gasunie
crossing borders in energy

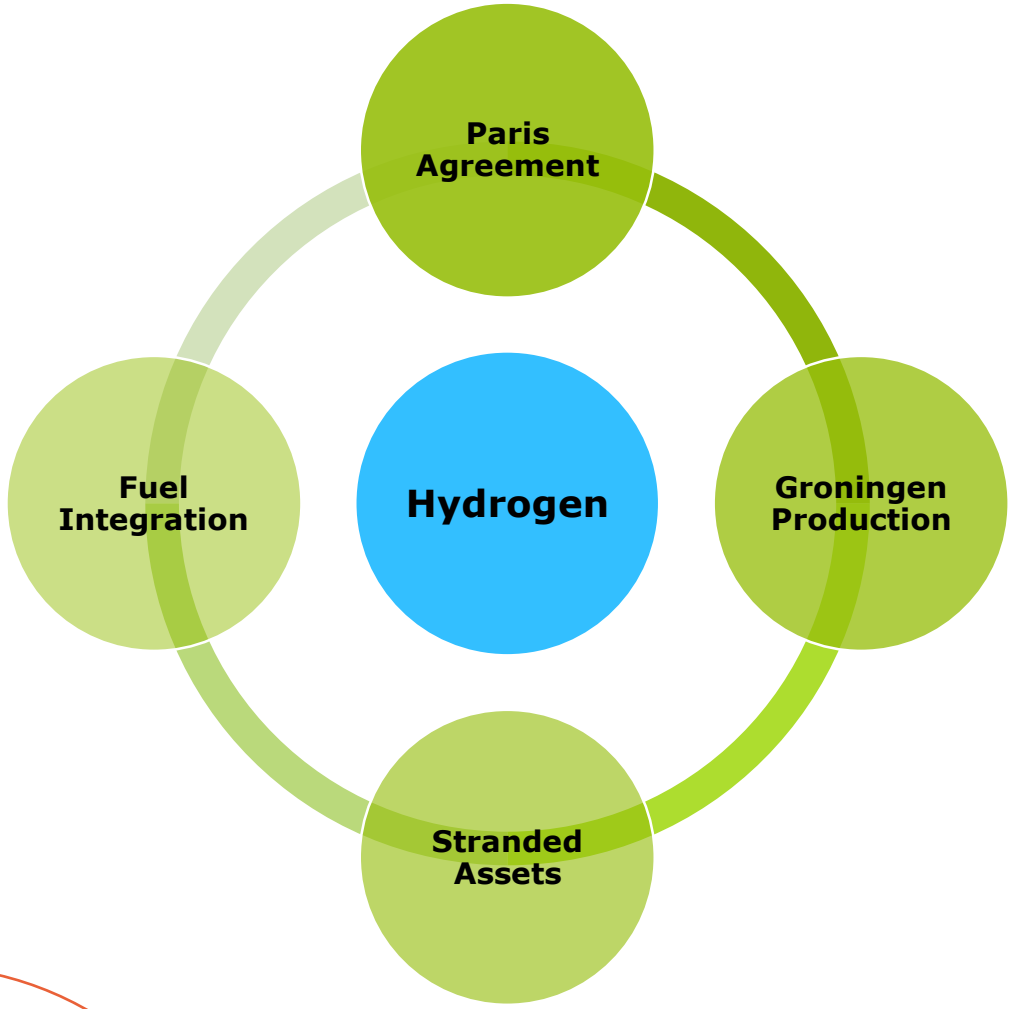
St. Petersburg, 10 July 2018

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



Transport of gas is much cheaper and more efficient than transport of electricity

Power

BritNed

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

Gas

bbl company

- 230 km
- € 500 mln
- 20 GW capacity
- € 11/kW/100 km

Nord Stream

- € 9/kW/100 km

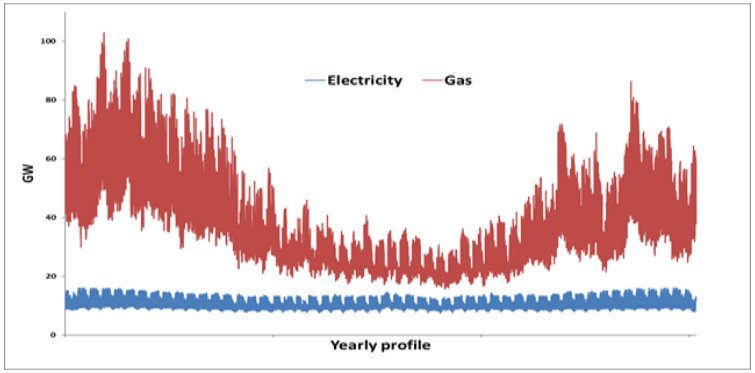
Hydrogen storage is an excellent option for the balancing of power markets

