

## XII.10 Fuel Cell-Powered Lift Truck Sysco Houston Fleet Deployment

Scott Kliever  
Sysco Houston  
10710 Greens Crossing Boulevard  
Houston, TX 77038  
Phone: (713) 679-5574  
E-mail: kliever.scott@hou.sysco.com

DOE Managers  
HQ: Dimitrios Papageorgopoulos  
Phone: (202) 586-5463  
E-mail: Dimitrios.Papageorgopoulos@ee.doe.gov  
GO: David Peterson  
Phone: (720) 356-1747  
E-mail: David.Peterson@go.doe.gov

Contract Number: DE-EE0000485

### Subcontractors:

- Plug Power Inc., Latham, NY
- Air Products and Chemicals, Inc., Allentown, PA
- Big-D Construction, Salt Lake City, UT

Project Start Date: October 1, 2009

Project End Date: September 30, 2013

### Relevance to the American Recovery and Reinvestment Act (ARRA) of 2009 Goals

This project advances the goals of the American Recovery and Reinvestment Act (ARRA) of 2009 to create new jobs, save existing jobs, and spur economic activity and investment in long-term economic growth by:

- Creating jobs at Plug Power to design, build and commission the fuel cell power units.
- Creating jobs at Air Products and Big-D Construction to design, install and commission hydrogen storage and fueling equipment.
- Creating jobs at Air Products to deliver hydrogen to the Sysco Houston facility.
- Training Sysco Houston lift truck operators in hydrogen safety, fueling procedures and fuel cell operation.
- Training Sysco Houston lift truck maintenance personnel to service fuel cells.
- Improving the overall economic efficiency of material handling operations.

This project advances the DOE-Fuel Cell Technologies' ARRA project goals of accelerating the commercialization and deployment of fuel cells and fuel cell manufacturing, installation, maintenance, and support services by demonstrating:

- Safe and reliable operation of hydrogen storage and fueling equipment and fuel delivery.
- Reliable and efficient operation of hydrogen fuel cells.
- Economic and environmental advantages of fuel cells over batteries.
- Practical operation and maintenance of fuel cells.

### Technical Barriers

This project addresses the following technical barriers to the use of fuel cell-powered lift trucks:

- Safe and reliable hydrogen use in a high-throughput distribution center.
- Fuel cell use in sub-zero temperatures.
- Fuel cell lifetime and reliability.

### Technical Targets and Milestones

The technical targets and milestones of this project include:

- Installing hydrogen storage and fueling equipment by December 2009.
- Developing a hydrogen safety plan by May 2010.

### Objectives

The objectives of this project are to:

- Convert a fleet of 79 class-3 electric lift trucks to hydrogen fuel cells at the Sysco Houston facility (including seven temporary rental units and 25 sub-zero temperature units).
- Demonstrate the safe and reliable operation of hydrogen-fueled material handling equipment (MHE).
- Demonstrate the economic benefits of conversion to hydrogen fuel cell-powered MHE.
- Demonstrate operator acceptance of hydrogen fuel cell-powered MHE.
- Demonstrate the operation of hydrogen fuel cells in sub-zero temperatures.
- Provide a cost-effective and reliable hydrogen fuel supply.
- Spur further lift truck fleet conversions to hydrogen fuel cells.
- Establish a proving ground for hydrogen fuel cell-powered MHE.

- Commissioning 79 class-3 power units by February 2010.
- Completing startup and training by February 2010.
- Starting operation and evaluation by March 2010.

**Accomplishments**

The accomplishments of this project include:

- Commissioning hydrogen storage and fueling equipment by December 2009.
- Commissioning 79 GenDrive class-3 power units by February 2010.
- Completing all fueling, operation and maintenance training by February 2010.
- Training over 100 Sysco personnel in the safe use and fueling of hydrogen fuel cells.
- Commissioning 26 GenDrive class-2 power units by April 2010 (these power units are not included in the scope of this project).
- Logging 12 months and over 300,000 hours of fuel cell operation by February 2011.
- Completing 31,000 fueling operations, consuming 38,760 pounds (17,618 kilograms) of hydrogen by February 2011.
- Demonstrating the successful operation of 25 class-3 power units in sub-zero temperatures.
- Monitoring operating costs and reliability of all GenDrive power units (ongoing).



**Introduction**

The purpose of this project is to demonstrate that hydrogen fuel cells are a safe and economical alternative to batteries for powering electric pallet jacks and lift trucks. The primary barriers to widespread use of hydrogen fuel cells for MHE are concerns about the safety of hydrogen storage and fueling equipment, operating costs for fuel and maintenance, and the long-term reliability of fuel cells.

**Approach**

This project will evaluate the safety and economics of using hydrogen fuel cells to power a fleet of 26 class-2 and 79 class-3 electric lift trucks at the Sysco Houston facility. Sysco Houston will supply the lift trucks, Plug Power will supply the GenDrive fuel cell power units, Air Products and Big-D Construction will supply the hydrogen storage and fueling equipment, and Air Products will supply the hydrogen fuel. The equipment will be maintained by Sysco Houston personnel with assistance from Plug Power and Air Products personnel when necessary. Plug Power and

Air Products will also assist Sysco Houston in developing a comprehensive hydrogen safety plan.

