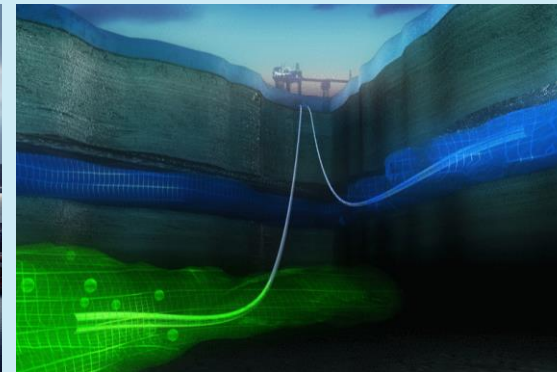


The Equinor way; natural gas reforming and carbon capture and offshore storage (CCOS)

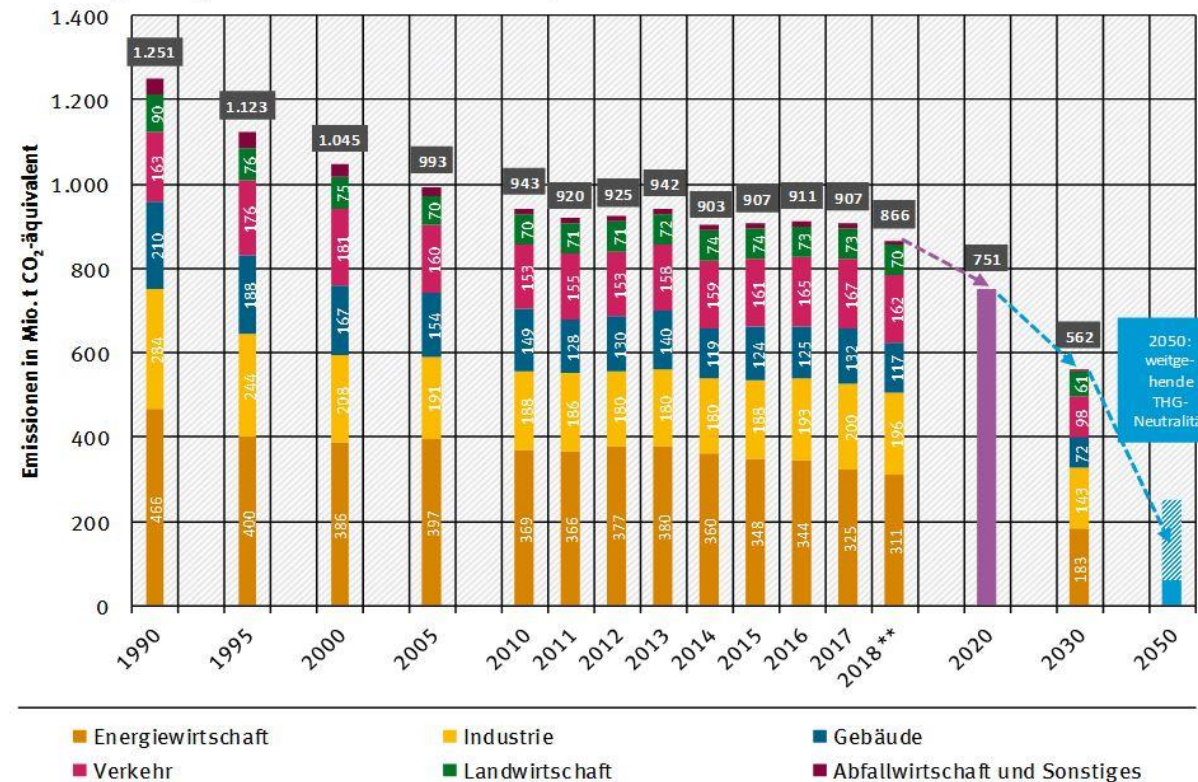
Bjarne L. Bull-Berg
Country Manager and VP
Equinor
EU-RU GAC WG2
Berlin, October 21, 2019



