Fuel Cells & Hydrogen Joint Undertaking 2

A portfolio of clean, efficient and competitive solutions based on fuel cells and hydrogen technologies in energy and transport.
Renewable H₂: electricity and electrolyser

Low-carbon H₂: natural gas/coal, Gasification/SMR/Pyrolysis, CCS/CCU
We need a European Hydrogen Backbone
Salt caverns for hydrogen storage
RES Import: Europe-North Africa Backbone

Natural gas pipelines
Hydrogen pipelines
Where to start? - The Netherlands

- Low caloric gas pipelines will become available, because the Groningen gas field has to reduce production to 0 in 2030
- 1 Transport pipeline capacity about 15 GW
- New hydrogen pipeline connections to offshore wind farms
- Connections to Germany (Ruhr-area, Bremen-Hamburg and Belgium (Antwerp, Zeebrugge)
- European connections to France, Austria, Italy, etc.

Diagram:
- Existing gas pipeline
- Retrofitted compressors
- New hydrogen pipeline
- Industrial cluster
- Hydrogen storage in salt cavern
Gas Market Regulation (next battlefield)

• Prepared now but presented beginning 2020
• It will be a Regulation and not a Directive
• Content:
  1. One part of the package will be mirroring the electricity market (retail).
  2. Another part of the package will mostly cover the future content of the gas grids

⇒ Hydrogen Europe to publish its Vision paper
Hydrogen Valleys: H2 in The Netherlands

Moving towards 2030 and 2050 with hydrogen

- The earth has warmed up by 1.1°C since 1850
- CO₂ concentration has increased

Paris Agreement
- Global warming set at a maximum of 2°C
- 2050: 450 ppm
- 2030: 400 ppm

Hydrogen pipeline
- Linking hydrogen industries in Zeeland and the Delta region

Pilot project HyStock
- Converting zero-emission hydrogen in Zuidwending

The energy transition requires new forms of infrastructure and intelligent use of existing networks. Gasunie wants to invest in new infrastructure for renewable gases such as hydrogen.

Hydrogen is a clean energy carrier. Its combustion yields only water vapour.

Further deployment H2- and CO2-network Zeeland

- National hydrogen transport network
  - H2 gas pipeline network links major industrial areas: Cresheim, Eemshaven, Rotterdam, Chemelot, Zwijndrecht and the Ruhr area

- North Sea Wind Power Hub
  - An island where power from offshore wind farms is partly converted into hydrogen that is piped onshore
Hydrogen Roadmap for Europe

Besides CO₂ abatement, deployment of the hydrogen roadmap also cuts local emissions, creates new markets and secures sustainable employment in Europe.

2050 hydrogen vision

- ~24% of final energy demand
- ~560 Mt annual CO₂ abatement
- ~EUR 820bn annual revenue (hydrogen and equipment)
- ~15% reduction of local emissions (NOₓ) relative to road transport
- ~5.4m jobs (hydrogen, equipment, supplier industries)
# Hydrogen Roadmap for Europe

## Hydrogen Technology Exists and Is Ready to Be Deployed

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2020</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>2045</th>
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<tbody>
<tr>
<td><strong>Transportation</strong></td>
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<td>Ambitious scenario</td>
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<td>Business as usual scenario</td>
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<td>Start of commercialization</td>
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<td><strong>Heating and power for buildings</strong></td>
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<tr>
<td>mCHPs²</td>
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<td><strong>Industry heat</strong></td>
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<tr>
<td>Low/medium industry heat</td>
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<td>High-grade industry heat</td>
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<td><strong>Industry feedstock</strong></td>
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<td>Existing: refining, chemicals (production of ammonia, methanol, and others), metal processing</td>
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<tr>
<td>CCU (methanol, olefins, BTX)⁵</td>
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<td>Steelmaking⁴</td>
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<td><strong>Power generation</strong></td>
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<tr>
<td>Power generation, balancing, buffering</td>
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1. Mass market acceptability
2. mCHPs²: Micro Combined Heat and Power
3. Industry heat
4. Black carbon (BC) emissions
5. CCU: Capture, Conversion, Utilization
6. Steelmaking
Important Projects of Common European Interest

Geographically, 3 IPCEI’s can be identified.
Important Projects of Common European Interest

IPCEI 3: Spain, Portugal, France, Germany & Poland:
- Stacks
- Buses & trains
- Tanks
- Electrolyser capacity?
Important Projects of Common European Interest

IPCEI 2: Italy, Slovenia & Austria:
- Port strategy
- Pipeline hub in Austria
- Liquid hydrogen
Important Projects of Common European Interest

IPCEI 1: Netherlands, Belgium & Germany:
- Off-shore wind
- L-gas pipelines
- Electrolyser capacity
- Trucks
- Light Duty Vehicles
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