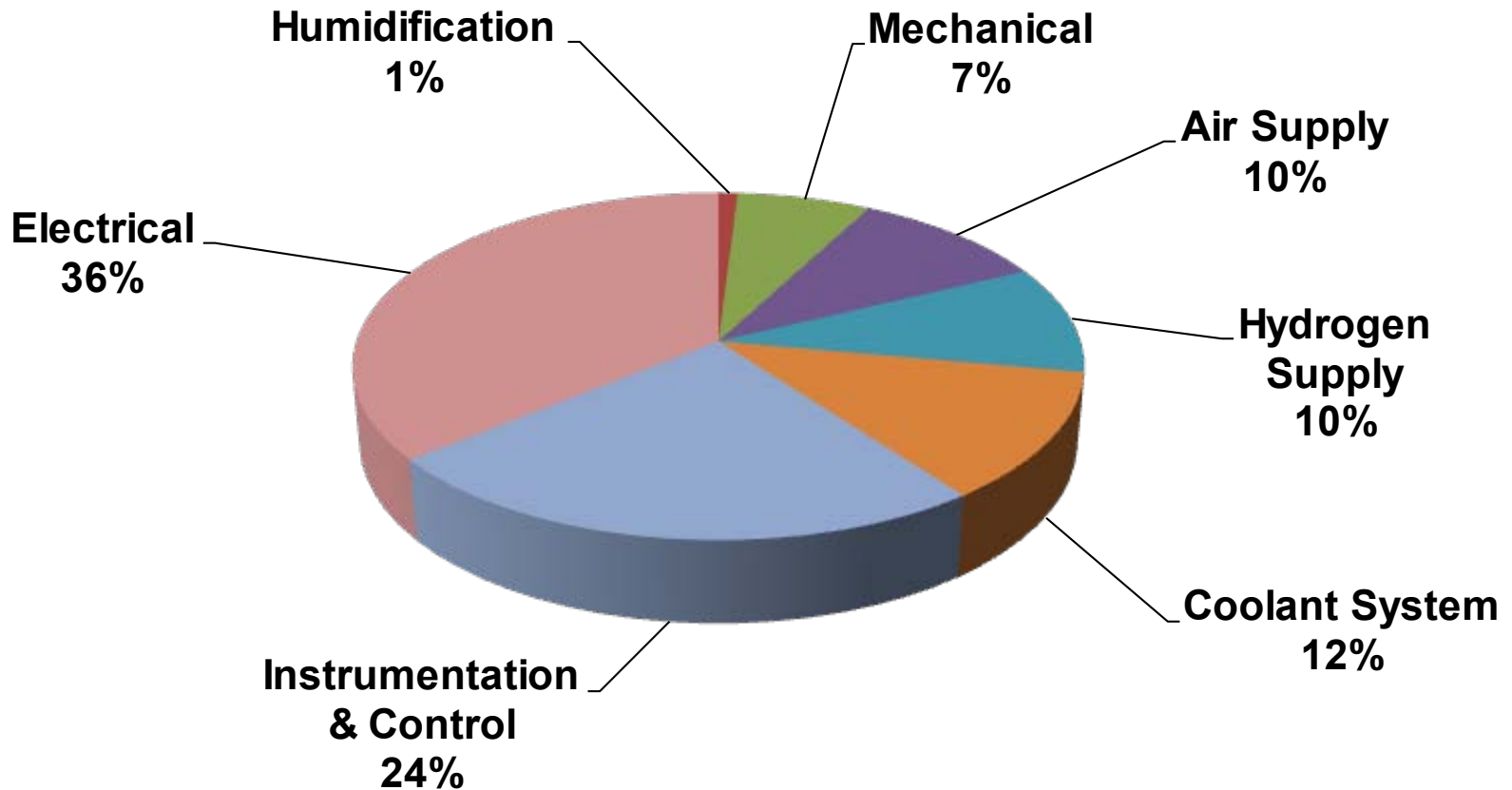
Technical Accomplishments and Progress: Fuel Cells

- Over 12 months and 300,000 hours of continuous fuel cell operation to February 2011
- Successfully demonstrated the operation of 25 class-3 power units in sub-zero temperatures
- We are saving nearly \$100,000 per year in man-hours spent on refueling fuel cells versus swapping batteries
- Performance of fuel cells is much better than lead-acid batteries
- The current cost of hydrogen fuel is approximately the same as the cost of electricity to charge lead-acid batteries
- The cost of fuel cells is coming down as production increases
- Tax credits for fuel cells continue through the end of 2016
- We have changed the way we maintain our pallet jack and forklift power source from reactive maintenance with lead-acid batteries to preventative maintenance with the hydrogen fuel cells

Fuel Cell Repair Frequency



Types of Fuel Cell Repairs



Technical Accomplishments and Progress: Hydrogen

- Air Products commissioned the fueling station in December 2009
- Liquid tank operates with a MAWP of 150 psig, bulk high-pressure storage tanks operate at 6,000 psig
- Indoor dispensers are 250 bar and capable of 700 kg/day
- Operator dispenser recognition requires pin code and badge scan
- 27,000 fueling operations and 38,760 lb (17,618 kg) of hydrogen consumed to February 2011
- Developed a hydrogen safety plan
- Helped DOE develop a process for reviewing future hydrogen safety plans



Collaborations

■ Partners:

- Plug Power – GenDrive system and service provider
- Air Products – Hydrogen and hydrogen infrastructure provider
- Big-D Construction – Site preparation provider for hydrogen infrastructure

Proposed Future Work - 1

- Sysco plans to replace approximately 1,000 lead-acid batteries with 500+ fuel cells at seven additional sites over the next 24 months
- Sysco has committed to fuel cell fleet conversions at Philadelphia, San Antonio, Long Island and Northeast RDC facilities
- Sysco is considering additional fuel cell fleet conversions for Los Angeles, San Francisco, and Boston facilities
- Expansion plans are based on proven reliability and safety of current operations at Sysco Houston
- Sysco is supporting the conversion to fuel cells to help reduce the overall costs of fuel cell power units and hydrogen fuel
- Sysco Houston will help other Sysco facilities develop hydrogen safety plans

Proposed Future Work - 2



Continue Operation And Evaluation

- Monitor GenDrive power units project performance, operability and safety
- Monitor liquid and gaseous hydrogen fueling equipment project performance, operability and safety
- Monitor and provide project performance, operability and safety reports to the DOE, including any safety and performance data and issues identified during operation of the power units
- Support DOE communication efforts

Summary

- Relevance:** Demonstrate the economic benefits of large fleet conversions of lift trucks from lead-acid batteries to fuel cell power units
- Approach:** Install an Air Products hydrogen fueling station, build Plug Power GenDrive power units and evaluate program to ensure success
- Technical Accomplishments:** Plug Power built and commissioned GenDrive units; Air Products installed the hydrogen fueling system
- Technology Transfer/Collaborations:** Plug Power, Air Products and Big-D Construction
- Future Work:** Continue operation and evaluation at Sysco Houston; replace approximately 1,000 lead-acid batteries with 500+ fuel cells at seven additional sites over the next 24 months

Supplemental Slides

Fuel Cell Performance Results

Unit Type	# of Units	Average Hours/Unit	Total Hours	Average MTBR
Class-2	26	2383	61,958	566
Class-3	47	3441	161,727	2184
Class-3 Cold Temperature	25	3381	84,525	1913
Total	98		308,210	

MTBR = Mean Time Between Repairs (all data to February 2011)