HEB Grocery Total Power Solution™ for Fuel Cell Powered Material Handling Equipment

Fuel Cell Hybrid Power Packs and Hydrogen Refueling

William L. Mitchell
Nuvera Fuel Cells, Inc.
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Project ID # ARR AH2008

This presentation does not contain any proprietary, confidential, or otherwise restricted information
Overview

Timeline
- Project Start – 09/01/09
- Project End – 08/31/11
- Percent Complete: 37% (based on calendar time)

Barriers and Risks
- Fuel Cell Operation and Maintenance
- Hydrogen Station Operation and Maintenance

Budget
- Total Project Funding:
  - Overall: $3,137K
  - DOE: $1,139K
  - Cost share: $2,178K

Partners
- HEB Grocery – Host Site
- DOE

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Project Summary

- **Objectives:**

- **Expected Outcomes:**
  - Periodic reports documenting system performance and any issues
  - Enable widespread adoption of hydrogen and fuel cell technology by employing this across the H-E-B fleet of 1,000 forklifts upon verification of economic/operational advantages
  - Validation of the DOE market transformation activities:
    - Demonstrate forklift operation in highly transient environments
    - Demonstrate a distributed natural gas based hydrogen refueling system as a precursor to automotive stations

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Task Description

- Task 1: Build
- Task 2: Site-specific service plan
- Task 3: Deploy fleet
- "Go/No Go" - To include quantitative metric of customer satisfaction
- Task 4: Confirm value proposition
- Task 5: Final testing
- Task 6: Project management/ reporting
Project Schedule and Status

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Build

- Build RL-25’s and PT-50
  - Fabricate and complete factory acceptance tests (FAT)
  - Build complete as of 10/30/09
  - FAT certification as of 12/30/09
# PowerEdge Fuel cell Overview

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## Product Specifications

<table>
<thead>
<tr>
<th><strong>Rated Power (30 sec)</strong></th>
<th>25 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voltage</strong></td>
<td>36 VDC</td>
</tr>
<tr>
<td><strong>Operating Current Range</strong></td>
<td>-400A to 1150A</td>
</tr>
<tr>
<td><strong>Energy Storage Capacity</strong></td>
<td>35.7 kWh</td>
</tr>
<tr>
<td><strong>Size - in. (mm)</strong></td>
<td>38.2 in. x 20.1 in. x 30.8 in. (970 mm x 510 mm x 781 mm)</td>
</tr>
<tr>
<td><strong>Target Weight - lbs (kg)</strong></td>
<td>2600 lbs (1155 kg)</td>
</tr>
<tr>
<td><strong>Refueling Time</strong></td>
<td>120 sec</td>
</tr>
<tr>
<td><strong>Hydrogen Storage</strong></td>
<td>1.0 kg</td>
</tr>
<tr>
<td><strong>Hydrogen Pressure</strong></td>
<td>5075 psig (350 bar)</td>
</tr>
<tr>
<td><strong>Hydrogen Port</strong></td>
<td>SAE J-2600 H35, CE 0036</td>
</tr>
<tr>
<td><strong>Ambient Operating Temperature</strong></td>
<td>25 to 95°F (-4 to 35°C)</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Indoor Use Only</td>
</tr>
<tr>
<td><strong>Emissions</strong></td>
<td>Water Vapor</td>
</tr>
</tbody>
</table>

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**Notes:**
1. Actual lower limit is dependent on truck upper voltage threshold (value shown based on 440)
2. Based on LHV of H2 at 5075 psig (350 bar), 15°C and 1 hr battery discharge rate
3. System must be stored and started above freezing conditions (4°F, 30°F minimum)
# PowerTap Hydrogen Infrastructure

## PowerTap Hydrogen Generator Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Hydrogen Production</td>
<td>50 kg/day</td>
</tr>
<tr>
<td>Hydrogen Purity</td>
<td>99.995%</td>
</tr>
<tr>
<td>Natural Gas Consumption</td>
<td>7.5 MBTU/day</td>
</tr>
<tr>
<td></td>
<td>222 Nm³/day</td>
</tr>
<tr>
<td>Water Consumption</td>
<td>2400 L/day</td>
</tr>
<tr>
<td>Electrical Consumption</td>
<td>9 kW average</td>
</tr>
<tr>
<td>Size</td>
<td>12 ft x 4 ft x 9 ft</td>
</tr>
<tr>
<td></td>
<td>3.66 m x 1.22 m x 2.74 m</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-4°F to 104°F (-20°C to 40°C)</td>
</tr>
<tr>
<td>Standards Compliance</td>
<td>Designed for CSA, CE</td>
</tr>
<tr>
<td>Environment</td>
<td>Outdoor</td>
</tr>
<tr>
<td>Emissions¹</td>
<td>NOx: &lt;15 ppm</td>
</tr>
<tr>
<td></td>
<td>CO: &lt;50 ppm</td>
</tr>
<tr>
<td></td>
<td>SOx: undetectable</td>
</tr>
</tbody>
</table>

