Utsira – demonstrating the hydrogen society on renewable terms

Senior Vice President Knut Harg
Oil & Energy

- 2nd largest offshore operator on Norwegian Continental Shelf
- Strong production growth through 2007
- Strengthening our international oil and gas position

- Operating the Ormen Lange field development – the world’s most challenging gas field at 850 – 1100 m below sea
- Energy provider to the European market: oil, gas and power
Aluminium

- One of three leading integrated global aluminium companies
- Strong market position – broad product range: Automotive, Packaging, Building and Litho
- Production of 1.47 million tonnes primary metal and developing next-generation primary capacity
- Supplied market with 3.3 million tonnes of aluminium, including 1.2 million tonnes remelted and recycled metal
- 27 000 employees and turnover of NOK 69 billion
Hydro’s involvement in new energy

Tradition

Present

Future
Hydrogen as energy carrier – Hydro priorities

Complete hydrogen solutions with local H₂ production for the transport sector

Hydrogen in renewable energy systems

Future large scale hydrogen production from natural gas with CO₂ handling
Hydrogen solutions for Europe

Complete hydrogen fuelling stations from Hydro

- The ECTOS-project in Reykjavik

- CUTE – a pan-European demonstration project of hydrogen for transportation in 10 cities

- CEP Berlin – Clean Energy Partnership comprises 10 international companies Hydro delivers gaseous hydrogen to 13 of 16 vehicles at a public station
The demonstration project at Utsira
Full scale energy supply with renewable energy in remote areas
The world’s first full scale wind – hydrogen plant

- **Purpose**: Demonstrate how renewable energy can provide safe and efficient energy supply to isolated areas
- **Goals**: Full scale demonstration and testing of a wind - hydrogen energy system
- **Partners**: Hydro and Enercon, Norwegian Authorities
- **Perspective**: Test of system for two years
Main focus in demonstration project

- Ensure that the installed components in the system work together
- Deliver power to the customers at the expected quality
- Cost reductions and optimization of technical solutions
- Commercialization and marketing
The wind – hydrogen plant at Utsira
A vision becoming reality
## Main components

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind turbines</td>
<td>2 * 600 kW</td>
</tr>
<tr>
<td>Hydrogen engine</td>
<td>55 kW</td>
</tr>
<tr>
<td>Fuel cell</td>
<td>10 kW</td>
</tr>
<tr>
<td>Electrolyser</td>
<td>10 Nm³/h, 48 kW</td>
</tr>
<tr>
<td>Compressor</td>
<td>5,5 kW</td>
</tr>
<tr>
<td>Hydrogen storage capacity</td>
<td>2400 Nm³, 200 bar</td>
</tr>
<tr>
<td>Flywheel</td>
<td>5 kWh</td>
</tr>
<tr>
<td>Battery</td>
<td>50 kWh</td>
</tr>
<tr>
<td>Master Synchronous Machine</td>
<td>100 kVA</td>
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</tbody>
</table>
Project partner: Enercon

- Specialized in stand alone renewable power solutions
- 2 Enercon E40 wind turbines - 600 kW each
- Control system for the wind-hydrogen plant
- Efficient project team, well received at the island
Electrolyser with remote control features
Remote control of entire plant from Power Plant Operations Centre

Continuous control (24 hours x 365 days)
Utsira – How it works

Diagram showing the components of Utsira:

- Electrolyser
- H₂ storage
- Fuel cell/H₂ engine
- Grid
- Flywheel
- Battery
- PMSM

Nodes labeled A, B, C, D.
## Project Plan – Milestones

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision</td>
<td>April – 2003</td>
</tr>
<tr>
<td>Site construction start up</td>
<td>June – 2003</td>
</tr>
<tr>
<td>Wind turbines in operation</td>
<td>September – 2003</td>
</tr>
<tr>
<td>Electrolyser and H₂ gen.set commissioned</td>
<td>winter – 2004</td>
</tr>
<tr>
<td>Inauguration</td>
<td>July – 2004</td>
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<tr>
<td>Stand alone system in operation</td>
<td>November – 2004</td>
</tr>
</tbody>
</table>
Lessons learned

- Remote location complicates project execution and challenges project costs
- Early and well defined operational philosophy prior to design basis
- Early and well defined design basis on equipment and systems
- Continuous dialogue with local community necessary
Market opportunities for renewable systems

- Remote areas and areas without steady power supply
- Support systems for renewable power systems
- Power generation for remote systems like weather stations and cellular phone systems

... so what is next?
What is needed in the future?

- Improved electrolysers
  - Reliable, flexible high pressure electrolysers
  - Wide capacity range
- Improved fuel cells
  - Reliable, proven systems
- Suppliers of integrated systems
  - Remote control, stand-alone
  - Integrated systems
  - Competitive with diesel generators
High performance electrolysers: Small footprint, higher efficiency

Gesellschaft für Hochleistungs-electrolyseure zur Wasserstofferzeugung
Norsk Hydro Electrolysers AS 50 %
MTU, Friedriechshafen 50 %

Targets for New Generation:
- Current density: 8 - 10 kA/m²
- Energy consumption: 4,1 kWh/Nm³ @ 8 kA/m²
- Operating pressure: 30 bar g
- Operating temperature: 80 °C
- Active area: 2 m²
- Max. no cells in one stack: 70
- Max. prod. capacity: 460 - 574 Nm³/h
- Operational range: 10 - 100 %
- Foot print: 2,5 x 2,3 x 3,0 m
Watch out for Inergon!
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