Climate-neutrality 2050: GHG emissions reduction in Germany

Entwicklung der Treibhausgasemissionen in Deutschland

in der Abgrenzung der Sektoren des Klimaschutzplans 2050*

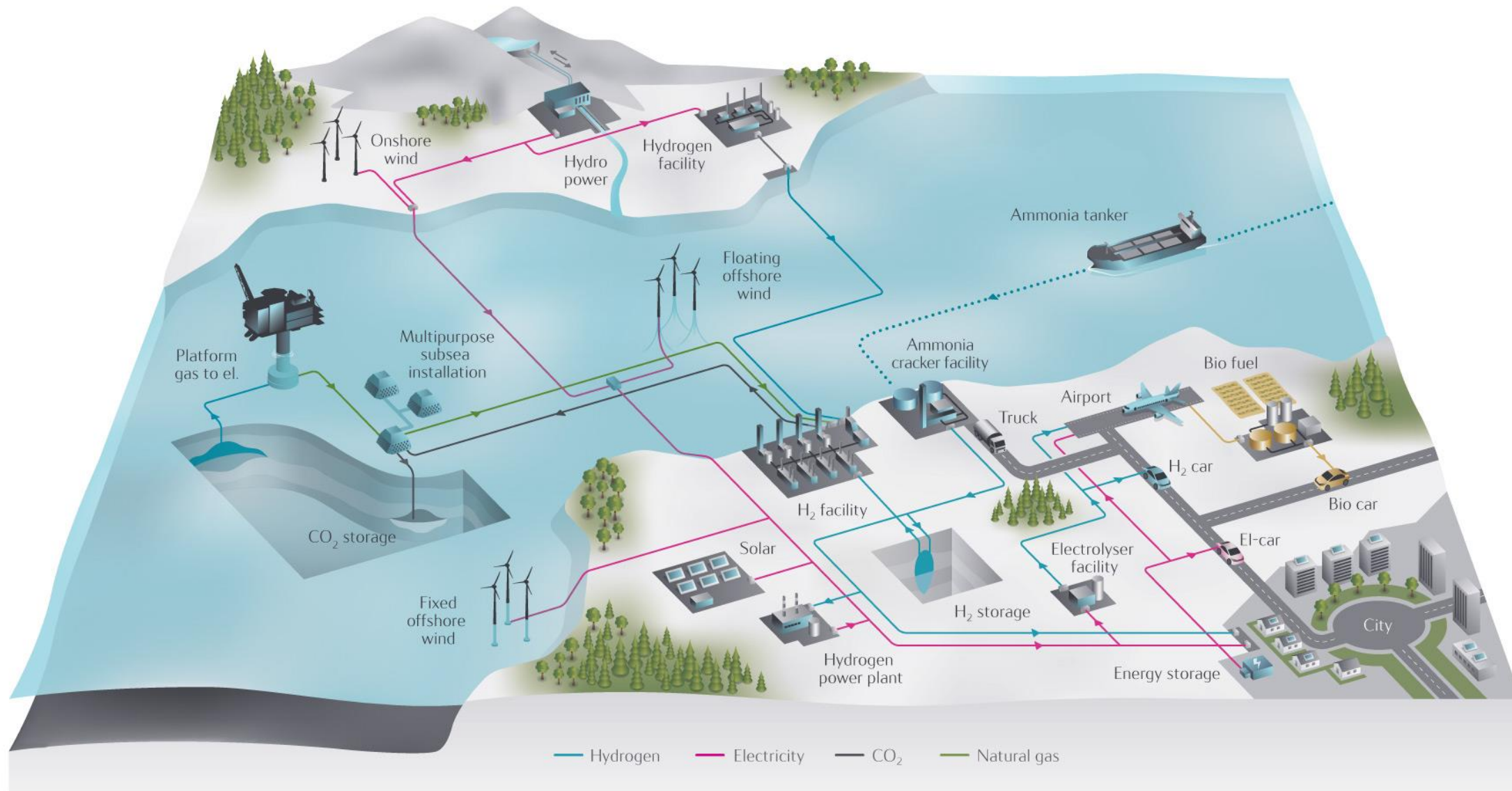


* Die Aufteilung der Emissionen weicht von der UN-Berichterstattung ab, die Gesamtemissionen sind identisch

** Schätzung

Quelle: Umweltbundesamt 04.04.2019

Low Carbon Solutions



Gas is a cost efficient enabler ... to a carbon neutral energy system



Gas displacing more carbon intense fuels in transport, heating and power

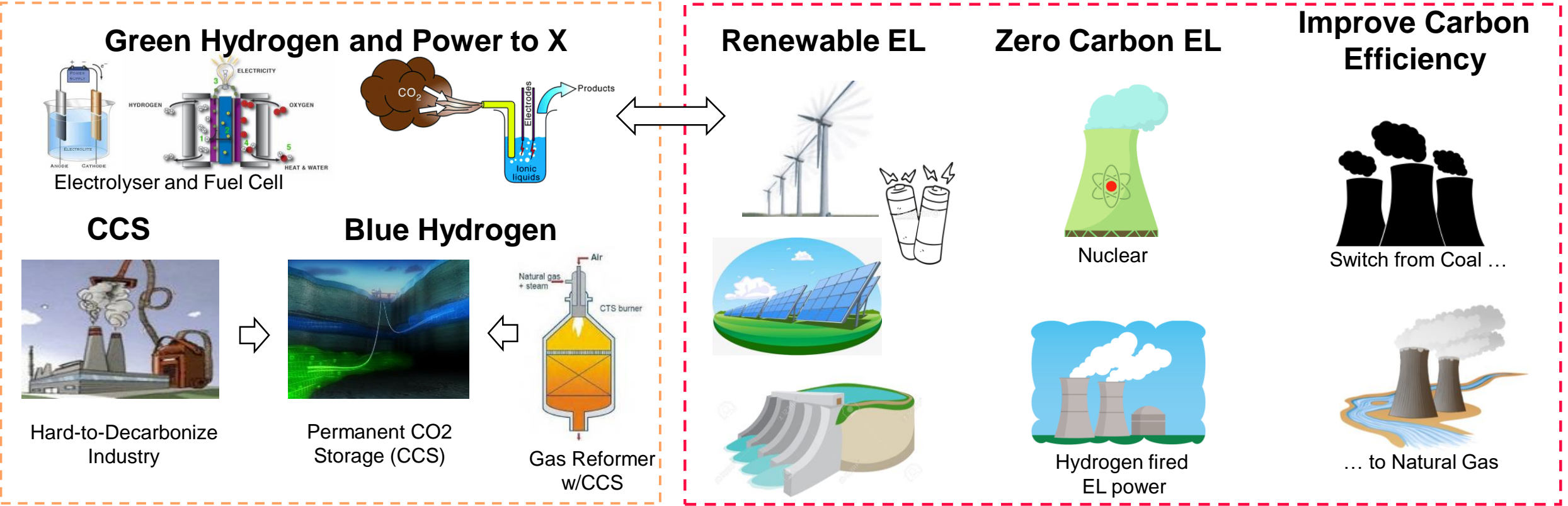
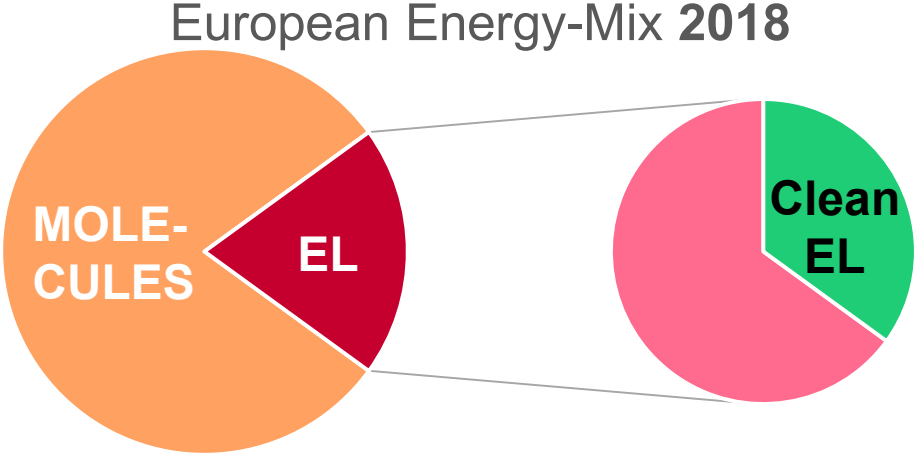
Gas combination with renewables
(gas and electricity)

