Hydrogen Energy Storage Applications

Canadian Institute: Energy Storage
Sutton Place Hotel, Toronto, ON

July 8, 2010
Key Facts about Hydrogenics

- World leading manufacturer of electrolysers and fuel cells
- Headquarters in Toronto, Canada
- 1,700 + products deployed worldwide since 1948
- Listed at NASDAQ (HYGS) and TSX (HYG)
- Canadian-based company with offices in Toronto, Belgium and Germany:
  - **On Site Generation Systems**: HySTAT™ Electrolyzers for industrial hydrogen and energy applications
  - **Power Systems**: HyPM™ Fuel cells for backup power and mobility applications
  - **Renewable Energy Systems**: Hydrogen system applications for community energy storage and smart grid
Hydrogenics’ Lines of Business

**TODAY’S MARKETS**
- Industrial Hydrogen
- Hydrogen Fueling
- Backup Power
- Mobility Applications

**OPERATING SEGMENTS**
- OnSite Generation
  - Electrolyzers
- Power Systems
  - Fuel Cells

**EMERGING MARKETS**
- Hydrogen Energy Storage / Power Systems
  - Off-grid renewable power
  - On-grid community or residential power
  - Grid incentives for load control
  - Renewable hydrogen fueling
  - Grid optimization
Products and Technology

- **HyUPS**
  - Backup Power System

- **HyPM® XR**
  - Fuel Cell Power Module extended run data centre and telecom UPS power

- **HyPM® HD**
  - Fuel Cell Power Module for mobility applications

- **HyPX®**
  - Fuel Cell Power Pack for material handling

- **IMET Electrolyzer Stations and HyLYZER PEM Electrolyzer Modules**
  - for OnSite hydrogen generation
Energy Storage
The Energy Storage Problem

- Renewable energy is driving the need for energy storage
  - Wind and solar are intermittent
  - Consumers and governments are pushing RE to higher proportions of grid mix

- Problems occurring when RE provides >10% of the grid mix
  - Increased need for standby power and frequency regulation services
  - Fossil fuel regulation undermines value of RE

- Higher RE penetration raises the need for energy storage
Among alternative Energy Storage Technologies hydrogen provides large capacity longer duration capability.
Data Storage: Many Needs + Many Tools

Energy Storage is No Different
Renewable Energy and Transportation
Case Study: Wind Energy, the Electric Grid and H₂

- German Wind Energy Example
- Over 19,868 turbines installed
- Capacity: 23,044 MW
- Electricity production 2007: 39.6 TWh (7.2% of annual consumption)
German is the leader with high RE penetration

- High RE penetration
- Deep understanding of the need for storage
- Committed policy framework
- 200M € funding
- Recognize “Smart Grid” application of Hydrogen
- Wind – Hydrogen – H2 Vehicles
- Major study being completed
Hydrogen & Smart Grid

High Generation
Low Demand Case

6 interstate “pinch points”

Distributed Hydrogen electrolysis will relieve the pressure on the grid and enable greater RE penetration
Hydrogen
The Energy Storage Solution for Renewable Energy

This much could be fed into an underground hydrogen reservoir (2 Mio m³ salt cavern):

**600,000 MWh**
(equals 3.6 Mio tank fills)

→ Only hydrogen offers storage capacity for several days
Unequalled Storage Density – Utility Scale
This example (actually a NG installation covering 4 acres) would contain 2.5 Gigawatt-hours of energy storage when applied to Hydrogen.
Hydrogen Fueling Pathway

- Electrolysis hydrogen generation pathway to fueling
- Controllable load matches with intermittent renewable energy
September 2009, Major Companies sign up to Hydrogen Infrastructure build-up plan in Germany

Source: Mercedes
# Hydrogen Bus Refueling Scenario

<table>
<thead>
<tr>
<th></th>
<th>Bus Refueling Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of buses</strong></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td><strong>Fuel consumption (kg/100km)</strong></td>
<td>15</td>
</tr>
<tr>
<td><strong>On board storage (kg)</strong></td>
<td>40</td>
</tr>
<tr>
<td><strong>Daily travelled distance (km)</strong></td>
<td>250</td>
</tr>
<tr>
<td><strong>Facility daily H₂ required (kg)</strong></td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>375</td>
</tr>
<tr>
<td></td>
<td>3750</td>
</tr>
<tr>
<td><strong>Resulting H₂ production capacity (Nm³/h)</strong></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>1800</td>
</tr>
<tr>
<td><strong>Resulting power requirement (MW)</strong></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td><strong>HySTAT Q’s required</strong></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td><strong>S1000 stacks required</strong></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td><strong>S4000-90 stacks required</strong></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td><strong>S4000-135 stacks required</strong></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>
Fueling Economics with Demand Response