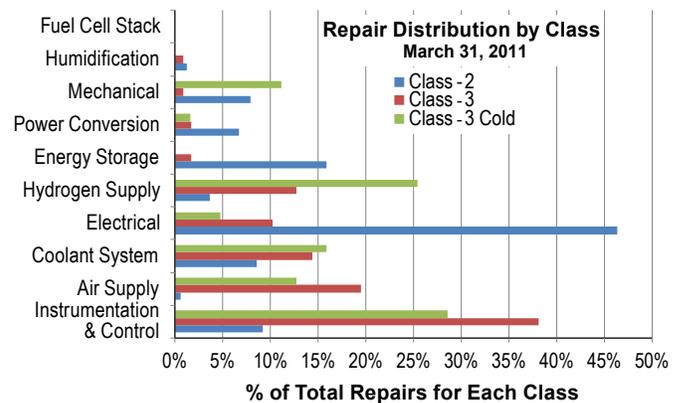
Sysco Houston and Plug Power will monitor the operation and maintenance of the power units and the hydrogen storage and fueling equipment over the duration of the project. This information will be reported to the DOE and National Renewable Energy Laboratory quarterly and summarized annually.

**Results**

This project has successfully demonstrated the safe and economical operation of 26 class-2 and 72 class-3 power units and associated hydrogen storage and fueling equipment. The class-2 power units were not included in the funding for this project. Seven of the original 79 power units were rentals and have been returned to Plug Power. Twenty-five of the class-3 power units were modified to operate in sub-zero temperatures.

The fuel cell power units accumulated over 300,000 hours of operation and consumed 13,500 kilograms of hydrogen by February 2011. The current cost of hydrogen fuel is approximately the same as the cost of electricity to charge lead-acid batteries but Sysco is saving nearly \$100,000 per year in fewer man-hours spent refueling fuel cells compared to swapping batteries. The lift truck operators also appreciate the improved performance of fuel cells compared to lead-acid batteries.

Sysco and Plug Power have been monitoring the type and frequency of fuel cell repairs. Figure 1 shows the distribution of repairs by class and Figure 2 shows the mean time between repairs (MTBR) distribution by class. To date, no conclusions have been drawn to explain the differences in repair statistics between the class-2 and class-3 power units. However, Sysco has changed the way they maintain pallet jack and lift truck power sources from reactive maintenance with lead-acid batteries to preventative maintenance with the hydrogen fuel cells.



**FIGURE 1.** Repair Distribution by Class

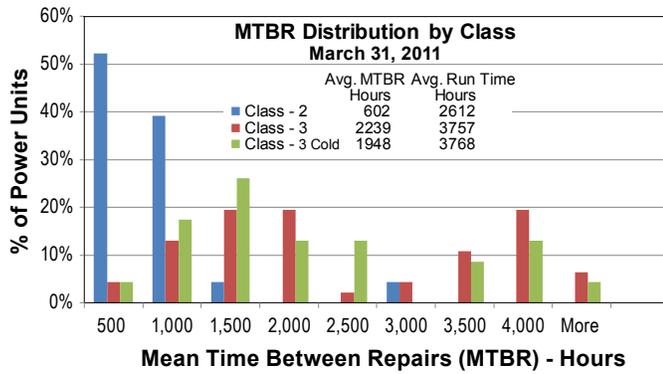


FIGURE 2. MTBR Distribution by Class

### Conclusions and Future Directions

Based on the proven reliability and safety of current hydrogen fuel cell operations at Sysco Houston, Sysco’s future directions include:

- Ongoing operational and maintenance support for power units and hydrogen storage and fueling equipment.
- Ongoing data collection from power units and hydrogen storage and fueling equipment.
- Planning to replace approximately 1,000 lead-acid batteries with 500+ fuel cells at seven additional sites over the next 24 months.
- Committed to fuel cell fleet conversions at Philadelphia, San Antonio, Long Island and Northeast Redistribution Center facilities.

- Considering additional fuel cell fleet conversions for Los Angeles, San Francisco, and Boston facilities.
- Supporting the conversion to fuel cells to help reduce the overall costs of fuel cell power units and hydrogen fuel.
- Helping other Sysco facilities develop hydrogen safety plans.

### FY 2011 Publications/Presentations

1. Sysco hosted several open houses to showcase the fuel-cell-powered lift truck fleet, which subsequently became the subject of various local news articles and television news stories.
2. Scott Kliever delivered a presentation at the 2010 Fuel Cell Seminar and Exposition in San Antonio, TX, October 18–20, 2010.
3. Sysco and Plug Power prepared a case study of the Sysco Houston distribution center.
4. Scott Kliever was interviewed for the April 2011 cover story in *Materials Handling & Logistics* magazine titled *Making Sense of Power Sources*.
5. Scott Kliever delivered an American Recovery and Reinvestment Act merit review presentation in Washington, D.C. in May 2011.
6. Scott Kliever delivered a presentation at the Hydrogen + Fuel Cells 2011: International Conference and Exhibition, May 15–18, 2011, in Vancouver, BC, Canada.