Hydrogen as a Fuel

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Business Development
Changing the way the world moves by developing industry-leading hydrogen fuel cell energy solutions for high growth markets around the globe
Plug Power is the Leader in Hydrogen and Fuel Cell Technology

- 1st to create a market for HFC technology
- 5x revenue growth since 2013
- 20K+ units in the field
- 13MM+ Hydrogen fuelings
- 180MM+ operating hours
- 150 HFC patents
- 80% Blue Chip Customer Base
- 70% reduction in cost profile since 2013
- 150 MM+
# Full Product Suite Accelerates Customer Adoption

## Fuel Cell Technology

### Fuel Cell Stacks and Systems

**PROGEN**
- High-power and air-cooled designs
- Lower cost / higher performance
- 35+ years of Plug Power IP

### Fuel Cells for Stationary Applications

**GENSURE**
- 10,000+ units in the field worldwide
- High reliability with 99.6% uptime
- Environmentally hardened from -20F to 120F

### Hybrid Fuel Cell Solutions for Forklifts

**GENDRIVE**
- 20,000+ units in the field
- Drop-in replacement
- 180MM+ operating hours

## Fueling Infrastructure and Delivery

**GENFUEL**
- 60+ installed sites
- 300+ hydrogen dispensers
- 15K+ fuelings / day, 13MM+ total

## Complete Service and Maintenance

**GENCARE**
- 98+% uptime performance
- IoT data collection, monitoring and control
- driving efficiency and uptime
Infinite Drive: Distribution Center Operations

Product suite for Class 1 / 2 / 3 = Complete DC conversion

- Maximize work time with Fast Fills
- Re-purpose and Improve labor deployment
- Increased Productivity by maximizing picks per hour
- Re-purpose battery room into productive space
- Electrical Grid Independence
- Eliminate toxic and hazardous material
- Zero tailpipe emissions

Plug Power holds more than 90% of the hydrogen battery fuel cell market in the material handling industry.
Fork Truck Economics

According to accumulated field data presented at MODEX2014* the cost to operate a class 1, 2, or 3 MHV is dominated by these TWO factors.

By switching to hydrogen, a small change in energy costs pays huge vehicle and labor dividends.

*As presented by TotalTrax: www.youtube.com/watch?v=IRV_YqVyGVE
Loyal “Blue Chip” Customers Globally
Why We Entered Material Handling

- Clear Value Proposition
- Large Addressable Market
- Natural Entry to New Markets
- Hydrogen Fueling Available
- Cost Reduction Path
Fuel Cells will Enable the Key Trends in the Motive Industry

Each trend is driven by the value customers place on time, reliability, convenience, predictability, and cost savings

Fuel Cell Vehicles are Electric Vehicles with Significant Enabling Traits

Adaptability
- Wide span of addressable power ranges (50W to >30 kW)
- Performance and cost optimization through hybrid design
- Enables a variety of use cases including delivery trucks/vans, busses, cars, industrial vehicles, robots, drones, etc.

High Energy Density
- Energy scales with hydrogen storage
- Enables longer range, heavier payloads, increased hotel loads (sensors, communications, active devices)

Fast Refueling
- Quick turn-around of high-value assets
- Enables 24/7 operations to address ever-increasing consumer demand

Scalable Infrastructure
- Scales with increased fleet size and energy needs
- Enables rapid deployment and scaling of EV platforms

Renewable Fuel Options
- Available today; scaling rapidly with expansion of renewable power and advancements in hydrogen conversion technologies
- Enables truly flexible and renewable fuel options for transportation
Fuel Cells Hasten Changing Market Dynamics

Heavy use cases, heavy loads and long ranges are enabled by fuel cell technology.
Hydrogen fueling system deployment: driven growth of fuel cells within material handling market

Today, Plug Power has dispensed more hydrogen into fuel cells than anyone!
Proven H2 Supply: GenFuel