Large-scale hydrogen fueling with demand response revenue

<table>
<thead>
<tr>
<th>CURRENT MODEL</th>
<th>S4000 x 16</th>
<th>$8.25/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elec Cost $3.6M/yr</td>
<td>960 Nm³/h (5 MW)</td>
<td>$15M installed</td>
</tr>
<tr>
<td></td>
<td>100% Cap. Util.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEMAND RESPONSE MODEL</th>
<th>S4000 x 16</th>
<th>$7.00/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elec Cost $3.6M/yr</td>
<td>960 Nm³/h (5 MW)</td>
<td>$15M installed</td>
</tr>
<tr>
<td>Demand Response Revenue $1M/yr</td>
<td>100% Cap. Util.</td>
<td></td>
</tr>
</tbody>
</table>

Demand Response = $200k/MW/yr; Electricity cost = .08/kWh
Product Offering: HySTAT™-360 (Q)
August 6th, 2009: DOE, NREL and SNRL Complete “Real World” Driving Evaluation

2009 Toyota Highlander Gasoline Hybrid
Full Tank Range: 710 km
Avg. Fuel Economy: 9.0 L /100km
Cost to fill up @ $ 0.95/litre: $ 63.90

2009 Toyota Highlander H₂ Fuel Cell Hybrid Vehicle
Full Tank Range: 690 km
Avg. Fuel Economy¹: 3.4 L /100km
Cost to fill up @ $ 8/kg_H₂: $ 50.48

Competitive fuel prices → Accelerating the transition to hydrogen

¹. Converted from (kg) of hydrogen to litres of gasoline equivalent
Hybrid Midi Bus Demonstration Vehicle

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>17 ft (5.3 m)</td>
</tr>
<tr>
<td>Type</td>
<td>Low floor</td>
</tr>
<tr>
<td>Seats</td>
<td>8 + standing</td>
</tr>
<tr>
<td>Max speed</td>
<td>20 mph (33 km/h)</td>
</tr>
<tr>
<td>Autonomy</td>
<td>125 mi (200 km)</td>
</tr>
<tr>
<td>Drive</td>
<td>12 kW PEM Fuel Cell</td>
</tr>
<tr>
<td>Motor</td>
<td>25 kW</td>
</tr>
<tr>
<td>Fuel</td>
<td>Hydrogen (99.99 %)</td>
</tr>
<tr>
<td>Hydrogen storage</td>
<td>5.8 kg</td>
</tr>
<tr>
<td>Energy storage</td>
<td>NiCd Batteries</td>
</tr>
</tbody>
</table>
### Proterra Fuel Cell Plug-in Hybrid Bus

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>35 ft (10.7 m)</td>
</tr>
<tr>
<td>Type</td>
<td>Low floor</td>
</tr>
<tr>
<td>Seats</td>
<td>37</td>
</tr>
<tr>
<td>Max speed</td>
<td>60 mph (96 km/h)</td>
</tr>
<tr>
<td>Autonomy</td>
<td>300 mi (480 km)</td>
</tr>
<tr>
<td>Drive</td>
<td>32 kW PEM Fuel Cell</td>
</tr>
<tr>
<td>Motor</td>
<td>150 kW</td>
</tr>
<tr>
<td>Fuel</td>
<td>Hydrogen (99.99%)</td>
</tr>
<tr>
<td>Hydrogen storage</td>
<td>30 kg</td>
</tr>
<tr>
<td>Energy storage</td>
<td>Li Titanate Batteries</td>
</tr>
</tbody>
</table>

2 x HyPM HD 16s Hydrogenics Fuel Cells
Community Hydrogen Energy Storage (HES)
Remote Community Power

- **Application**
  - Enable continuous off-grid power from wind or solar
  - Remote communities, islands and resorts

- **Current Solution**
  - Served by diesel gensets
  - Typical costs $0.60-$1.00/kWh

- **Renewable Hydrogen System**
  - Hydrogen generation, storage and fuel cell coupled to renewable energy
  - Fully zero-emission energy
  - Self-contained energy system
Community Hydrogen System

WIND GENERATED ELECTRICITY

- Excess Wind Energy dissipated
- Excess Wind Energy diverted to Hydrogen production
- Heating from excess Wind Energy

