
Webinar
27th November, 2013

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Energy Generation & Supply KTN

A dynamic network delivering strategic value to the UK energy sector

by enabling

- accelerated innovation
- access to funding
- partnerships
- international engagement
- cross-sector links
- technology deployment
EG&S KTN Priority Areas

- Offshore Wind
- Carbon Abatement Technologies
- Nuclear
- Maximising Oil & Gas Resources
- Wave & Tidal
- Fuel Cells & Hydrogen
- Future & Emerging Opportunities

Representing the UK Hydrogen and Fuel Cell Industry
Membership of the EG&S KTN is free of charge and provides multiple benefits, including:

- greater awareness of developments in the energy space, particularly the cross-cutting issues
- the opportunity to attend regular workshops and networking events,
- the opportunity to participate in webinars,
- access to reports and other KTN materials,
- participation in focus working groups, and
- insights into new funding opportunities and key developments across the fuel cell and hydrogen landscape

...over 4,500 members
Events: Stimulating access to funding

Fuel cells manufacturing and supply chain Competition – Consortium Building Event, November 2013
Joint TSB and EG&S KTN workshops on “Fuel Cell Manufacturing and Supply Chain”, August / September 2013
Joint TSB, EG&S KTN and RCUK workshop on “Outstanding Business and Research Challenges for Hydrogen”, May 2013
Joint EG&S KTN and EU Energy Focus webinar on the FCH JU 2013 Call, March 2013

Events: Exploring specific themes
Power to Gas: New Opportunities - webinar, March 2013

Expanding your reach into energy – we can help you:
Find new partners / build new relationships
Gain deeper understanding of challenges and opportunities and how you can respond
Access new funding

Facilitating on-line collaboration
Focus work groups to support new Calls
On-line sub-groups to provide a focus for specific interests / activities
Private groups to allow sharing and exchange
Representing the UK Hydrogen and Fuel cell industry.
Accelerating the commercialization of fuel cell and hydrogen energy.
Helping fuel cells and hydrogen energy to become a key component of a low carbon economy – reducing greenhouse gases, enhancing energy security and delivering ‘green collar’ jobs.

We cover:
- All fuel cell types and applications;
- The full fuel cell supply chain (from research into material science through to systems integration and distribution);
- Hydrogen production and storage;
- Hydrogen infrastructure; and
- Other issues around the delivery, storage and use of associated fuels.
Webinar tips

- Please type any questions that arise during the presentations in the chat box. These will be addressed to speakers during the Q&A part of the webinar.

- If you face any technical difficulties please send Nikoleta a private note via the chat box by choosing her name from the list, give her a call on 07580 945008 or send an e-mail at n.piperidou@synnogy.co.uk.

- Please keep your microphones muted throughout the session to avoid interference.
This event will:

- Provide an overview of U.S. and European developments in fuel cell material handling
- Explain how DOE support and other activities have helped stimulate the sector
- Give a commercial view of recent progress and prospects for further growth, both in the U.S. and Europe
Agenda

- 14.00pm  Introduction, Celia Greaves, Energy Generation and Supply  KTN and UK Hydrogen and Fuel Cell Association
- 14.10pm  U.S. DOE funded performance validation of fuel cell material handling deployments and current status, Jennifer Kurtz, National Renewable Energy Laboratory
- 15.10pm  Q&A session
- 15.30pm  Close
FCMHE Validation Overview

• U.S. DOE enabling early fuel cell markets
• National Fuel Cell Technology Evaluation Center objectives
• FCMHE Performance Status
Enabling Early Markets

Deployments help catalyze market penetration and ensure continued technology utilization growth while providing data and lessons learned.

Leveraging DOE Funds:
Government as “catalyst” for market success of emerging technologies.

~9,000 ADDITIONAL FUEL CELL LIFT TRUCKS AND BACKUP POWER UNITS PLANNED OR INSTALLED with NO DOE funding

Examples of industry* sectors in DOE ARRA projects
• Telecommunications (e.g. AT&T, PG&E. Sprint, etc.)
• Distribution Centers/Warehouses (e.g. FedEx, Genco, Sysco, Wegmans, Whole Foods, etc.)

DOE cost-shared deployments led to >5X additional purchases and orders.