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

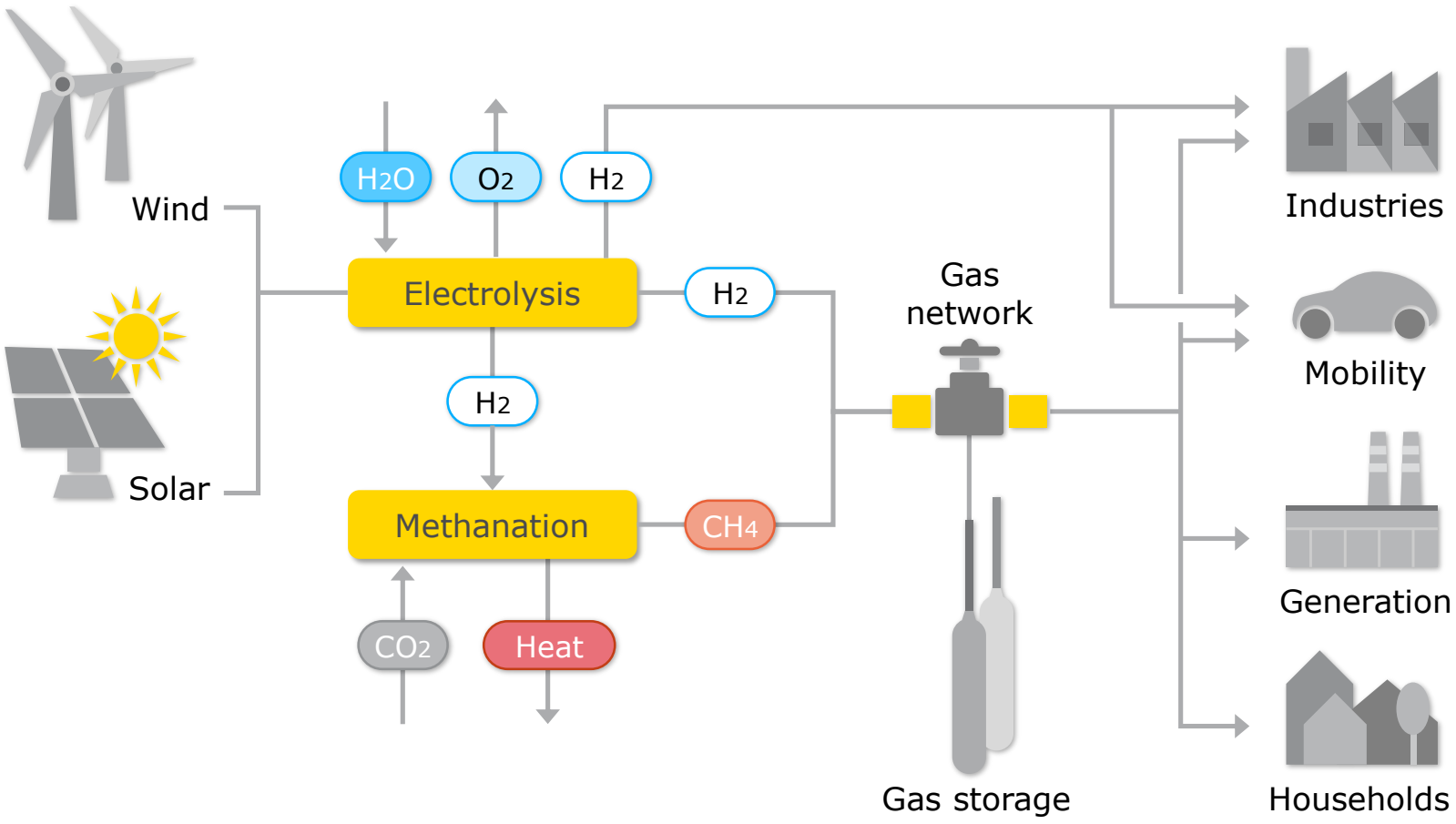
Gas can be stored more efficiently than electricity