Hydrogen and renewable electricity
smartly integrated

The Challenge and the Tool-Box



Cost Efficiency EL : MOL
Energy Transport 1 : 10
Long Term Storage 1 : 100



Blue Hydrogen – What Will it Cost?

<u>Sector</u>	<u>Price Premium</u>	<u>Compared to ...</u>
Industry	+25%	Grey Hydrogen
Heat	+50%	Natural Gas
Power (on demand)	+100%	Natural Gas

Market Build (2019 – First Operations)

2023

Northern Lights



Applications:

- CCS for industry

2026

HyDemo Norway



Applications:

- Hydrogen for maritime

2028

Clean Steel



Applications:

- Hydrogen for industry (steel)

2026

Zero Carbon Humber



Applications:

- Hydrogen for industry
- Chemicals
- Synthetic fuels
- BECCS
- Hydrogen power

2026

Clean Gas Project



Applications:

- Post-combustion CCS power generation
- CCS for industry
- BECCS
- Hydrogen production

2027

H2 Magnum



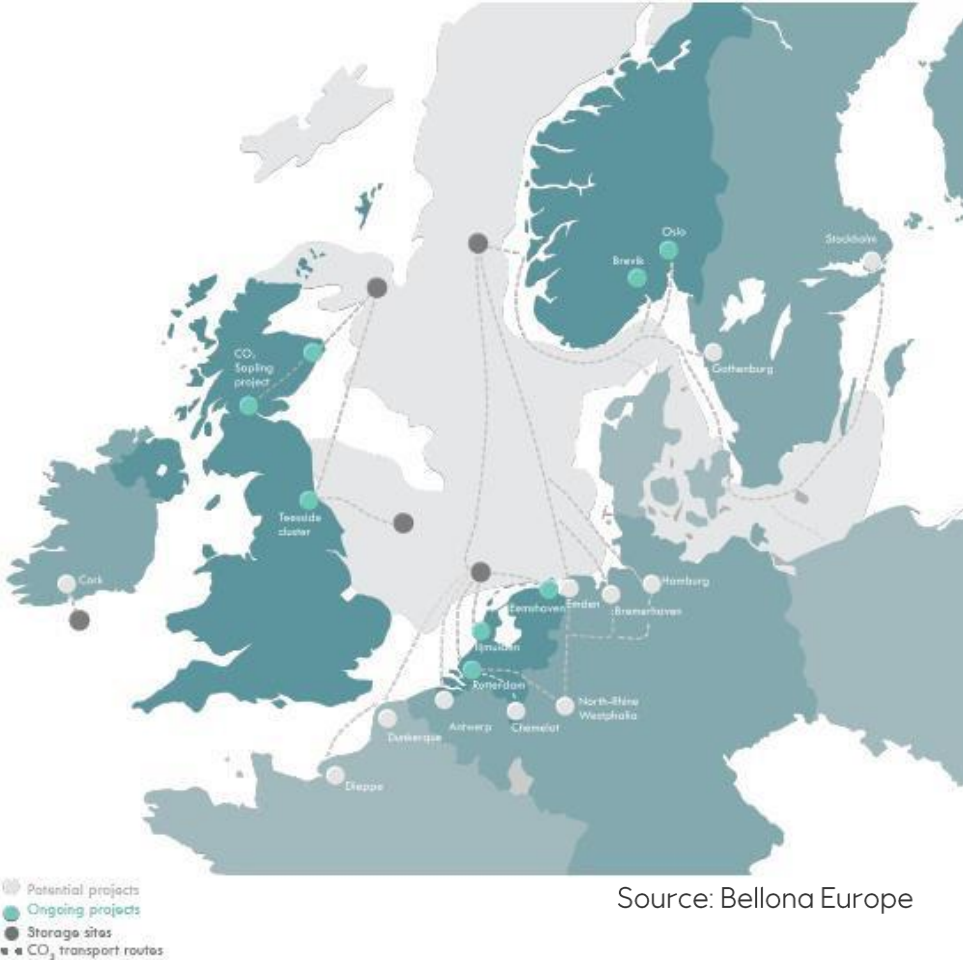
Applications:

- Hydrogen power

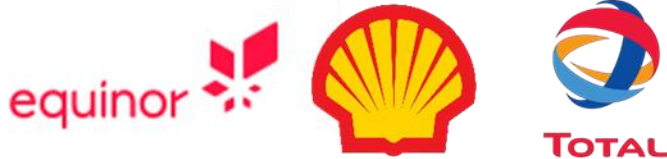
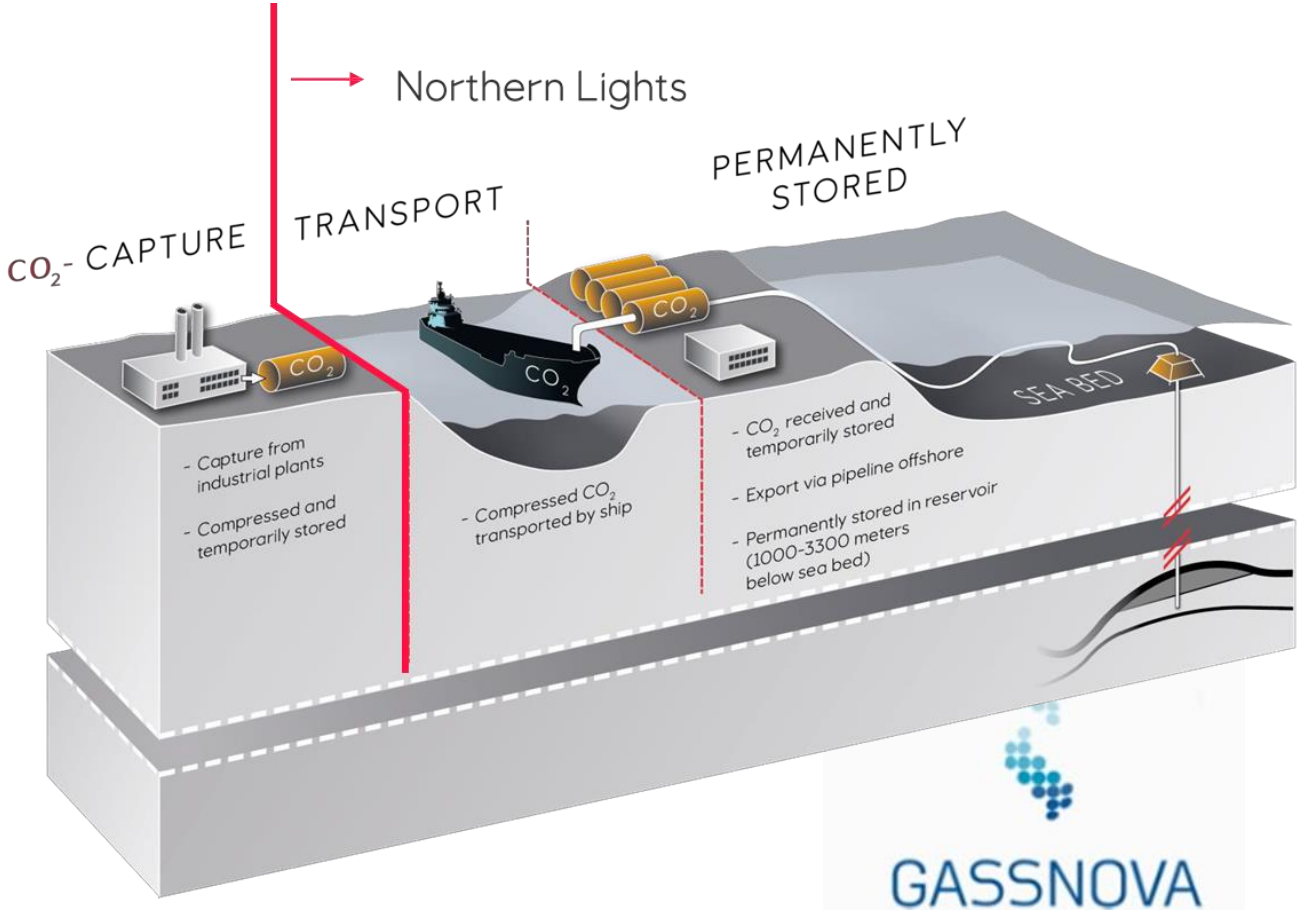
Norther Lights - a European “open source” network for CO2 removal and permanent offshore storage