*Provided as examples and not intended as endorsement

DOE FCTO Fall 2013
http://www1.eere.energy.gov/hydrogenandfuelcells/presentations.html
The Case for Fuel Cell Forklifts

Fuel cell forklifts offer several advantages compared to conventional forklift technology

Preliminary Analysis

- Compared to conventional forklifts, fuel cell forklifts have:
  - 1.5 X lower maintenance cost
  - 8 X lower refueling/recharging labor cost
  - 2 X lower net present value of total system cost

Preliminary Analysis: Comparison of PEM Fuel Cell- and Battery-Powered Forklifts

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<thead>
<tr>
<th></th>
<th>PEM Fuel Cell Forklifts</th>
<th>Battery-Powered Forklifts</th>
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<tbody>
<tr>
<td>Time for Refueling/Changing Batteries</td>
<td>4-8 min/day</td>
<td>45-60 min/day (for battery change-outs) 8 hours (for battery recharging &amp; cooling)</td>
</tr>
<tr>
<td>Labor Cost of Refueling/Recharging</td>
<td>$1,100/year</td>
<td>$8,750/year</td>
</tr>
<tr>
<td>NPV of Capital Costs (including fuel)</td>
<td>$12,600 ($18,000 w/o incentives)</td>
<td>$14,000</td>
</tr>
<tr>
<td>NPV of O&amp;M Costs</td>
<td>$52,000</td>
<td>$128,000</td>
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</tbody>
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Published Fact Sheets & Case Studies

DOE FCTO Fall 2013
http://www1.eere.energy.gov/hydrogenandfuelcells/presentations.html
NFCTEC Analysis Approach

Analysis and reporting of real-world operation data

Operational and Performance Data

NREL Data Analysis

NFCTEC

National Fuel Cell Technology Evaluation Center

Results

DDPs

Confidential

Detailed Data Products (DDPs)
- Individual data analyses, shared only with partner supplying data
- Identify individual contribution to CDPs

Composite Data Products (CDPs)
- Aggregated data across multiple systems, sites, and teams
- Publicly available analyses, published without revealing proprietary data

www.nrel.gov/hydrogen/proj_tech_validation.html
Objectives

Assess the technology status in real world operations, establish performance baselines, report on fuel cell and hydrogen technology, and support market growth by evaluating performance relevant to the markets’ value proposition

• **Assess technology**
  - Perform independent technology assessment in real world operation conditions
  - Focus on fuel cell system and hydrogen infrastructure: performance, operation, and safety
  - Leverage data processing and analysis capabilities developed under the fuel cell vehicle Learning Demonstration project
  - Evaluate material handling equipment (MHE) and backup power
  - Analysis includes up to 1,000 fuel cell systems deployed with American Recovery and Reinvestment Act (ARRA) funds

• **Support market growth**
  - Provide analyses and results relevant to the markets’ value proposition
  - Report on technology status to fuel cell and hydrogen communities and other key stakeholders such as end users
Validation of MHE is based on real-world operation data from high-use facilities.

**1,859,616**
Operation hours

**291,114**
Hydrogen fills

**490**
Units in operation*

**4.4**
Average operation hours between fills

**232,551**
Hydrogen dispensed in kg

**0.6**
Average fill amount in kg

**2.3**
Average fill time in minutes

*One project has completed

Valid operation of MHE is based on real-world operation data from high-use facilities.
More than 50% of stacks have projected hours to 10% voltage degradation >10,000 hours.

Projected Hours to 10% Voltage Degradation

1) Projection using field data, calculated at high stack current, from operation hour 0. Projected hours may differ from an OEM's end-of-life criterion and does not address "catastrophic" failure modes.
2) Indicates stacks that are no longer accumulating hours either a) temporarily or b) have been retired for non-stack performance related issues or c) removed from DOE program.
3) Projected hours limited based on demonstrated hours.
Published MHE Cost of Ownership Report

Cost advantage per unit is ~$2,000/year for the average high-use facility with Class I and II fuel cell lift trucks analyzed by NREL

Key Findings
- Cost advantages dependent on deployment size and use (i.e., multi-shift operation per day)
- H₂ fuel cell cost advantages in maintenance, warehouse infrastructure space, and refueling labor cost
- H₂ fuel cell cost disadvantages in infrastructure and fuel cell cost and hydrogen cost

Report Sections
- Inputs, assumptions, and results for Class I/II and Class III
- Sensitivity study
- Intensive deployment scenario
The maximum daily fill count for two sites was >200 fills. Those two sites average nearly 100 fills per day.