## PowerTap Hydrogen Station Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaseous Hydrogen Source</td>
<td>Steam reformer, electrolyzer or delivered via tube trailer or liquid hydrogen</td>
</tr>
<tr>
<td>Dispensing Rate</td>
<td>500 – 1000 gram/minute</td>
</tr>
<tr>
<td>Dispensing Pressure</td>
<td>5000 psig (350 bar)</td>
</tr>
<tr>
<td>Storage Capacity</td>
<td>Configurable from 12 – 128 kg</td>
</tr>
<tr>
<td>Compressor</td>
<td>Hydraulically driven intensifier</td>
</tr>
<tr>
<td>Electrical Consumption</td>
<td>12 kW average</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-4°F to 104°F (-20°C to 40°C)</td>
</tr>
<tr>
<td>Standards Compliance</td>
<td>System Designed to: CSA HGV4 &amp; NFPA 52 Dispenser Nozzle: SAE J2600-H35 Type A Compliant</td>
</tr>
<tr>
<td>Environment</td>
<td>Compression and Storage: Outdoor Dispenser: Indoor or Outdoor</td>
</tr>
</tbody>
</table>

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¹ Emissions are subject to operating conditions and maintenance.
Site Planning

- Powertap Location
- Dispenser 1: Refrigerated Warehouse
- Dispenser 2: Grocery Warehouse

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Safety Plan

- Nuvera to comply with the DOE Safety Planning Guidance for Hydrogen Projects
  - Appendix IV Safety plan Checklist
  - Consistent with commercial requirements of applicable codes and standards
  - Product Electrical zone classification
  - Product FMEA
  - Site HAZOP
  - 3rd party PE review
  - Permits and AHJ reviews
  - Operating manuals
  - Service manuals
  - Hydrogen Safety training
Deploy Fuel Cell Truck Fleet

- Deploy Fleet
  - Site Planning
  - Hazards & Operability Analysis (HAZOP)
  - Site layout
  - Permitting & Approvals
  - Site Construction
  - Wireless Data Collection Infrastructure
  - Installation, Commissioning & Training

- Result: safe, code compliant, and cost-effective installation
Deploy Hydrogen Infrastructure

- Installed according to NFPA 52
  - Indoor Dispenser in Produce Distribution Warehouse
  - Indoor Dispenser in Grocery Warehouse
  - Outdoor PowerTap generation, compression, and storage system
- All permits and insurance in place
- All systems operational
Site Specific Service Plan

- **Service Plan**
  - Nuvera Customer Care will provide safety & service training, spare parts, data analysis, warranty, and factory service support

- **H-E-B to be the local Service Providers for PowerEdge**
  - 1st Responder Role: minimize customer downtime
  - Tier-1 Service training
    - Operator training
    - Schedule maintenance
    - Basic diagnostics and repairs
  - Tier-2 Service qualification
    - Advanced qualification for safety critical repairs (high pressure/voltage)

- **Airgas to be the local service provider for the PowerTap**

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Confirm Value Proposition

- Confirm Value Proposition
  - Compile performance data of PowerEdge and PowerTap
    - Analysis by NREL
  ✓ Assess productivity gains and operating costs
  ✓ Validate the value proposition model
    - Update assumptions based on data generated

- H-E-B to assess whether to expand the fleet
  - Nuvera to develop PowerEdge models for use in additional forklifts types and applications
Initial Productivity Testing

- 3 month average – January - March 2010

- Reduced truck maintenance also expected – to be confirmed during operation

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Future Work

- 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.
Summary

- Completed installation of PowerTap hydrogen infrastructure
- Completed Installation of 14 PowerEdge fuel cells in forklift trucks
- Verified initial productivity
- Expansion opportunities identified
- Continued operation will verify long term durability and life cycle costs
William L. Mitchell
Vice President
Nuvera Fuel Cells
(617) 245-7623
mitchell.w@nuvera.com

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