THE EUROPEAN CO₂ NETWORK

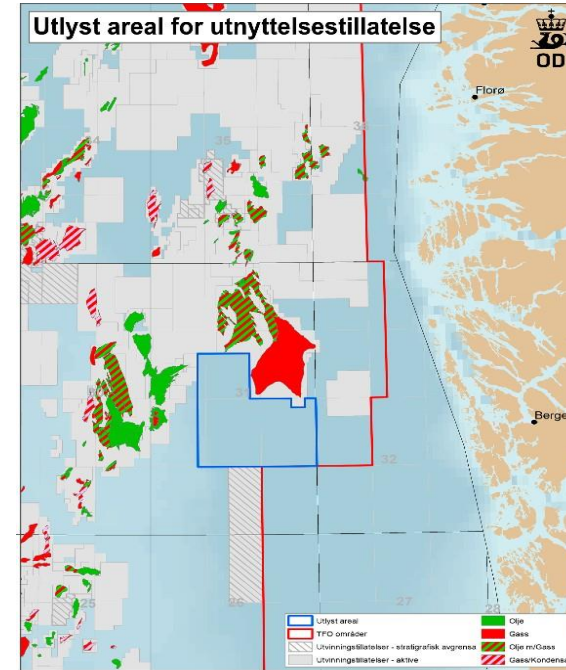


Source: Bellona Europe



Northern Lights - Project status & future

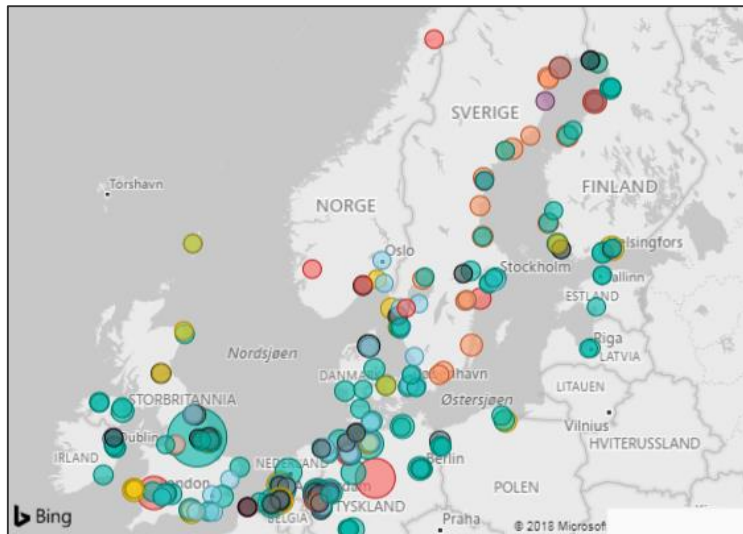
- **Transport, intermediate storage & pipeline**
FEED to be delivered Q3 2019
- **Storage**
 - Use permission Nr 001 given for “Aurora” south of Troll
 - Confirmation well to be drilled November 2019, subsea equipment is being built
- **Potential beyond anchor customers**
In dialogue with 15 possible users in 8 European countries
- **Investment decisions**
Planned for December 2020 (State budget)
- **Operational 2023**
Then all emitters have a storage solution – start capture!



Northern Lights: a solution for European heavy industry

Large potential in **energy-intensive** industrial sectors:

- Hydrogen and power from natural gas
- Waste incineration
- Cement
- Biomass and biofuel
- Steel
- Refinery

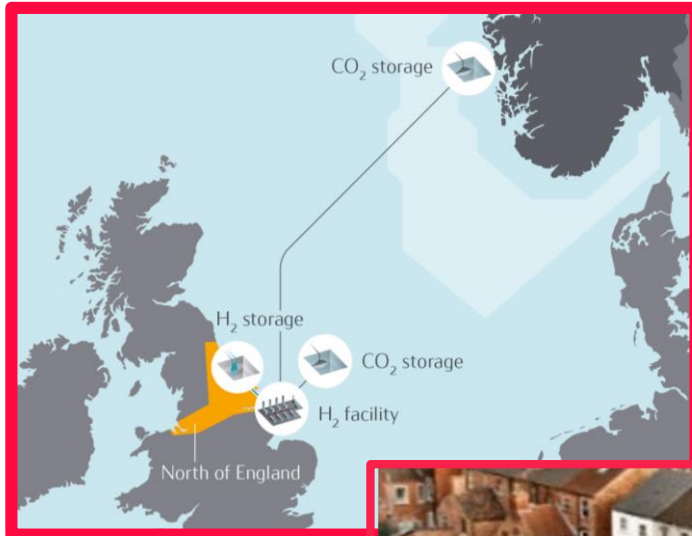


Equinor and Heidelberg Cement: signing of the Northern Lights MoU



Northern Lights is within reach of about 350 of the most 'attractive' European facilities amounting to **300 million tons of CO₂**

H21 North of England



System approach to decarbonise residential heating and distributed gas

Energy: ~85 TWh (12.5% of UK population)

/ 12 GW hydrogen production

CO₂ emissions reduction: 12,5 Mt CO₂ pa

CO₂ **storage** offshore UK / Norway

8 TWh (**seasonal**) **hydrogen storage**

CO₂ footprint 14,5 g/KWh

Unlimited system coupling

CAPEX: £23 billion



H21 NoE supply concept



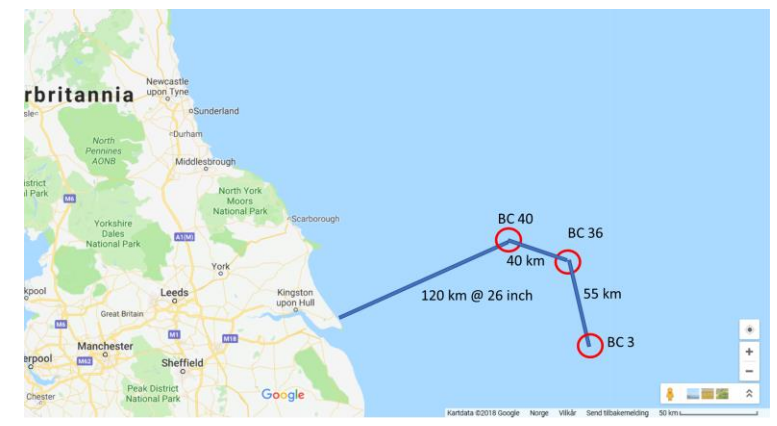
Greenfield Hydrogen Facility

- Location: Easington
- Capacity: 12 GW
- Configuration: Multi train, self-sufficient with power