Total H2 Dispensed: 8,194,122 kg
Total H2 Fills: 13,353,790
Background: US Hydrogen Market

• North America is unique in the world with the amount of liquid hydrogen infrastructure:
  • Direct result of the space program
  • All >>20 years old
  • Stressed a model of large central generation and widely distributed customers
  • Capacity being strained due to addition of Plug Power customers and consumer sites in CA
  • First new capacity coming on this year (UHG (TN), Air Liquide/AirGas (KY))

• Other geographies have not made the investment in liquid, generally resulting in higher delivered molecule prices

• Fueling applications (350/700 bar) have added challenges and complexity to the supply chain – capacity, cost, reliability, etc.

• “Green” demands increasing (even outside of CA)
Transition to Hydrogen as a Fuel

• Fuel is where the growth in the hydrogen market is centered
• Traditional commercial/industrial users had to use hydrogen, so molecule costs were less of a focus
• In many cases, fuel applications are driven by pricing, as they are compared to alternates (electricity, gasoline, natural gas, etc.)
• Hurdles as we transition to hydrogen as a fuel include:

  • Capital risk: Other fueling infrastructure has been built and paid for, but for hydrogen, who pays for the new infrastructure? Who is willing to finance it? Who is willing to take the risk of uncertainties of H2 as a fuel, future technology advances, unknown demand, high fixed costs, etc.?
  • Compression and Storage: Fuel users need to keep or convert the molecule to high pressures (350 or 700 bar) for storage or use in their applications.
  • CapEx: As a result, fuel users need to add expensive equipment to convert and manage the gas at high pressures.
  • Efficiency: The added equipment, in many cases, causes additional handling/conversion losses, reducing system efficiencies and increasing costs.
  • Green: Users increasingly are looking to new energy carriers to be sustainable, minimizing their impact on the environment.
  • Safety Impressions: Users and the general public continue to have concerns about safety.
  • Cost Impressions: Adoption of EV platforms incorrectly drives comparison to grid electricity costs.

Molecule Cost
Capital Cost
Capital Risk/Allocation
Pace of Adoption
Hydrogen is the Enabler of the Sustained Growth of Fuel Cell Applications

Future hydrogen systems need to be:
- Reliable
- Proven
- Lower Cost (Molecule and CapEx)
- Increasingly Green

Leveraging existing technology to increase range & power

- **Captive**
  - Today
    - Vehicles within a defined space
      - e.g. Forklifts, Ground Support
  - TODAY & NEAR HORIZON
    - Vehicles that return home each night
      - e.g. FedEx, USPS
- **Tethered**
  - Vehicles stay in a defined region
    - e.g. Utility, delivery, buses, drones
- **Local**
  - 4-6 YEARS
    - Supports broader range than local area
      - e.g. Taxis, longer range buses, trucks
- **Regional**
  - 6 YEARS+
    - Supports broader range than regional area
      - e.g. Personal vehicles
H2 Opportunity

**TODAY**

![Map of North America with markers indicating green and non-green H2 suppliers.]

- **H2 as an Industrial Gas**
  - IGCS do not think of H2 as a fuel
  - Pass through cost to customers
  - Option on future advances

**2-4 YEARS**

- **Distributed Generation**
  - Technology and demand advances H2 as a fuel
  - Local and regional deployments and business models will further drive adoption
  - Consumer adoption further accelerates cost/performance curve

**6-10+ YEARS**

- **H2 as a Renewable Fuel**
  - Leverage low-cost renewable energy
  - Additional benefit stranded power opportunities
  - Accelerated tech advancement reduces costs and enhances value

**Lower Cost Over Time**
Addressable Market Expansion Leveraging GenFuel H2 Infrastructure

50 Mile Radius from Production Plant

Example Assets: Hub & Spoke Delivery

Customer Site or H₂ Production Plant
Low-cost fuel system infrastructure increases addressable market
The Outlook for Hydrogen and Fuel Cells is Bright!!