Volume
- 1 cavern with 1 mln m^3 of hydrogen equals 240,000 MWh

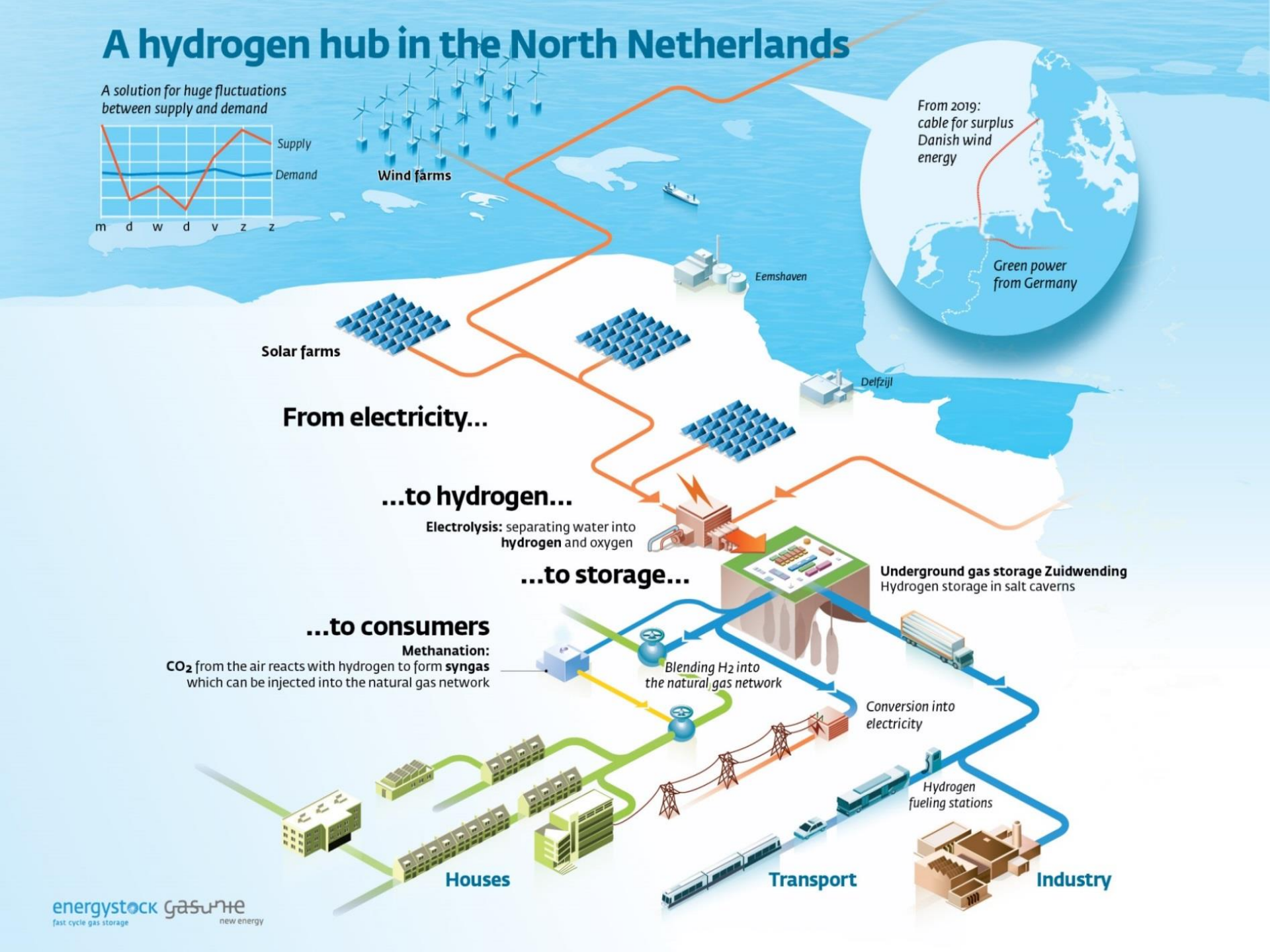
Equivalents
- 24 mln. power walls (10 KWh, Tesla)
- 2400 of the largest batteries in the world (100 MWh, Tesla)

Experience
- H_2 storage in caverns is an existing technology
- Many years of experience in the UK and US

