

IX.8 Dedicated to the Continued Education, Training and Demonstration of PEM Fuel Cell-Powered Lift Trucks in Real World Applications

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Hydrogenics, Mississauga, Ontario, Canada

Project Start Date: September 1, 2008

Project End Date: August 31, 2011

- Infrastructure/Cost Justification
- Difficulty in Measuring Success

Contribution to Achievement of DOE Education Milestones

This project has and will continue to contribute to achievement of the following DOE milestones from the Education section of the Fuel Cell Technologies Multi-Year Research, Development and Demonstration Plan:

- **Milestone 1:** Developed “Awareness- Level” information for first responders (3Q, 2010). This work continued during the LiftOne Program’s 6th and final fuel cell-powered lift truck deployment at AGI in Forest City, NC - through the active participation of the local Forest City Fire Department at the H2 Orientation/ Safety Training sessions.
- **Milestone 14:** Hold Community Seminars to introduce local segments of those communities to hydrogen (3Q, 2010, 4Q 2009, 1Q 2010). Handled through participation and “Live” fuel cell-powered lift truck demonstrations at regional business events such as the “Green Is Good For Business Expo” - Columbia, SC (9/14/2010); Odyssey Week Events in Columbia, SC (10/11/2010), and Charlotte, NC (10/14/2010) (Figure 1).
- **Milestone 18:** Develop end-user workshop materials for use at events (3Q-2010 through 2Q-2011). The LiftOne hydrogen fuel cell-powered lift trucks continued to be shown at sessions conducted with selected end-users at their facilities as well as at the LiftOne branch locations.

Fiscal Year (FY) 2011 Objectives

Through both segments of the project: 1) Education and 2) Deployment, the objective has been focused on increasing hydrogen awareness through:

- Continued education of an ever-broadening group of stakeholders to the benefits of fuel cell and hydrogen technologies in material handling applications to include: facility management, operators, maintenance personnel, safety groups, first responders, authorities having jurisdiction, technical/community colleges.
- Demonstration of fuel cell and hydrogen technology through the continuing demonstration schedule of two hydrogen fuel cell-powered lift trucks in real-world applications at large prominent companies.
- Demonstration of these fuel cell-powered trucks at high profile public events.
- Assisting in the further commercialization of fuel cell and hydrogen technology by establishing a series of cost value propositions to interested companies.

Technical Barriers

This project addresses the following technical barriers from the Education section (3.9.5) of the 2009 Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (B) Mixed Messages for Education
- Product Performance



FIGURE 1. LiftOne Demonstrating Fuel Cell-Powered Lift Truck at the Odyssey Day Event at Central Piedmont Community College, Charlotte, NC on October 15, 2010

Updated cost justification information has been shared with key company personnel at the sessions.

FY 2011 Accomplishments

- Within the past 12 months, LiftOne successfully completed the project's 6th and final deployment of two CAT® electric trucks, each powered by a Hydrogenics Fuel Cell Power Pack. The performance was very good, with all data compiled and sent to the National Renewable Energy Laboratory for analysis and comparison to similar fuel cell projects.
- These LiftOne deployments have allowed important end-users operating large lift truck fleets to test the benefits associated with hydrogen fuel cell power, while experiencing hands-on refueling. Their involvement has enhanced those opportunities present for acquisition and eventual conversion to hydrogen fuel at some point in the future.
- LiftOne's continued participation at strategic regional Clean Energy/Green Expo events again provided a large cross section of the business and local community with an introduction to H₂ power and included live demonstrations of the fuel cell-powered lift truck. These events held in Charlotte (NC), as well as Greenville and Columbia (SC), were attended by well over 1,000 people and increased overall hydrogen awareness levels.
- With the valuable experience gained over the course of the lift truck deployments, LiftOne's Hydrogen Education Program Director Tom Dever has participated as a presenter as well as provided material handling expertise at several notable hydrogen events, and has been referenced in several national fuel cell publications.



Introduction

The materials handling industry, a \$12 billion global market representing approximately 750,000 lift trucks sold each year, has proven to be a significant near-term market for proton exchange membrane (PEM) fuel cell adoption in a mobility application. This is due to the lack of emissions and the increased productivity the technology provides vs. that of using lead-acid batteries or fossil fuels (liquefied petroleum gas, gasoline, diesel) for lift trucks and other material-handling units. As a leading dealership in the Carolinas and Virginia, LiftOne first demonstrated PEM fuel cells in 2007, and was able to gain early field trial experience, while recognizing the acute need for overall hydrogen education.

To assist in facilitating the integration of hydrogen fuel cells into real-world material handling application, LiftOne developed a Hydrogen Education and Awareness Presentation for lift truck users. These sessions have been conducted at each of the LiftOne branches on a rotational basis. Additional sessions have been tailored for

presentations at selected technical colleges, professional organization meetings, industrial shows and to large companies with actual live demos at their facilities. These Hydrogen Awareness Classes began in early 2009, and will continue through August of 2011. The Deployment Segment of the LiftOne project, where the two fuel cell-powered lift trucks are put into real-world applications at six strategically selected major companies' facilities for one-month long trials, have provided an excellent method for demonstrating the viability of fuel cell power. The deployments began in May of 2009 and concluded in August of 2010.