Hydrogen Storage

- Location: Aldbrough
- Capacity: 8 TWh
- Configuration: 56 caverns at 300,000 m3



CO2 Storage

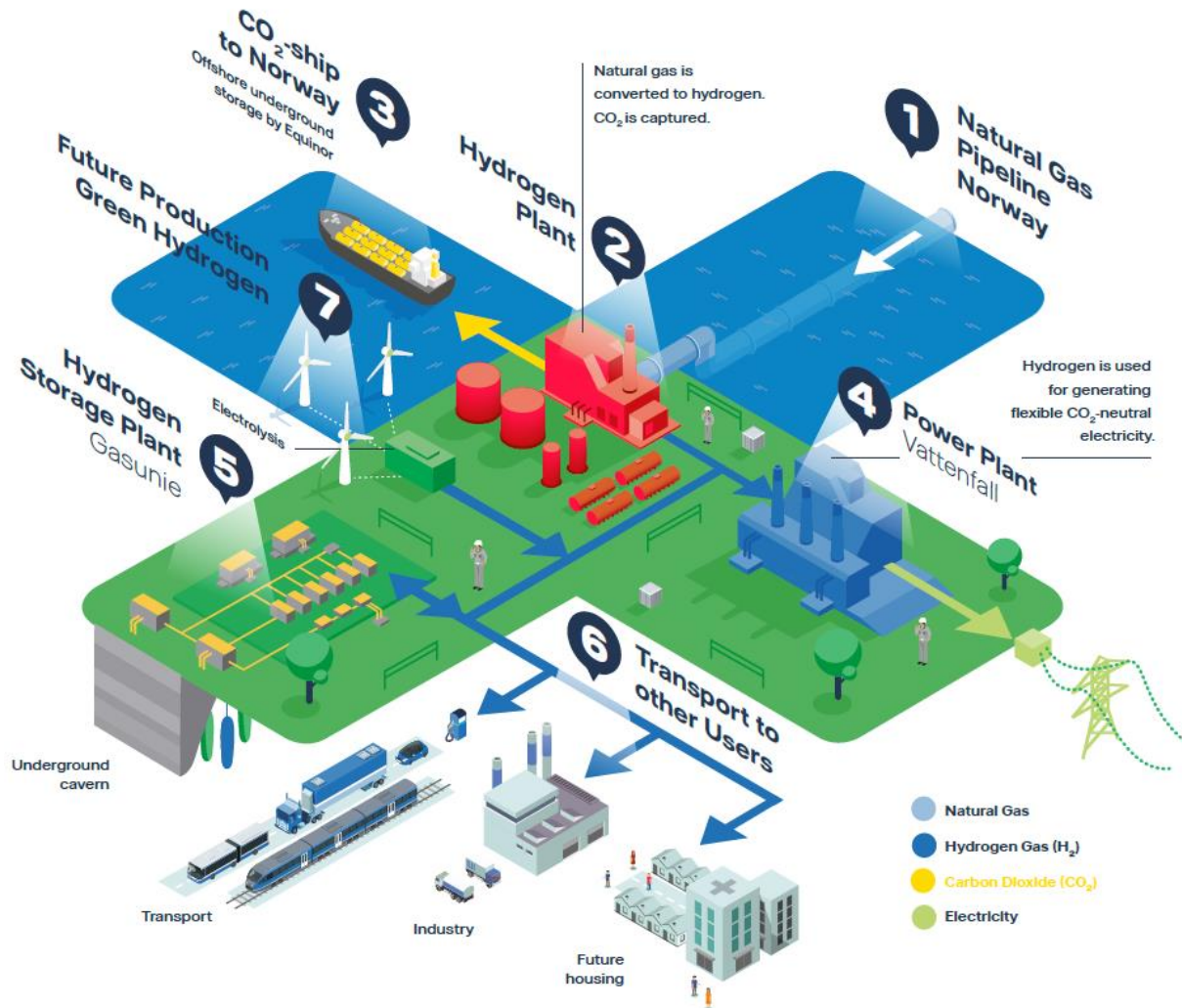
- Location: Bundter
- Capacity: +600 Million @ 17 mtpa
- Configuration: Saline aquifers

H21 - What will it cost?