Power to gas and gas infrastructure



A hydrogen hub in the North Netherlands



energystock fast cycle gas storage

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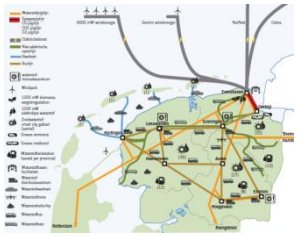
Timeline of Gasunie's hydrogen projects



2018 **2020** **2025** **2030** **2050**

2018 – 2020
Early adopters

- HyStock 1.1 MW electrolyser
- First H_2 pipeline (Zeeland)
- Start mobility market: Several refueling stations
- Development >20 MW P2G projects
- Development "Blue H_2" projects (e.g. Statoil/Nuon)
- Development large scale P2G projects (e.g. NSWPH)

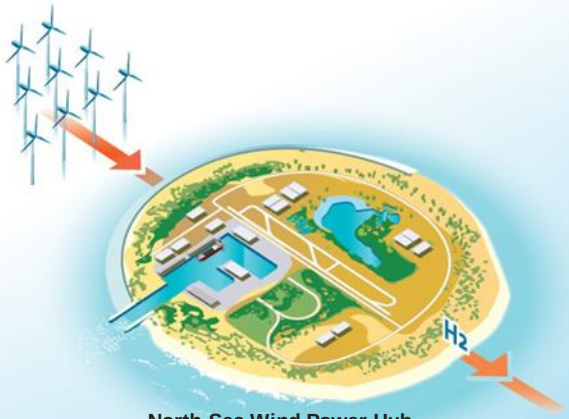
2020 – 2030
Scaling up

- 20MW – 100MW scale electrolysers
- Increase mobility market: Dozens of refueling stations
- Blue H_2 projects operational
- Green Hydrogen projects operational/execution phase
- Multiple H_2 pipelines
- Storage of H_2 in caverns

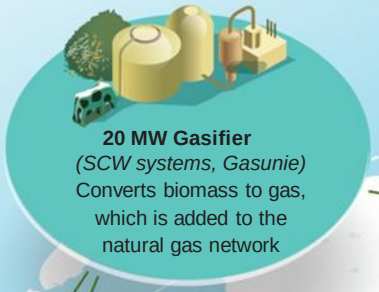
2030 – 2050
Mature market

- 100 MW - 1 GW scale electrolysers
- Mobility market is matured Hundreds of refueling stations
- P2G and H_2 dominant in energy system
- Hydrogen grid realised

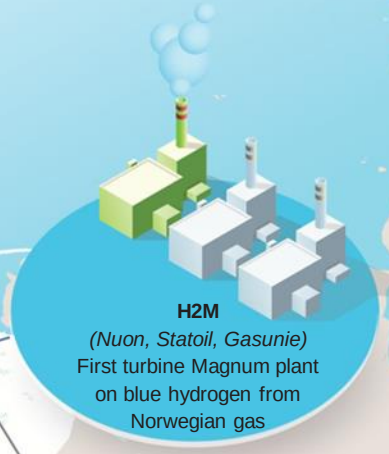
Overview of projects



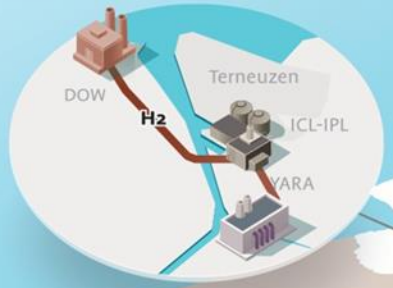
North Sea Wind Power Hub
(Tennet, Energienet, Gasunie, Port of Rotterdam)
Hydrogen production at sea from wind farms



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



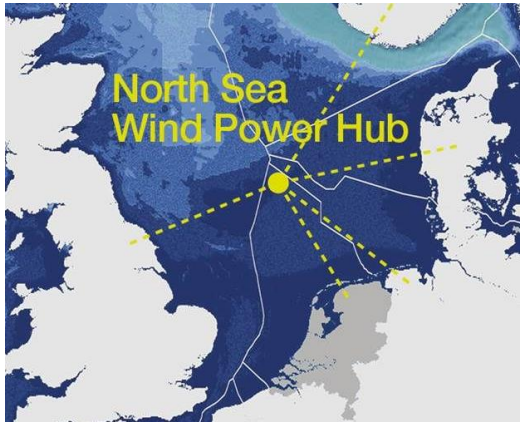
Hydrogen pipeline Zeeland
(Dow, Yara, Gasunie)
Existing pipeline for natural gas converted to hydrogen pipeline for industries