Approach

Recognizing the need to help increase hydrogen awareness among material handling users, LiftOne's approach for Hydrogen Education has been focused on the identification of key target audiences. This strategy has been employed for both the Education and Deployment segments. For the Education segment, the seminar content has been designed for the layman's introduction to hydrogen and included in the 4- to 5-hour long sessions are a thorough review of hydrogen uses, its properties, infrastructure review as well as acquisition cost models and a live demonstration. The target audience for the Education Segment includes representatives from companies operating medium to large electric material handling fleets, with a secondary audience being those operating fossil fuel powered fleets. Smaller fleet operators also have participated.

For the LiftOne Deployment Segment, high profile companies with sizable fleets and multiple locations were selected for the trial sites, in order to gain the best opportunities with potential for effective regional exposure. For each site, presentations and proposals for the trials were made, detailing the equipment, fueler location/regulations, on-site monitoring arrangements and data gathering. At the conclusion of each deployment, comprehensive review meetings are held, in which all performance data presented, feedback from operators reviewed, and a cost justification evaluations presented with full proposals for fuel cell and infrastructure acquisition for more involved "pilot" type projects.

Results

Over the past year, LiftOne has seen positive results in both the Education and Deployment segments associated with the project. Sessions have been conducted at the LiftOne branches, at customer locations, at community colleges and at the regional "Green"-type business expos attended. LiftOne has included the live demonstration of the working fuel cell-powered lift truck, an essential element necessary to satisfy the interest present and maximize awareness.

The Deployment Segment of the project generally yielded very good results. The deployments were conducted at: 1) Stanley Tools, 2) a distribution center (name withheld

by request), 3) Bausch & Lomb, 4) BMW, 5) Electrolux and 6) AGI - In Store, which was conducted this past year (Table 1). There were decent run times, truck performance, power, and ease of refueling (Figure 2). All sites were able to experience fuel cell power, with well over 200 employees at each site made aware of the hydrogen power. As was mentioned at this time last year - LiftOne’s participation at the BMW trial (Site # 4), alongside other fuel cell manufacturers (Plug Power and Nuvera), solidly contributed to that trial’s overall success and BMW’s eventual large-scale fuel cell acquisition in 2010.

TABLE 1. Site # 6 – LiftOne Fuel Cell Deployment Summary

LiftOne Site # 6 - AGI - In Store: 25 days
* Truck 0264 / Cell # 17 ran 190 hrs
* Truck 0265 / Cell # 18 ran 229 hrs
* 86 kg of H ₂ used / 62 fills / 53.75 tanks
* 4.7 minutes average fuel time
* 7.8 hrs avg run time per tank (1.6kg)
Notes: water pump, purge valve
Straight forks - sidershifter application
Good trial - 2 technical issues fixed.
Decent hours run. Good time per tank.

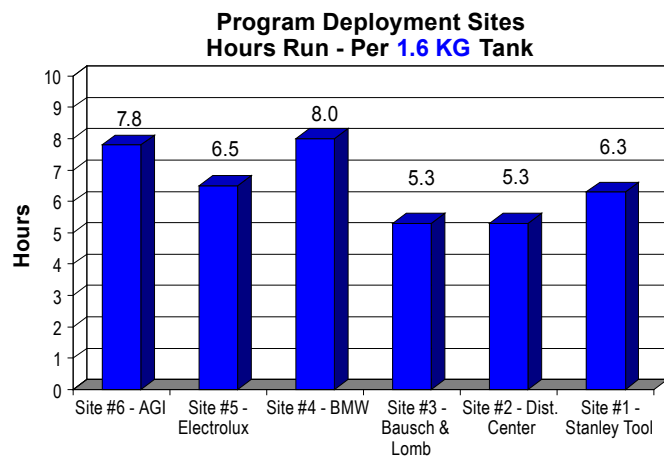


FIGURE 2. LiftOne – Average Hours Run per Tank for all Six Deployment Sites

Conclusions and Future Directions

For the third and final year of the LiftOne Hydrogen Education Program, the following conclusions have been determined:

- A wide variety of users have learned about hydrogen, and seen the fuel cells powering lift trucks in real-world applications. LiftOne’s project addressed this critical “first step”.
- There still remains a large degree of intrigue, but the adoption of fuel cells by major corporations has greatly increased H₂ awareness through the accompanying positive publicity.
- While viable in many large applications, the fuel cell power option is still not economically justified for lift truck fleets of less than 30-35 units at this point in time.
- There is a need for more viable competition in the fuel cell manufacturer arena in order for the necessary price efficiencies, broadened product improvements and size offerings.
- Infrastructure cost remains the major concern for companies considering fuel cell adoption. It has been the single largest obstacle to overcome during proposals.

Future plans for year three of the project involve:

- The LiftOne Hydrogen Education sessions with the live demo will continue at company sites through the remainder of the project term (August 31, 2011).
- LiftOne has considered trying to complete one additional deployment with another supplier’s fuel cells prior to the project’s completion. Time constraints may not allow for this to take place.

FY 2011 Publications/Presentations

1. Tom Dever, Hydrogen Education Program Director – LiftOne, Presenter: “Dedicated To The Continued Education, Training and Demonstration of PEM Fuel Cell Powered Lift Trucks In Material Handling Applications”, Fuel Cell & Hydrogen Energy Conference, Washington, D.C., February 14, 2011.