Hydrogen Fuel for Material Handling

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7201 Hamilton Blvd., Allentown PA 18195
Fuel Cell Packs for MHE
Form, Fit and Function Battery Replacement

Courtesy of Ballard Power Systems
## MHE Classes and Pack size

<table>
<thead>
<tr>
<th>Class</th>
<th>4kW Dimensions</th>
<th>9kW Dimensions</th>
<th>14kW Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS 1 Forklift</td>
<td>LWH 32 x 38.6 x 22.7&quot;</td>
<td>LWH 38.7 x 18.0 x 30.5&quot;</td>
<td>LWH 32 x 38.6 x 22.7&quot;</td>
</tr>
<tr>
<td>CLASS 2 Forklift</td>
<td>LWH 31.1 x 13.2 x 31.6&quot;</td>
<td>LWH 31.1 x 13.2 x 31.6&quot;</td>
<td>LWH 38.7 x 18.0 x 30.5&quot;</td>
</tr>
<tr>
<td>CLASS 3 Forklift</td>
<td>LWH 31.1 x 13.2 x 31.6&quot;</td>
<td>LWH 31.1 x 13.2 x 31.6&quot;</td>
<td>LWH 31.1 x 13.2 x 31.6&quot;</td>
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Courtesy of Plug Power
Value to the MHE Market

- Trend has been toward electric
  - Indoor air quality issues

- Early adopter of fuel cell technology
  - Fleet market
  - Central Fueling
  - Economic Benefits

- Replacement of batteries with fuel cell “packs”
  - Increased productivity
## The Value Proposition!

<table>
<thead>
<tr>
<th>Battery Baseline</th>
<th>Fuel Cell Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6 hours run-time in heavy apps</td>
<td>Run 2 to 3 times as long</td>
</tr>
<tr>
<td>Take up to 8 hours to recharge</td>
<td>Refueled in 3- 5 minutes</td>
</tr>
<tr>
<td>Battery rooms take up valuable floor space</td>
<td>No battery room required</td>
</tr>
<tr>
<td>Tie vehicles to centralized battery rooms</td>
<td>Fuel dispensers distributed in facility</td>
</tr>
<tr>
<td>Vehicle downtime for battery changing</td>
<td>No battery related productivity losses</td>
</tr>
<tr>
<td>Battery discharge voltage - machines slow down and incur motor damage</td>
<td>Constant voltage, vehicles never slow down</td>
</tr>
</tbody>
</table>
MH Market

- Any location with a large material handling fleet
  - Forklifts, Tugs, AGV’s combined
- Manufacturing Facilities
  - Auto assembly and parts
- Distribution Warehouses
- Defense Depots
  - Defense Logistics Agency
Fueling Infrastructure for MH Market

Hydrogen Fuel Supply → Pumps → Vaporizers → High-Pressure Storage → Dispenser
Technology Demonstration

- Typically one week to a month deployment
- Outdoor refueling
- Supported by our extensive fleet of mobile fuelers
- Customers get the “feel” of the technology
- Couple of dozen a year
Pilot Programs

- Extended demonstration – 3 months to a year
- Indoor preferred
- Anticipation of long-term deployment
- Supported through on-purpose built tube trailer supply and specialized HYDRA liquid trailers
Phased Conversions

- Manufacturing facilities
  - Conversion started in January 2007
  - Short term gas supply
  - Grow out around 30 kg/day
  - Specialized HYDRA liquid trailers
Intermediate ramp up phase

- Delivered Liquid system
- Multiple dispensing nodes
- System reliability
Powering DoD Warehouse Equipment

...DLA Hydrogen Fuel Cell Pilot

Helping DDSP go GREEN

- 936 dispensing transactions in one month
- Largest user in US for indoor dispensing
Central Grocers, Inc.

- Liquid supply
- Three indoor dispensers
- Opened on 03/29/2009
- Greenfield site
- Largest FC fleet in the world
Numerous projects in the pipeline

tell me more!

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Thank you