X.8 Dedicated To The Continued Education, Training and Demonstration of PEM Fuel Cell-Powered Lift Trucks In Real-World Applications

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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 (3.95) of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

(B) Mixed Messages
- Product Performance
- Limited Model Availability
- Infrastructure/Cost Justification

Contribution to Achievement of DOE Technology Validation 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 (4Q, 2009). Accomplished by LiftOne's on-site presentation to the Kannapolis, NC, Fire Department of the Hydrogen 101 seminar, with specific emphasis on hydrogen properties, safety items and general hydrogen awareness geared toward fuel cell applications for material handling applications. Included was a live demonstration of the fuel cell-powered lift truck (10/09). More are planned for September and October - 2010.
- **Milestone 14**: Hold community seminars to introduce local segments of the community to hydrogen (3Q, 2009, 4Q 2009, 1Q 2010). Accomplished through participation and "live" demonstrations at regional business events such as the "Green Is Good For Business Expo" (Columbia, SC - 9/2009); North Carolina Trucking Association Maintenance Council Chapter Meetings (Charlotte -10/09) and Asheville -1/10); BMW's H2 Expo (Greer, SC 11/2009) (see Figure 1); "Upstate Green Business Summit", (Spartanburg, SC - 4/10).
- **Milestone 18**: Develop end-user workshop materials for use at events. (3Q, 2009 through 4Q 2010). The LiftOne hydrogen fuel cell-powered lift trucks continue to be shown in conjunction with both the projects' deployments and at the Hydrogen 101 Sessions conducted with end-users at the LiftOne branch locations in NC, SC and VA. Moreover, the education sessions were updated to include real-world performance data from the deployments and the evolving cost models for group discussions.

FIGURE 1. LiftOne's Display Booth at the BMW H2 Expo, Greer, SC, November, 2009

- **Milestone 19**: Develop short courses for end-users at technical colleges (3Q, 2010 through 2Q, 2011). The LiftOne Hydrogen 101 Seminar has been condensed for presentations at local technical and community colleges, and includes the live demonstration of the fuel cell power pack. Two additional sessions are planned for the upcoming year.
- **Milestone 29**: Evaluate knowledge and opinion of hydrogen technology of key target audiences and progress toward meeting objectives. (4Q, 2009 through 4Q, 2010). Each Hydrogen education session includes an introduction segment where the hydrogen awareness level of each attendee is assessed. Again, these sessions have primarily included attendees that manage material handling fleets at large companies.

Accomplishments

- Within the past 12 months, LiftOne has successfully executed and concluded five deployments of two CAT® electric sit-down rider lift trucks powered by the Hydrogenics Fuel Cell Power Packs. The data from these deployments were compiled and sent to the National Renewable Energy Laboratory for analysis.
- The final of the project's six deployments commenced in early July and will continue through mid-August. Through theses deployments, end-users are introduced to the benefits of fuel cell power with the hands-on experience of operation and refueling.
- LiftOne's participation at one of the five sites (in conjunction with two other providers), led to an agreement for the eventual acquisition of over 100 fuel cells for a large corporation. The collective effort was a major triumph for the fuel cell industry.
- LiftOne's continued participation at several regional city "Green Business" expos and forums, with live demonstrations of the working fuel cell-powered lift trucks, has provided a large cross-section of businesses with the opportunity to witness this alternative and clean source of fuel cell power. As a result, the general awareness level of hydrogen has been increased in regional areas including Charlotte, North Carolina, and the cities of Greenville, Columbia and Spartanburg in South Carolina.

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 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 (propane, gasoline, diesel) for lift trucks and other material-handling units. As a leading dealership in the Carolinas and Virginia, LiftOne first demonstrated proton exchange membrane (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 in a Web format. 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, provide an excellent method for demonstrating the viability of fuel cell power. The deployments began in May of 2009 and will conclude 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 4-5 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 programs.