Average daily fills considers only days when at least one fill occurred.
Infrastructure Reliability Analysis

Site MTBF (Calendar Days In Operation): Infrastructure

Infrastructure consistently delivering 250 and 350 bar fills even though the majority of the sites have a MTBF of 25 days or less.

Delivered H2 Maintenance Count by Category
1,330 Maintenance Events
63% unscheduled

- Compressor 51%
- Control Electronics 20%
- Dispenser 19%
- Air System 10%

1. Cumulative Mean Time Between Failure
Compressor and dispenser repairs consistent over evaluation period.

*Calculated as a percentage of all maintenance each month; bars may not total to 100% if other maintenance categories were present.
Consistent across all sites are failures with control electronics and hydrogen compressors. These two categories have low MTBF.
Breakdown of Failure Modes for Top Four Maintenance Categories for Infrastructure

There are many different failure modes for the top four categories and these modes provide insight for RD&D needs.
Majority of MHE safety reports (217) are minor hydrogen leaks 
(*4,480 stack hours per report*)

By Number of Incidents 
Total Incidents = 7

- Control Electronics: 29%
- Electrical: 14%
- FC Stack: 14%
- Fittings & Piping: 14%
- Fuel System: 14%
- Operator Protocol: 14%

Majority of infrastructure safety reports (82) are hydrogen leaks primarily from the hydrogen compressor and plumbing 
(*2,879 kg dispensed per report*)

By Number of Incidents 
Total Incidents = 21

- Dispenser: 90%
- Compressor: 5%
- Valves: 5%
- Misc: 5%

An INCIDENT is an event that results in:
- a lost time accident and/or injury to personnel
- damage/unplanned downtime for project equipment, facilities or property
- impact to the public or environment
- any hydrogen release that unintentionally ignites or is sufficient to sustain a flame if ignited
- release of any volatile, hydrogen containing compound (other than the hydrocarbons used as common fuels)

A NEAR-MISS is:
- an event that under slightly different circumstances could have become an incident
- unplanned H2 release insufficient to sustain a flame
Technical Summary—*What We’ve Learned*

• Operating with an average availability of ~98% at eight end-user facilities.
• Most systems operate at least 6 hours a day.
• Cost of ownership comparison between fuel cell and battery MHE indicate significant cost savings for refueling labor and infrastructure space but much greater cost for hydrogen infrastructure and fuel.
• MHE infrastructure can provide insight into infrastructure performance for the light duty vehicle application.

Aggregated data showcase performance over the last two years in MHE and backup power.

Performance results address a need for published results on the technology status.

Data analyses develop as systems operate and based on the key performance areas in the markets.
This project is supported by the U.S. Department of Energy Fuel Cell Technology Office EERE, Jason Marcinkoski, Sara Dillich, & Pete Devlin

