Exploring the role of hydrogen in the future energy mix

A brief overview of Gasunie's hydrogen projects

Wim Groenendijk
The changing role of gas in Northwest Europe

- Paris Agreement
- Hydrogen
- Fuel Integration
- Groningen Production
- Stranded Assets
Transport of gas is much cheaper and more efficient than transport of electricity

**Power**

- 260 km
- € 600 mln
- 1 GW capacity
- € 230/kW/100 km

**Gas**

- 230 km
- € 500 mln
- 20 GW capacity
- € 11/kW/100 km
- € 9/kW/100 km
Hydrogen storage is an excellent option for the balancing of power markets

**Energy imbalances**

Gas is an essential fuel in the energy mix

**Capacity**
- Most of peak energy demand is satisfied by gas
- Insufficient power capacity available to satisfy peak demand

**Balancing**
- RES are not always available and require back-up capacity in the form of gas
- Temporary oversupply of power can be stored

---

**Storage**

Gas can be stored more efficiently than electricity

**Volume**
- 1 cavern with 1 mln m³ of hydrogen equals 240,000 MWh

**Equivalents**
- 24 mln. power walls (10 KWh, Tesla)
- 2400 of the largest batteries in the world (100 MWh, Tesla)

**Experience**
- H₂ storage in caverns is an existing technology
- Many years of experience in the UK and US
Power to gas and gas infrastructure

Wind

Solar

Electrolysis

Methanation

Gas network

Gas storage

Industries

Mobility

Generation

Households
A hydrogen hub in the North Netherlands

Supply vs Demand

Wind farms
Solar farms

From electricity...

...to hydrogen...
Electrolysis: separating water into hydrogen and oxygen

...to storage...
Underground gas storage Zuidwending
Hydrogen storage in salt caverns

...to consumers
Methanation: CO₂ from the air reacts with hydrogen to form syngas which can be injected into the natural gas network

Blending H₂ into the natural gas network
Conversion into electricity
Hydrogen fueling stations

Houses
Transport
Industry
# Timeline of Gasunie’s hydrogen projects

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early adopters</strong></td>
<td><strong>Scaling up</strong></td>
<td><strong>Mature market</strong></td>
</tr>
<tr>
<td>- HyStock 1.1 MW electrolyser</td>
<td>- 20MW – 100MW scale electrolysers</td>
<td>- 100 MW - 1 GW scale electrolysers</td>
</tr>
<tr>
<td>- First $\text{H}_2$ pipeline (Zeeland)</td>
<td>- Increase mobility market: Dozens of refueling stations</td>
<td>- Mobility market is matured</td>
</tr>
<tr>
<td>- Start mobility market: Several refueling stations</td>
<td>- Blue $\text{H}_2$ projects operational</td>
<td>- Hundreds of refueling stations</td>
</tr>
<tr>
<td>- Development &gt;20 MW P2G projects</td>
<td>- Green Hydrogen projects operational/execution phase</td>
<td>- P2G and $\text{H}_2$ dominant in energy system</td>
</tr>
<tr>
<td>- Development “Blue $\text{H}_2$” projects (e.g. Statoil/Nuon)</td>
<td>- Multiple $\text{H}_2$ pipelines</td>
<td>- Hydrogen grid realised</td>
</tr>
<tr>
<td>- Development large scale P2G projects (e.g. NSWPH)</td>
<td>- Storage of $\text{H}_2$ in caverns</td>
<td></td>
</tr>
</tbody>
</table>
Overview of projects

North Sea Wind Power Hub
(Tennet, Energienet, Gasunie, Port of Rotterdam)
Hydrogen production at sea from wind farms

Hydrogen pipeline Zeeland
(Dow, Yara, Gasunie)
Existing pipeline for natural gas converted to hydrogen pipeline for industries

20 MW Gasifier
(SCW systems, Gasunie)
Converts biomass to gas, which is added to the natural gas network

H2M
(Nuon, Statoil, Gasunie)
First turbine Magnum plant on blue hydrogen from Norwegian gas

20MW electrolyzer
(Akzo, Gasunie)
Transforms green electricity into hydrogen for greening of industries

HyStock 1MW pilot
(Gasunie, EnergyStock)
Turns sustainable electricity into hydrogen for transport and industry
North Sea Wind Power Hub

- 180 GW offshore wind capacity in the North Sea
- Cost savings can be achieved by integrating capacity into a single offshore hub
- Contributes to the balancing of NWE electricity markets, including in the form of hydrogen conversion and transportation.
- Consortium with TenneT, Energinet, Gasunie, and Port of Rotterdam
Refit from natural gas to hydrogen pipeline

Project Symbiose

- Refitting an existing natural gas pipeline to hydrogen transport
- DOW has excess hydrogen and YARA uses hydrogen for fertilizer production
Refit Nuon Magnum power plant from natural gas to hydrogen

**Option 1:**
H₂ production in Norway

**Option 2:**
H₂ production in NL

**Option 3:**
NH₃ production in Norway

EH: Eemshaven; CCGT = Magnum power plant; SMR = steam methane reforming plant to split natural gas into hydrogen and CO₂; HB = Haber Bosch process to convert hydrogen into ammonia
Hydrogen 2\textsuperscript{nd} project

- Gasunie & AkzoNobel
- Elektrolysis plant of 20MW
- FID next year
- Biggest in Europe
- Production of 3000 tons of hydrogen, or the equivalent of 300 buses
HyStock

- Pilot project
- 1.1 MW
- 5000 solar panels
- Store hydrogen in cavern
thanks for your attention questions?