



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	1. Fuel station was fully tested and deemed operational 2. Fuel cells passed factory acceptance testing	100%
Annual Assessments Month 18, 30 and 48	Assess reliability of the fuel cells by measuring the time between failures and examining the cause of failure Assess cost to maintain and operate the fuel cells, as well as overall operator experience	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

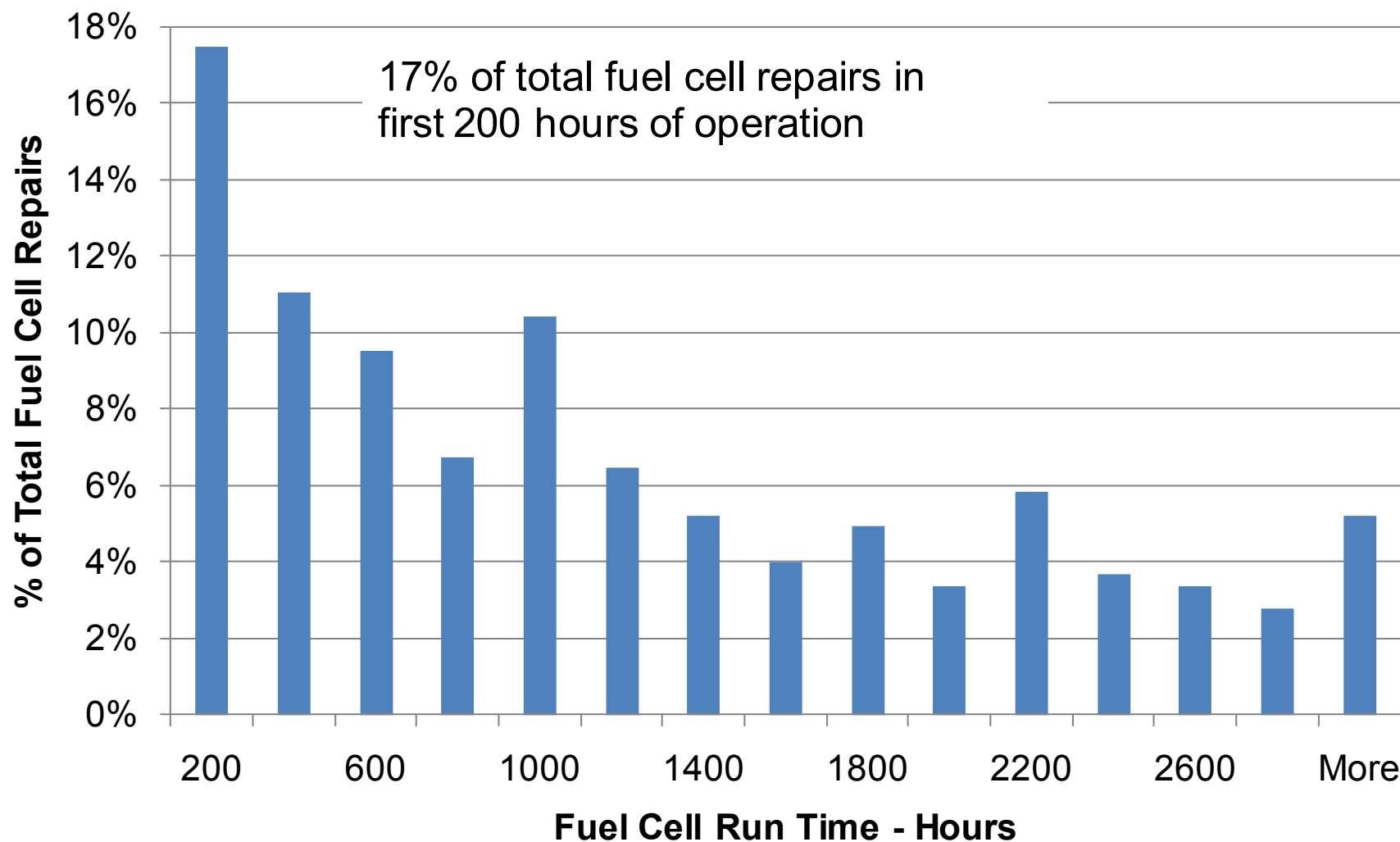
- Converted the entire class-2 and class-3 lift truck fleet in a greenfield distribution center to fuel cell use
- Built permanent hydrogen fueling infrastructure
- Trained over 100 employees on operation and safety of hydrogen use
- Improved operator productivity due to elimination of battery degradation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