Air Compressor

N₂ Generator

Water Treatment

Thermal Dump Load – distributed to improve usability of heat energy

Synchronous Condenser for grid stability

Control System

HySTATstandby heating

HySTAT cooling

HySTAT Electrolyzer

Hydrogen

HyPM fuel cell system

Standby heating

Generators

DIESEL Back Up power

HEATING LOAD

Water supply to HySTAT

Condensation Recovery

HyPM fuel cell system

Heating from Waste Heat Recovery

Excess Wind Energy diverted to Hydrogen production

Electrical Load

Load – distributed to improve usability of heat energy

Synchronous Condenser for grid stability

Control System
The HySTAT™ Electrolyzers

- Mature product serving industrial gas and fuelling markets
- On-demand, onsite high purity hydrogen production
- Automated, reliable, efficient and low maintenance

HySTAT™-15
15 Nm³/h, 1.4 kg/h
10 or 25 bar

HySTAT™-30
30 Nm³/h, 2.7 kg/h
10 or 25 bar

HySTAT™-60
60 Nm³/h, 5.4 kg/h
10 bar
Containerized Fuel Cell Module

- HyPM 150KVA Fuel Cell System (20’ ISO container)
  - HyPM XR rack serves backup power market
  - Reliable and scalable power for critical systems
  - Zero-emission, compact and highly efficient
Energy Storage – Low Incremental Cost

- Tube trailer can deliver 6 MWh from fuel cell
- No leakage and no parasitic losses over time
- Storage costs of less than $100/kWh
Case Study: Community HES
Model Inputs

- Site Profile using Alaska Data
  - 175kW peak load
  - 6.5m/s average wind speed
  - Low diesel price of $1/L

- Case A – Existing Diesel
  - Emissions based ultra low sulphur diesel

- Case B – Wind/Hydrogen + Diesel
  - Reduced diesel consumption

- Case C – Wind/Hydrogen only
  - Elimination of diesel
## Model Component Sizing

<table>
<thead>
<tr>
<th></th>
<th>Diesel only</th>
<th>Wind / Hydrogen + Diesel</th>
<th>Wind/Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diesel</strong> kW</td>
<td>175</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td><strong>Wind</strong> kW</td>
<td></td>
<td>2 x 330</td>
<td>3 x 330</td>
</tr>
<tr>
<td><strong>Fuel Cell</strong> kW</td>
<td>100</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td><strong>Electrolyzer</strong> Kg/day</td>
<td></td>
<td>168</td>
<td>330</td>
</tr>
<tr>
<td><strong>Storage</strong> Kg</td>
<td>100</td>
<td></td>
<td>1000</td>
</tr>
</tbody>
</table>
# Model Results

<table>
<thead>
<tr>
<th></th>
<th>Diesel Only</th>
<th>Wind/Hydrogen + Diesel</th>
<th>Wind/Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Capital Cost</strong></td>
<td>$3,250</td>
<td>$8,300</td>
<td>$10,620</td>
</tr>
<tr>
<td><strong>Net Present Cost</strong></td>
<td>$8,800</td>
<td>$10,980</td>
<td>$13,100</td>
</tr>
<tr>
<td><strong>Operating Cost</strong></td>
<td>$450</td>
<td>$215</td>
<td>$201</td>
</tr>
<tr>
<td><strong>Cost of Generation (Diesel @ $1/L)</strong></td>
<td>$0.78</td>
<td>0.97</td>
<td>1.16</td>
</tr>
<tr>
<td><strong>Diesel Usage</strong></td>
<td>291,400</td>
<td>49,400</td>
<td>0</td>
</tr>
<tr>
<td><strong>CO₂</strong></td>
<td>764,000</td>
<td>130,000</td>
<td>0</td>
</tr>
<tr>
<td><strong>CO</strong></td>
<td>4,050</td>
<td>690</td>
<td>0</td>
</tr>
<tr>
<td><strong>HC</strong></td>
<td>220</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td><strong>PM</strong></td>
<td>230</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td><strong>SO₂</strong></td>
<td>1,500</td>
<td>260</td>
<td>0</td>
</tr>
<tr>
<td><strong>NOₓ</strong></td>
<td>2,300</td>
<td>400</td>
<td>0</td>
</tr>
</tbody>
</table>
## Model Results: Wind

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total rated capacity</td>
<td>900</td>
<td>kW</td>
</tr>
<tr>
<td>Mean output</td>
<td>455</td>
<td>kW</td>
</tr>
<tr>
<td>Capacity factor</td>
<td>51</td>
<td>%</td>
</tr>
<tr>
<td>Total production</td>
<td>3,981,570</td>
<td>kWh/yr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum output</td>
<td>985</td>
<td>kW</td>
</tr>
<tr>
<td>Wind penetration</td>
<td>436</td>
<td>%</td>
</tr>
<tr>
<td>Hours of operation</td>
<td>8,529</td>
<td>hr/yr</td>
</tr>
<tr>
<td>Levelized cost of energy</td>
<td>0.0966</td>
<td>$/kWh</td>
</tr>
</tbody>
</table>
# Model Results: Fuel Cell

