XI.8 H-E-B Grocery Total Power Solution for Fuel Cell-Powered Material Handling Equipment

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Project End Date: August 31, 2011

Objectives

- Validate DOE market transformation activities by demonstrating fuel cell forklifts operating in highly transient environments and demonstrating a distributed natural gas-based hydrogen refilling system as a precursor to future automotive fuel cell refilling stations.
- Install one PowerTap™ hydrogen generation system and 14 PowerEdge™ fuel cell power pack units for use in the dry goods and produce sections of the H-E-B Grocery, Inc. (H-E-B), San Antonio, Texas distribution center.

Expected Outcomes

- One PowerTap™ and 14 PowerEdge™ fuel cell systems delivered, installed in forklifts and operated at the H-E-B distribution center.
- Periodic performance reports documenting results from operating systems including any safety or performance data and issues identified during the operation of the units.
- Widespread adoption of hydrogen and fuel cell technology by employing this as a best practice across the H-E-B fleet of 1,000 forklifts upon verification of the value proposition.

Relevance to ARRA and U.S. DOE Fuel Cell Technologies Goals

The project, per the methodology in quarterly reporting via grants.gov, has preserved 2.05 full-time equivalent jobs annualized. In addition, this project facilitates the fuel cell market transformation initiative by deploying 14 fuel cell power pack units and one on-site hydrogen generation system into a strategic early market application for this industry.

Other Accomplishments

- Conducted site planning and secured all required permits and insurance coverage.
- Created a site-specific service plan for both the PowerEdge™ and PowerTap™ products.
- Completed the installation of PowerTap™ hydrogen infrastructure.
- Completed the installation of 14 PowerEdge™ fuel cells in forklift trucks.
- Verified an initial productivity gain of 10% versus operation on standard lead acid batteries.

Introduction

H-E-B is a privately-held, San Antonio, Texas-based supermarket chain with 310 stores throughout Texas and northern Mexico. H-E-B management believes that fuel cell forklifts can help alleviate several issues in their distribution centers including truck operator downtime associated with battery changing (labor savings), truck and battery maintenance costs (expense savings), and reduction of grid electricity usage (environmental savings).

Currently, the H-E-B distribution center operates a total of approximately 300 Class II reach trucks and 700 Class III pallet jacks over two work shifts, for a total of 20 hours per day. There are three temperature zones in the facility, ranging from dry goods at ambient temperature, to refrigerated goods at 34°F (1°C), to freezer goods at -13°F (-25°C). The PowerEdge™ units provided will fit into Class II fork lift trucks designed for use with 1,000 Ah lead acid batteries, and are capable of operation in both the ambient and refrigerated goods temperature zones of the San Antonio facility.

Approach

The approach taken for this installation was to develop a site-specific installation plan that detailed where all hydrogen generation, compression, storage, and dispensing equipment would be placed. As the site plan was being developed, the PowerTap™ and PowerEdge™ equipment was manufactured and delivered to the H-E-B facility, where it was installed in accordance with all required codes and standards. Upon final sign-off from both the local authorities having jurisdiction and the insurance carrier, the forklift fleet was deployed for operation in the grocery and perishable sections of the distribution center alongside forklifts operating with standard lead-acid batteries. The fuel cell forklifts and the battery forklifts will operate in parallel to allow direct comparison between the two, allowing H-E-B and DOE to validate the value proposition associated with the PowerEdge™ and PowerTap™ products.

Market Transformation Barriers

As presented at the Annual Merit Review meeting on June 10th, 2010, the market transformation barriers and risks included "fuel cell operation and maintenance" and "hydrogen station operation and maintenance."

Fuel Cell Operation and Maintenance

Nuvera conducted an engineering trial at H-E-B in early December 2009 to tune the RL25 (PowerEdge™-motive power unit) field configurable parameters for optimal performance in H-E-B's produce warehouse. Discovered that the RL25 was not able to consistently satisfy all of the requirements of the customer's forklift duty cycle, which was considerably more intensive than any duty cycles previously measured. During the peak season demands of November-December, the duty cycle began to approach and exceed the 5 kW sustained maximum power rating of the RL25. As a high productivity warehouse, H-E-B has continually sought to move more pallets, of heavier weight, and be able to store them on higher racks. While the RL25 could effectively keep up with most of the needs of H-E-B's produce warehouse, it could not do so over multiple shifts without requiring a change in H-E-B's fleet operation. After extensive testing of performance and sustainable capability, as of January, 2010, 12 of the 14 trucks were transferred to the grocery warehouse for continuing operation.