20MW elektrolyzer
(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



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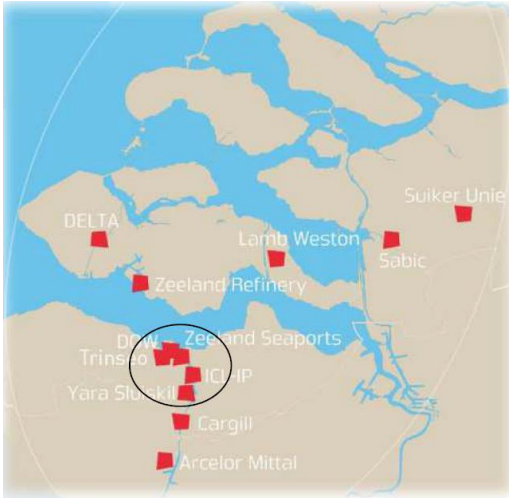
TenneT Taking power further
ENERGINET.DK
Port of Rotterdam

Refit from natural gas to hydrogen pipeline

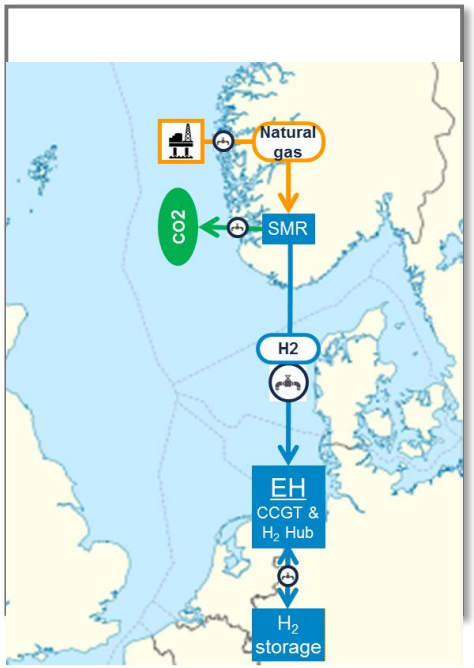
Project Symbiose

- Refitting an existing natural gas pipeline to hydrogen transport
- DOW has excess hydrogen and YARA uses hydrogen for fertilizer production

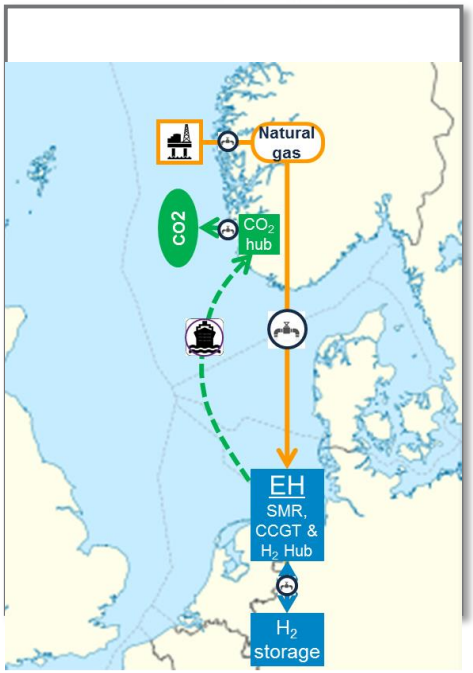
Zeeland Region



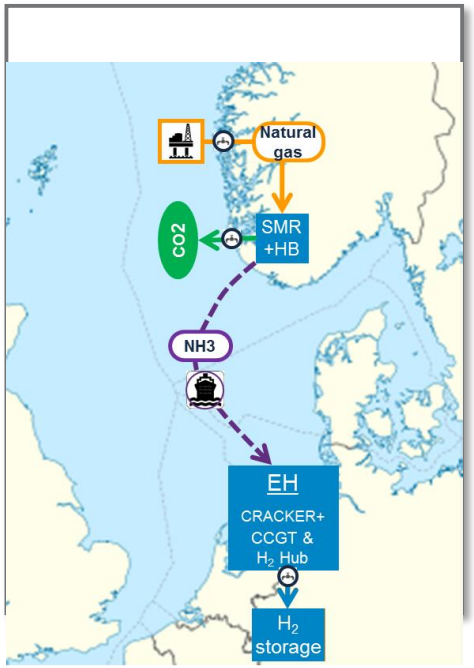
Refit Nuon Magnum power plant from natural gas to hydrogen