## Electrical Results

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical production</td>
<td>136,793</td>
<td>kWh/yr</td>
</tr>
<tr>
<td>Mean electrical output</td>
<td>56.3</td>
<td>kW</td>
</tr>
<tr>
<td>Min. electrical output</td>
<td>2.0</td>
<td>kW</td>
</tr>
</tbody>
</table>

### Fuel Consumption

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen consumption</td>
<td>11,727</td>
<td>kg/yr</td>
</tr>
<tr>
<td>Specific fuel consumption</td>
<td>0.086</td>
<td>kg/kWh</td>
</tr>
<tr>
<td>Fuel energy input</td>
<td>390,908</td>
<td>kWh/yr</td>
</tr>
</tbody>
</table>

### Operational Statistics

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of operation</td>
<td>2,430</td>
<td>hr/yr</td>
</tr>
<tr>
<td>Number of starts</td>
<td>589</td>
<td>starts/yr</td>
</tr>
<tr>
<td>Capacity factor</td>
<td>7.8</td>
<td>%</td>
</tr>
</tbody>
</table>

![Fuel Cell Output Chart](chart.png)
Model Results: Electrolyser

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolyzer Capacity</td>
<td>128</td>
<td>Kg/day</td>
</tr>
<tr>
<td>Electrolyzer Utilization</td>
<td>23.8</td>
<td>%</td>
</tr>
<tr>
<td>Annual H2 Production</td>
<td>12,227</td>
<td>Kg/yr</td>
</tr>
</tbody>
</table>
## Model Results: Hydrogen Storage

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen storage size</td>
<td>1000</td>
<td>kg</td>
</tr>
<tr>
<td>Hydrogen tank autonomy</td>
<td>320</td>
<td>Hours</td>
</tr>
<tr>
<td>Energy Stored (gross)</td>
<td>15</td>
<td>MWH</td>
</tr>
</tbody>
</table>

![Frequency Histogram](image1)

![Hydrogen Tank Storage Level](image2)
Case Study Conclusions

- **Wind/Hydrogen + Diesel**
  - Cost competitive with diesel today on a $/kWh basis
  - CO2 emissions reduced from 764,000kg/yr → 129,000kg/yr representing a reduction of 70%

- **Wind/Hydrogen**
  - Total elimination of emissions to a true zero-emission solution
  - Diesel gensets can remain as an emergency backup
  - Predictable future costs of energy
Summary

- Secure and sustainable source of energy to the community
  - Stable and predictable cost for energy
  - Zero-emission
  - Self-sufficient energy

- Wind HES can be cost effective relative to diesel
  - Hydrogen provides economic storage for large amounts of energy

- System is based on mature commercial products
  - Current products serve 10kW - 500kW – and growing
Hydrogen Experience and Case Studies
## Renewable Energy Projects to Date

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>RE Source</th>
<th>Country</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Beacon</td>
<td>2003</td>
<td>Wind + Solar</td>
<td>UK</td>
<td>HySTAT 8 + FC</td>
</tr>
<tr>
<td>Gas Natural</td>
<td>2007</td>
<td>Wind</td>
<td>Spain</td>
<td>HySTAT 60 + FC</td>
</tr>
<tr>
<td>Hychico</td>
<td>2007</td>
<td>Wind</td>
<td>Argentina</td>
<td>HySTAT 60 (x2) + H2ICE genset</td>
</tr>
<tr>
<td>Univ. of Glamorgan</td>
<td>2008</td>
<td>Wind + Solar</td>
<td>Wales</td>
<td>HySTAT 10 + FC</td>
</tr>
<tr>
<td>Basin Electric</td>
<td>2008</td>
<td>Wind</td>
<td>US</td>
<td>HySTAT 30 + storage</td>
</tr>
<tr>
<td>China Lake</td>
<td>2008</td>
<td>Solar</td>
<td>US</td>
<td>HySTAT 1 + HyPM</td>
</tr>
<tr>
<td>BC Hydro</td>
<td>2009</td>
<td>Small Hydro</td>
<td>Canada</td>
<td>HySTAT 30</td>
</tr>
<tr>
<td>Ramea</td>
<td>2009</td>
<td>Wind</td>
<td>Canada</td>
<td>HySTAT 30</td>
</tr>
</tbody>
</table>
Case Study – Renewable Power Generation

HySTAT™-A Hydrogen Station at Ramea Island, Nfld.