Hydrogen Station Operation and Maintenance

For the infrastructure, several challenges specific to project location have been identified:

Environment: High ambient temperatures required design modifications for improved cooling of both the PowerTap™ generation and compression modules. San Antonio averages 111 days per year >90°F. The hydrogen infrastructure also needed to be upgraded to withstand 120 mph winds as tropical storms are prone to come in from the Gulf Coast.

Electrical Power Quality: The San Antonio grid is susceptible to frequent brown-outs and instability of the local 480 V 3-phase power. This required design modifications to reduce sensitivity to momentary disruptions or fluctuations in power.

Natural Gas Quality: The San Antonio region has unusually high levels of mercaptan in the natural gas composition. This has required tailoring of the PowerTap™ desulfurizing media and the replacement schedule in order ensure high fuel processor lifetime and hydrogen purity for the fuel cell vehicles.

City Water Quality: The San Antonio region also suffers from very high water hardness levels. This has required more frequent replacement of membranes in the reverse osmosis water treatment system in order to prevent scaling in the steam generation subsystem.

Results

As presented in Table 1, the build of all 14 PowerEdge™ systems and the PowerTap™ hydrogen refueling equipment was complete as of October 30, 2009. In parallel, Nuvera application engineers, working with H-E-B facility engineers, created site-specific service and installation plans. As part of the process, Nuvera conducted a survey of H-E-B's site to identify potential locations for the on-site hydrogen generation and refueling infrastructure, and applied our knowledge of H-E-B's fleet operation in order to minimize the travel time to the dispensing locations.

Based on the agreed site plan, Nuvera identified and provided basic training to H-E-B service personnel. The role of these service personnel is to keep the PowerEdge™ systems operational by providing a fast response to diagnosing and repairing system faults. This type of service includes scheduled preventive maintenance, basic troubleshooting, and the repair or replacement of non-safety critical items. Nuvera's Customer Care group provided spare parts, training, data analysis, and more complex field support, including troubleshooting and repairs of safety-critical items (high pressure, high voltage).

During this process, all relevant codes and standards were identified, and working with the local authorities having jurisdiction and the H-E-B insurance carrier, all permits were obtained for site construction, installation, and operation.

TABLE 1. Work Breakdown Schedule

Task #	Project Milestones	Milestone Completion Date			
		Original Planned	Revised Planned	Actual	Percent Complete
1	Build	10/30/09		10/30/09	100%
2	Site Plan	10/30/09		10/30/09	100%
3	Deployment	11/30/09	2/28/10	2/28/10	100%
	Go/No-Go: 2 PowerEdges Productivity Trial; certify passing of FAT*; permitting and approvals	11/30/09	12/30/09	12/30/09	100%
4	Confirm Value Proposition	5/31/11	5/31/11		7%
5	Final Testing	7/31/11	7/31/11		0%
6	Project Management and Reporting	7/31/11	7/31/11		25%

* FAT - factory acceptance test. For the PowerEdges, this consisted of a two-week trial with two trucks versus electric stockpickers to verify productivity. For PowerTap, the FAT verified 50 kg daily production and purity.

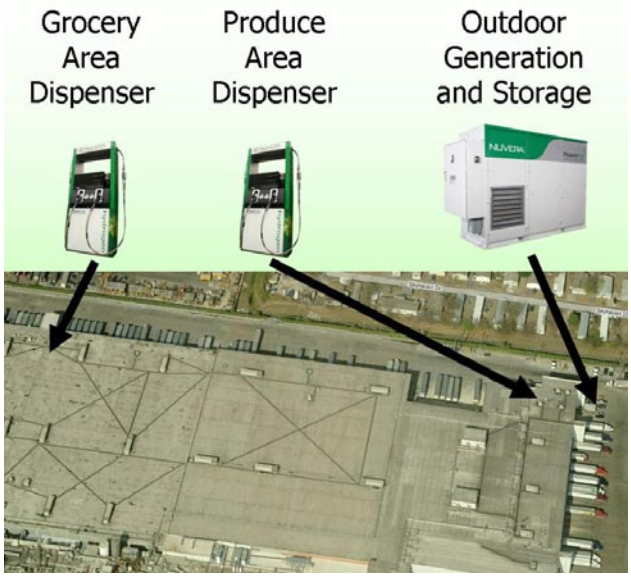

FIGURE 1. Location of Hydrogen Infrastructure at H-E-B Grocery Site

The deployment process began upon establishing the final site plan, shown pictorially in Figure 1, and was completed on February 28, 2010. During this process the following tasks were performed:

Hazards and Operability Analysis: Ensure safe design, installation, and operation of the equipment by rigorously identifying all potential hazards, and quantifying the resulting risks.