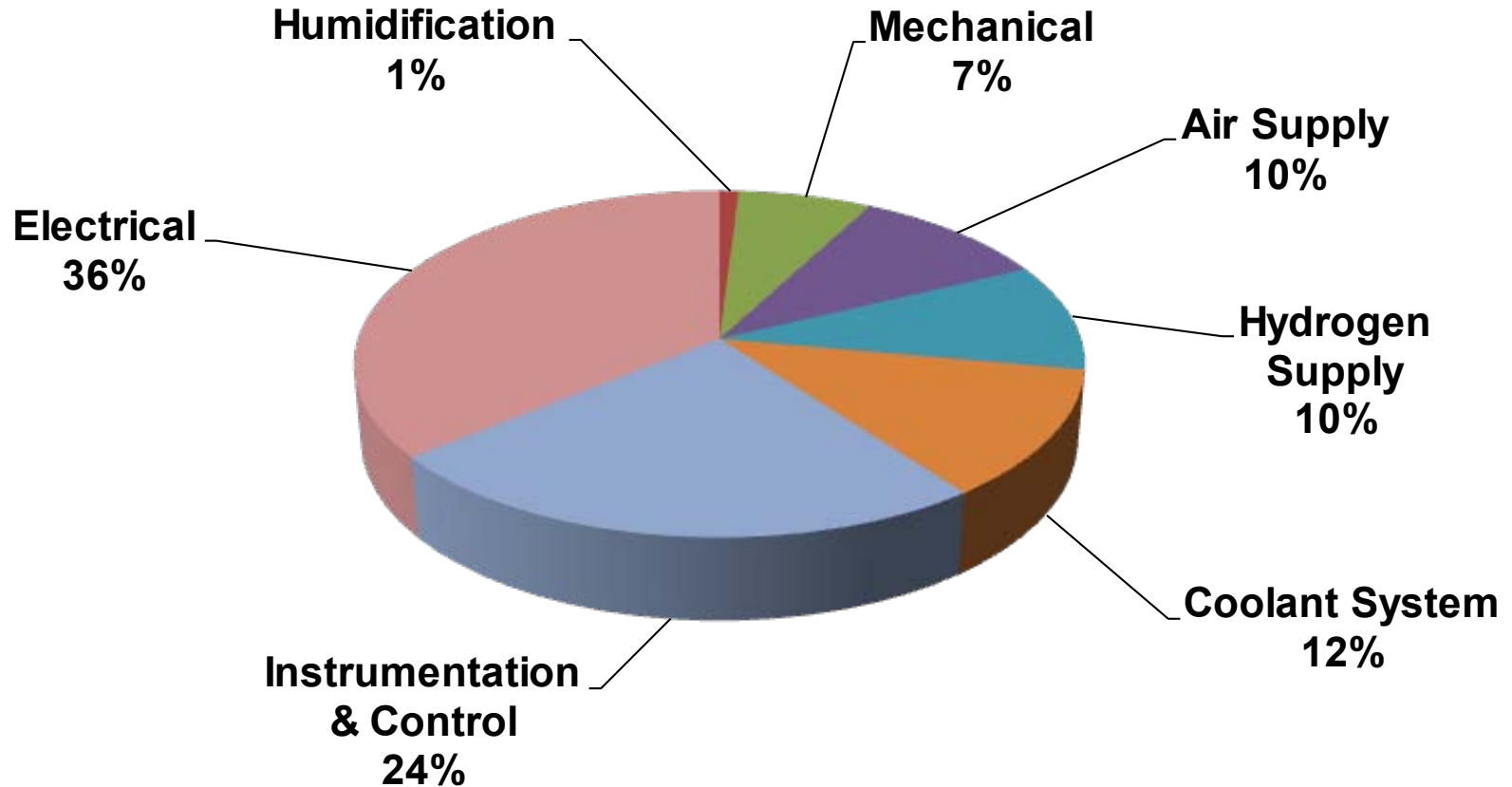
Technical Accomplishments and Progress: Fuel Cells

- 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)