Jennifer Kurtz
jenner.kurtz@nrel.gov

Image Source: NREL
This communication contains statements that are not historical facts and are considered forward-looking within the meaning of Section 27A of the Securities Act and Section 21E of the Exchange Act. These forward-looking statements contain projections of our future results of operations or of our financial position or state other forward-looking information. We believe that it is important to communicate our future expectations to our investors. However, there may be events in the future that we are not able to accurately predict or control and that may cause our actual results to differ materially from the expectations we describe in our forward-looking statements. Investors are cautioned not to unduly rely on forward-looking statements because they involve risks and uncertainties, and actual results may differ materially from those discussed as a result of various factors, including, but not limited to: the risk that we continue to incur losses and might never achieve or maintain profitability, the risk that we expect we will need to raise additional capital to fund our operations and such capital may not be available to us; the risk that we do not have enough cash to fund our operations to profitability and if we are unable to secure additional capital, we may need to reduce and/or cease our operations; the risk that a "going concern" opinion from our auditors, KPMG LLP, could impair our ability to finance its operations through the sale of equity, incurring debt, or other financing alternatives; the recent restructuring plan we adopted may adversely impact management’s ability to meet financial reporting requirements; our lack of extensive experience in manufacturing and marketing products may impact our ability to manufacture and market products on a profitable and large-scale commercial basis; the risk that unit orders will not ship, be installed and/or converted to revenue; the risk that pending orders may not convert to purchase orders; the risk that our continued failure to comply with NASDAQ’s listing standards may result in our common stock being delisted from the NASDAQ stock market, which may severely limit our ability to raise additional capital; the cost and timing of developing, marketing and selling our products and our ability to raise the necessary capital to fund such costs; the ability to achieve the forecasted gross margin on the sale of our products; the actual net cash used for operating expenses may exceed the projected net cash for operating expenses; the cost and availability of fuel and fueling infrastructures for our products; market acceptance of our GenDrive systems; our ability to establish and maintain relationships with third parties with respect to product development, manufacturing, distribution and servicing and the supply of key product components; the cost and availability of components and parts for our products; our ability to develop commercially viable products; our ability to reduce product and manufacturing costs; our ability to successfully expand our product lines; our ability to improve system reliability for our GenDrive systems; competitive factors, such as price competition and competition from other traditional and alternative energy companies; our ability to protect our intellectual property; the cost of complying with current and future federal, state and international governmental regulations; and other risks and uncertainties discussed under "Item IA—Risk Factors" in Plug Power’s annual report on Form 10-K for the fiscal year ended December 31, 2012, filed with the Securities and Exchange Commission (“SEC”) on April 1, 2013 and as amended on April 30, 2013 and the reports Plug Power filed from time to time with the SEC. These forward-looking statements speak only as of the date on which the statements were made and are not guarantees of future performance. Except as may be required by applicable law, we do not undertake or intend to update any forward-looking statements after the date of this communication.
Premier System Integrator of PEM Fuel Cells

Leader in development and production of clean, commercial energy solutions for the material handling industry.

- Founded in June 1997
- World class manufacturing facility in upstate NY
- Over 150 employees
- 152 issued patents
- Over 5,000 GenDrive fuel cell units in the field, accumulating over 20 M hours runtime
- Plug Power holds over 90% of the fuel cell market in the material handling industry
- European Expansion through the JV with Air Liquide
Plug Power: Poised for Profitability

Today’s focus: material handling market

- Endorsed via an investment by Air Liquide, a leading industrial gas firm
- Significant and new customers are buying
- Quality problems behind us
- EBITDA profitability within reach
- Success in materials transport is generating interest (and development funds) from adjacent markets

This is the first step toward Plug Power’s long-term goal to displace lead-acid batteries and diesel engines in a broad array of applications.
HyPulsion - European Joint Venture Created 2012

- Luc VANDEWALLE : Managing Director
- Warren BROWER : Product, Marketing, OEM Director
- Paul DEPREZ : Sales & After Sales Director
- Sosthene GRANDJEAN : Program Management
- Camille VRIGNAUD : Customer Support – Service Technician
- Arnaud CERCEAU : Operations & Manufacturing
- Michael NINDEL : Business Dev. Germany
- Ranjieve WILLIAMS : Engineering Director European Team
- US Engineers : 7 Design Engineers (Plug Power)
HyPulsion JV is Bearing Fruit

• HyPulsion has completed one year of business and product development activities
  • Shipment of product has begun in multiple countries with multiple OEMs
• Market opportunity greater than North America
• 9 CE certified products with multiple configurations available for deployment
• Collaboration projects in place with 7 fork lift OEMs
  • Includes Jungheinrich, TMHE, Linde/Fenwick, Still, Crown, NACCO, Airmarrel
### GenDrive Products

<table>
<thead>
<tr>
<th>GenDrive® Products</th>
<th>Operational Benefits</th>
</tr>
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<tbody>
<tr>
<td>Counterbalanced Trucks</td>
<td>• Increased Productivity</td>
</tr>
<tr>
<td>Reach Trucks</td>
<td>• Reduced Operational Costs</td>
</tr>
<tr>
<td>Rider Order Picking Trucks</td>
<td>• Additional Commercial Space</td>
</tr>
<tr>
<td></td>
<td>• Reduced Carbon Emissions</td>
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</tbody>
</table>

- Increased Productivity
- Reduced Operational Costs
- Additional Commercial Space
- Reduced Carbon Emissions
Total Power Solution