Site Layout: Apply knowledge of the applicable national and local codes to ensure proper offset distances between the hydrogen generation and refueling equipment, structures, and potential hazards.

Permitting and Approvals: Submit the site plan to qualified professional engineer for approval. Review the approved site plan with local authorities having jurisdiction with regard to applicable permits and approvals. Obtain applicable permits to allow commencement of site construction activities.

Site Construction: Prepare final site drawings for use by mechanical, electrical, and civil contractors. Source and select appropriate contractors and construct site.

Wireless Data Collection Infrastructure: Deploy a wireless infrastructure that collects operational and fault data from the fuel cell fleet and hydrogen generation and refueling equipment.

Installation, Commissioning, and Training: Deploy the fuel cell fleet and hydrogen generation and refueling equipment and complete the site acceptance test for each. Provide training to the forklift operators regarding safety, operation, refueling procedures, and appropriate responses to system faults.

The resulting deployment of PowerEdge™ fuel cell forklifts and PowerTap™ hydrogen generation, compression, storage, and dispensing products are shown in Figures 2 and 3, respectively.

Since the commencement of full fuel cell fleet operations in March 2010, H-E-B has operated the equipment in normal daily service, and continues to compare the productivity and life cycle costs of operation on a side-by-side basis with standard lead acid battery powered forklifts. Over the first three months of operation, H-E-B reported an increase in productivity of 10% for the PowerEdge™ systems compared to forklifts running on batteries, as shown in Figure 4.

As part of the ongoing project, Nuvera provides data to the National Renewable Energy Laboratory (NREL) using jointly agreed data templates. Information collected during the course of daily operations includes the following:

- Power pack fault code indication
- Service notifications

FIGURE 2. PowerEdge™ Fuel Cell Forklift Fleet at H-E-B

FIGURE 3. PowerTap™ Dispensers (top) and Generation, Compression, and Storage Equipment (bottom) for the H-E-B Fuel Cell Forklift Fleet

- Operating status
- Fuel cell run time
- Fuel cell power

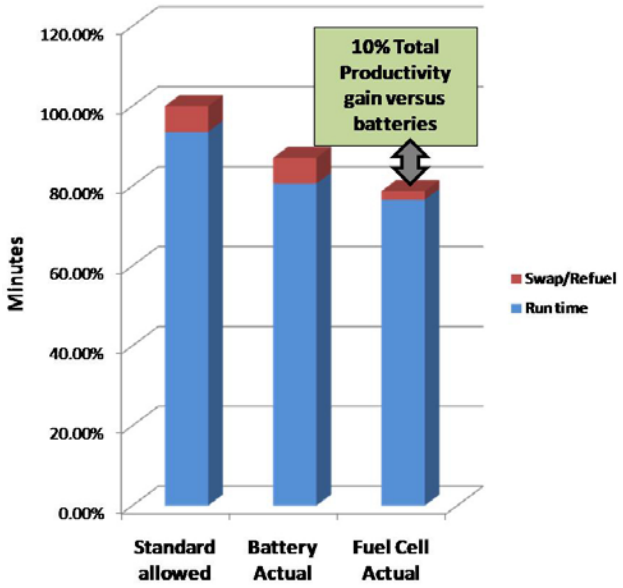

FIGURE 4. Productivity of Fuel Cell vs. Battery Forklift Operation at H-E-B, March to May 2010

- Total kWh energy produced
- Total kWh energy consumed

Conclusions and Future Directions

Currently, the PowerTap™ hydrogen generation, compression, storage, and dispensing system, as well as all 14 PowerEdge™ hybrid fuel cell power systems, are fully operational and are being used in normal daily operations. Over the next 12 months, H-E-B will:

- Continue to operate fleet in normal operations to gain durability and life cycle cost information on the fuel cell systems.
- Monitor and record the long-term operation cost of on-sight hydrogen generation.
- Compile performance data of PowerEdge™ and PowerTap™ systems and send to NREL for analysis.
- Continue to assess the increase in productivity associated with the fuel cell solution in comparison with the lead acid battery forklift.
- Assess whether to increase the size of the fleet as expansion opportunities arise.
- Nuvera completed revisions to safety plan and submitted final version on July 3, 2010.

FY 2010 Publications/Presentations

1. Collins, L. Christian, and Mitchell, William L., *HEB Grocery Total Power Solution™ for Fuel Cell Powered Material Handling Equipment – Fuel Cell Hybrid Power Packs and Hydrogen Refueling,* 2010 U.S. Department of Energy Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting, Washington, D.C., June 10, 2010.