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 2nd 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

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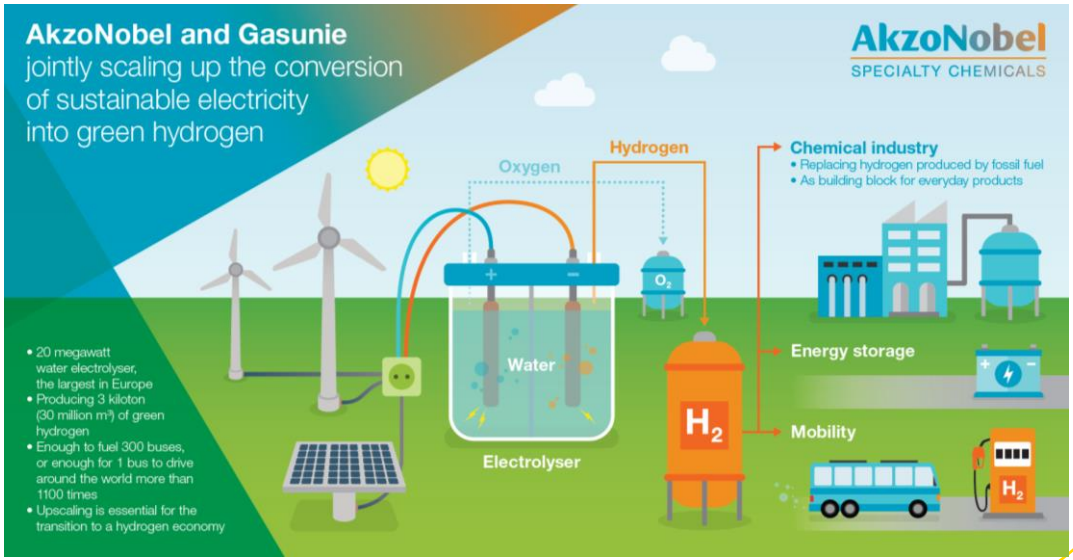
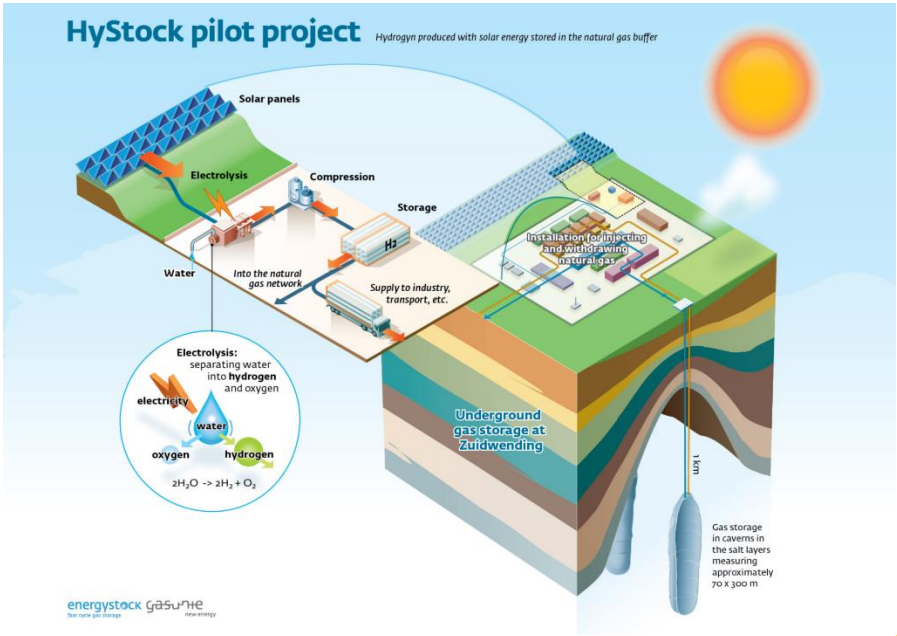
AkzoNobel
MCA



HyStock

- Pilot project
- 1.1 MW
- 5000 solar panels
- Store hydrogen in cavern




thanks
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questions?
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