Results

Over the past year, LiftOne has seen positive results in both the education and deployment segments associated with the project. Close to 20 hydrogen education sessions have been conducted at the LiftOne branches, at customer locations, at community colleges and at the regional "Green" type business expos attended. At each session or event, LiftOne has included a live demonstration of the working fuel cell-powered lift truck, an essential element necessary to satisfy the interest present and maximize awareness. A positive development has been LiftOne's tailoring of the hydrogen education session content to cater to the specific participating groups. In some cases, the session length has been shortened to encourage optimum participation. LiftOne also conducted a special session on hydrogen safety at the Kannapolis, NC, Fire Department that was transmitted simultaneously to multiple fire stations, and resulted from the fire department's participation at the Deployment #1 Orientation.

For the deployment segment of the project there have generally been medium to excellent results. The deployments were conducted at: 1) Stanley Tools, 2) ABC Company (name withheld by request), 3) Bausch & Lomb, 4) BMW, 5) Electrolux and 6) AGI - In Store (underway presently). There were good results at all sites with regard to run time, truck performance, power, and ease of refueling. At site # 2, there was some component failure on the fuel cell power packs that were corrected with parts replacements. There was never any danger as the system detectors in the packs worked to detect and shut down, while the input gathered allowed the manufacturer to make corrections. All sites were able to experience fuel cell power, with well over 200 employees at each site made aware of the hydrogen power. Site # 4 had particularly good results, and the trial among three fuel cell companies resulted in a large-scale fuel cell adoption by that company (see Table 1). LiftOne was able to self-grade each of the five completed deployments (Table 2).

TABLE 1. Site # 4 - LiftOne Fuel Cell Deployment Summary

LiftOne's Site # 4 - 23 days operated
* Lift Truck / Cell #1 ran 165 hrs
* Lift Truck / Cell #2 ran 190 hrs
* 71 kg of H_2 used / 62 fuelings
* 2.6 minutes average fuel time
* 8.0 hrs avg run time per tank (1.6 kg)
Notes: Best deployment of all five
Straight forks - sideshifter application
Trucks ran great. Fantastic run time.
Trial went well…moving forward.

TABLE 2. Self Grading each of the Five Completed LiftOne Fuel Cell Deployments

LiftOne

Fuel Cell Deployments
Self Grades - Sites 1 - 5

Site #	Participating Company	Time Frame	Grade	Comment
1	Stanley Tool - Concord, NC	May - June '09	A	Trucks ran well, efficiently
2	ABC Co. (name withheld by request)	July - Aug '09	C-	Component issues with fuel cell power packs
3	Bausch & Lomb, Greenville, SC	Oct - Nov '09	B	Trial went OK - low usage operation
4	BMW - Greer, SC	Nov - Dec '09	A	Excellent trial - high usage with 0 issues
5	Electrolux - Anderson, SC	Feb - Mar '10	A	Good trial - trucks worked well

Conclusions and Future Directions

For the second year of the LiftOne hydrogen education project, the following conclusions have been determined:

- The intrigue concerning fuel cells was addressed, as a wide variety of users were able to learn and see the hydrogen fuel cells powering lift trucks in real-world applications.
- The fuel cell power option is a viable method of accomplishing the work in most lift truck applications – however not all applications are ideal, for a variety of reasons.

- The cost justification is not there for every facility; larger fleets are still a requirement.
- Infrastructure cost remains a major concern for companies considering eventual fuel cell adoption.

Future plans for year three of the project involve:

- The hydrogen education sessions will continue at the LiftOne branches, at company sites and in some cases in Web-based formats for larger companies with multiple locations.
- Continued participation at material handling events, seminars and area business expos.
- Continued follow up with completed deployment sites to encourage fuel cell acquisition.

FY 2010 Publications/Presentations

1. Tom Dever, Hydrogen Education Program Director – LiftOne, Presenter and Panelist for "Material Handling Applications – Hydrogen Business Solutions Forum", National Hydrogen Association Conference and Expo, Long Beach, California, May 3, 2010.