- **Hydrogen Infrastructure**
  - Delivery, Storage and Compression on exterior

- **Dispensing**
  - Performed by operators in convenient location (part of work flow)
  - Three step process < 3 minutes
    - Data collection cable
    - De-watering hose
    - Hydrogen nozzle
  - Multiple locations if needed
    - Opportunity filling
    - Eliminates drive time and queuing
  - Mobile Hydrogen Solution for Demonstration

Refueling station:
1. Source of hydrogen
   - Delivered in bundles, tube trailers or pipelines.
2. Compression phase
   - Hydrogen is compressed at 350 bar.
3. Storage
   - Hydrogen is stored in pressure vessels known as buffers.
4. Dispenser
   - Hydrogen is filled at 350 bar, into the fuel cell tank in 3 minutes only.
5. Central control
   - It enables control and monitoring hydrogen refueling.

Fuel cell:
- It combines hydrogen with oxygen from air to produce power. Electricity is generated in an electrochemical process. The output from the process includes electricity, water and heat.
Applications and Markets

- Full suite of GenDrive fuel cell products to meet material handling customer needs
  - SAM Address 40% of today’s TAM*

- Address greenfield/brownfield sites in the markets:
  - Retail and Food Distribution
  - Manufacturing

- Potential for market expansion into Asia

*SAM: Serviceable Addressable Market
TAM: Total Available Market
Expanding the Opportunity in the $20B Material Handling Industry

North American shipments have been isolated to 40% of the total fork truck population

<table>
<thead>
<tr>
<th>Segment</th>
<th>Experience</th>
<th>Hydrogen Solutions</th>
<th>Market Size QTY*</th>
<th>Market Size USD**</th>
</tr>
</thead>
</table>
| North America | Large | 6 Years (1 Year onsite generation) | • Delivery with on-site liquefied storage  
• Large on-site generation w/ gaseous storage | 15% (~180 K) |  |
| | Medium | 6 Years (1 Year onsite generation) | • Delivery with on-site liquefied or gaseous storage  
• Small on-site generation w/ gaseous storage | 25% (~300 K) | $4.2 Billion |
| | Small | 1-3 Years | • Delivery with gaseous storage  
• Small on-site generation w/ gaseous storage | 20% (~240 K) |  |
| | Retail | Under development | • Under development | 40% (~480 K) |  |
| Europe | All | 1 Year | • AL advanced hydrogen fueling stations | ~1,700 K | $5.7 Billion |
| Japan & China | All | N/A | • Under review | N / A | $7.8 Billion |
| ROW | All | N/A | • Under review | N / A | $2.1 Billion |

Low-cost Hydrogen Infrastructure is Crucial to Expansion

* Sources: Analysis of Industrial Truck Association data, JVIA, and ongoing management discussions with OEM’s
NA Customer Base Continues to Grow

- 44 total site deployments with 24 different customers
- 29 brownfield sites
- 15 greenfield sites
- More than 5,000 units shipped
- >8,000 fills per day by customer
- More than 5,000 kg of H₂ dispensed per day
European Customer Traction Growing

High Throughput Distribution Centers

Consumer & Retail Distribution Centers

Manufacturing Facilities
Future Market Expansion

• Targeting adjacent markets that have the same dynamics as materials handling
  • Ground Support Equipment – 60,000 units deployed
  • Big Rig Transportation Refrigeration Units – 290,000 units deployed
  • Range extenders for heavy-duty electric vehicles
    • President Obama target: 1M electric vehicles by 2015

• Significant development funds provided by external agencies
  • DOE: grant for Bridge Terminal Transport tuggers (BTT)
    • $2.5 Million
  • NYSERDA: $500,000 for TRUs
  • DOE RFP: planned application for range extenders
Summary

- Plug Power is the premier system integrator for PEM fuel cells
  - Materials handling first mover advantage – 90% market share; HyPulsion JV gives us same advantage in Europe
  - Air Liquide now a key strategic investor and joined board of directors
  - Compelling customer experience with Fortune 500 client list – 4,000 units to 24 firms
  - Growing opportunities in adjacent markets with outside entities committing development funds
  - Momentum in lower-cost Hydrogen solutions is rapidly expanding our opportunities
- Material handling success is the first step to our goal of profitably displacing diesel engines and batteries with fuel cells in a wide array of applications