2035 Residential Prices

	<u>2035 Residential Prices</u>	<u>CO2 Footprint</u>
Electricity	£200/MWh (BEIS Projection)	50 g/KWh
Natural Gas	£50/MWh (BEIS Projection)	200 g/KWh
Hydrogen	£75/MWh (H21)	15 g/KWh (H21)

H2M – Magnum, Netherlands



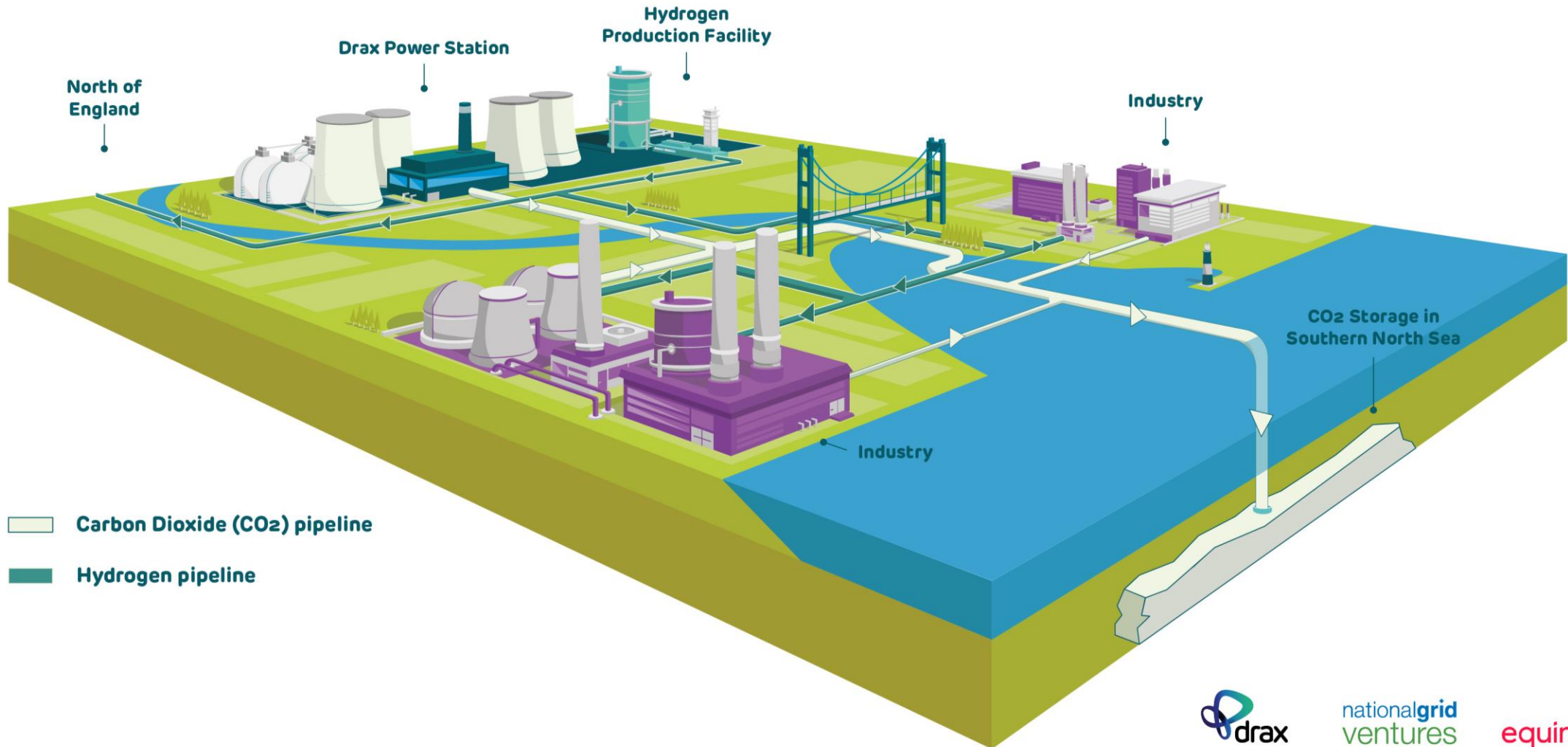
- **Energy:** 8-12 TWh
- **CO₂** emissions reduction of 2 Mton/year
- Utilise existing gas power plants and gas **infrastructure**
- Switch fuel from natural gas to clean H₂
- **Clean, flexible** electricity as **back-up** for solar and wind
- Launch large-scale H₂ economy