PROBLEM STATEMENT
Cost and storage issues associated with intermittent/ renewable energy generation

OUR SOLUTION
- Wind-hydrogen advanced power system
- Combine wind turbines with hydrogen generation to maximum contribution by the intermittent wind resources
- Provided continuous high quality power

BENEFITS
- Excess wind power is stored and used when needed
- Option of turning off diesel generators when demand is low
- Can run solely on wind and hydrogen
Case Study – Wind Hydrogen in USA

HySTAT™ A-30 together with CSD package in North Dakota

PROBLEM STATEMENT
Cost effective hydrogen fueling for hydrogen powered vehicles

OUR SOLUTION
- Comprehensive hydrogen fueling system powered by a 75MW wind farm
- One HySTAT™ A-30 together with a compression, storage and delivery package for hydrogen-powered vehicles

BENEFITS
- Combination of electrolyzer and renewable power provides cost effective approach to refueling
- Enables efficient use of stranded wind power for use as transport fuel
Case Study – Wind Hydrogen in Argentina

PROBLEM STATEMENT
Capturing value of stranded wind power

OUR SOLUTION
- Hydrogen and oxygen production and storage system
- Produces 120 Nm3/h of hydrogen and 60 Nm3/h of oxygen from a 6MW wind farm
- The system output pressure is 10 and 8 bar for the H2 and the O2 directly from the electrolyzer stack

BENEFITS
- Captures value of stranded wind resources
- Attractive market for renewable generation of hydrogen and oxygen – location over 1,000km from natural gas lines
West Beacon Farm: Leicestershire, UK

- Hydrogen and Renewables Integration (HARI) Project
- CREST (Centre for Renewable Energy Systems Technology), Loughborough University, BRYTE ENERGY

Existing System

- Utility
- Battery
- Wind
- Solar
- Hydro
- Critical Loads
- Electric Vehicles
- Opportune Loads
- DC Bus
- Fuel Cells (Car) (CHP)

Modifications

- No Utility
- H₂ Store
- Electrolyser

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Sotavento Wind Park: Galicia, Spain

- Sotovento Galacia PLC Wind Park
- Gas Natural SDG, S.A.
- Department Innovation, Innovation, Industry and Commerce, Xunta de Galicia
“HIDRÓLICA” Project: Cádiz, Adalusia, Spain

- Wind Park “El Gallego”, Tahivilla Municipality
- Partners: BESEL, ENDESA, INERCO, AICIA and GREENPOWER tech
‘HYRES’ Project: Greece

- SYSTEMS SUNLIGHT S.A. and CERTH (Center for Research and Technology Hellas), division Chemical Process Engineering Research Institute (CPERI)
- CPERI: System modeling, simulation, control systems, system integration, evaluation and optimization
Renewable H2 R&D Centre: Port Talbot, Wales

- Baglan Energy Park, Port Talbot, Wales
- University of Glamorgan
- UPS Systems PLC: FC Integration, Power Electronics and Control
Hydrogen Mini Grid System: Rotherham, Yorkshire

- Hydrogen Mini-Grid System
- Yorkshire Forward’s Advanced Manufacturing Park, Environmental Energy Technology Center Rotherham (Sheffield), Yorkshire
- Environmentally-Efficient Building
- UPS Systems PLC: FC Integration, Power Electronics and Control
Abalone Energie: Nantes, France

- Positive Energy Building
- Installing October 2009
H₂KT Project: Nuuk, Greenland

- Nukissiorfiit: Energy Utility, End Client
- H2Logic: System Integration and Project Management

Controller
DC-DC’s
Grid

Hydrogenics Scope:
- Fuel Cells
  - 2 x 10 kW
- Cooling Local
- Inverters Hybrid energy storage
Hydrogenics Electrolysers in Fueling Stations in Europe

- Malmö, Sweden
- Amsterdam, Netherlands (CUTE)
- Barcelona, Spain (CUTE)
- Stockholm, Sweden (CUTE)
- Porto, Portugal (CUTE)
- Barth, Germany
- Dunkirk, France
Hydrogen Fueling Stations Experience in North America

- Toronto, Ontario (4)
- Vancouver, British Columbia
- Ford, Arizona
- APG, Arizona
- Richmond, California
- Torrance, California
- Diamond Bar, California
- Chula Vista, California
- Chino, California
- Oakland, California
- Rosemead, California
- Detroit, Michigan
- Minot, North Dakota
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