• **Partners:**

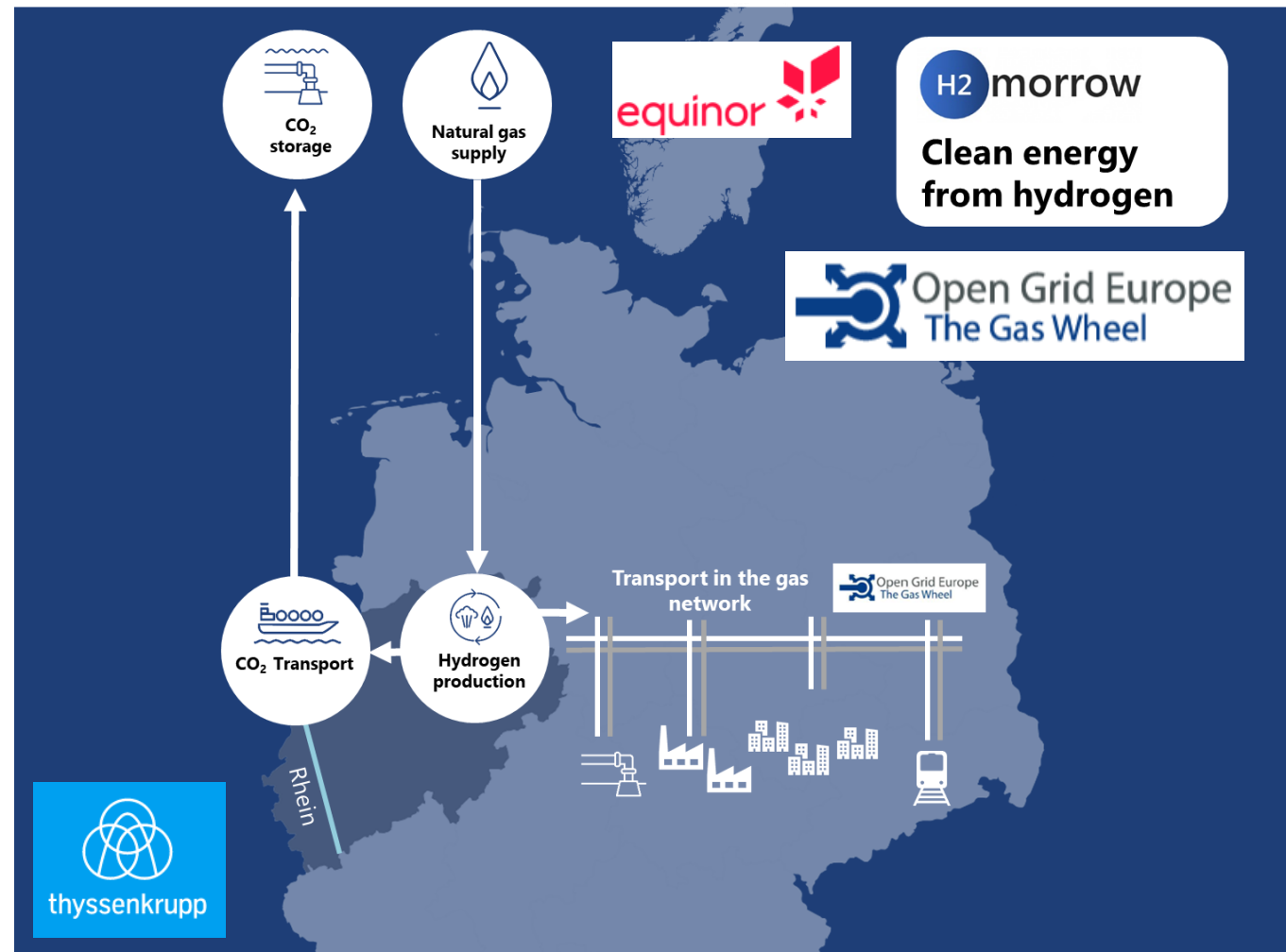


Zero Carbon Humber

Our vision



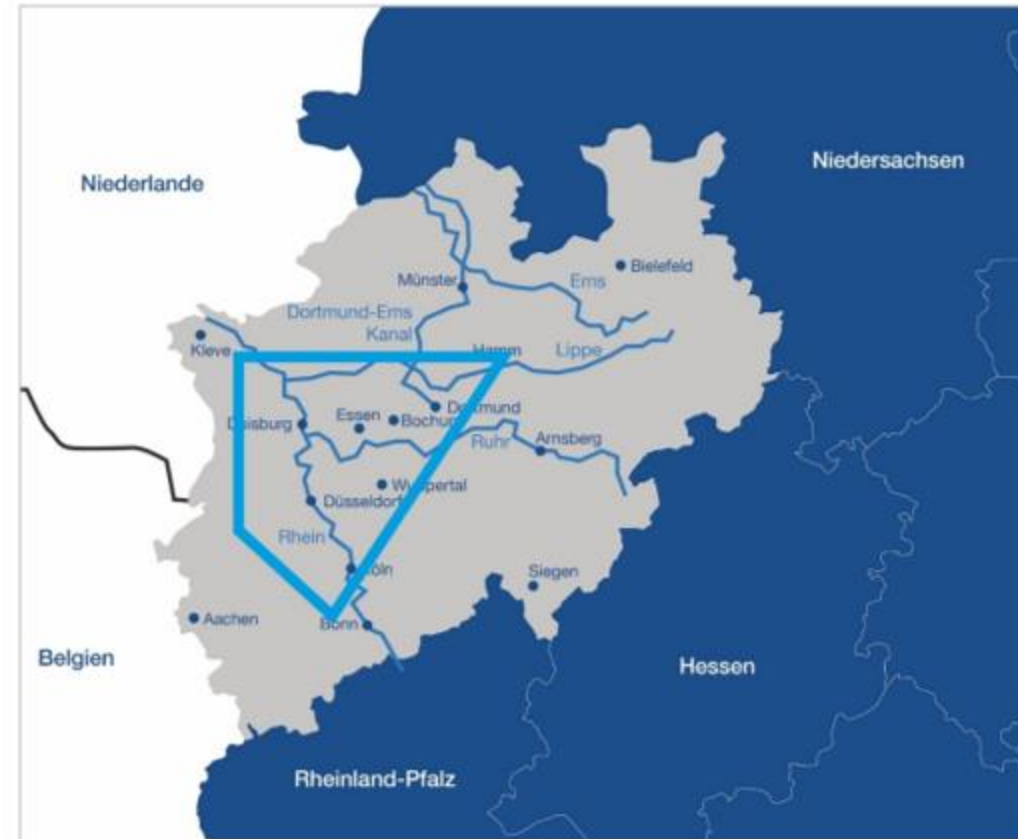
H2morrow: Building a platform for clean hydrogen in Germany



H2morrow pilot region

Why Nordrhein Westphalen?

- Well developed gas infrastructure
- Parallel L-gas and H-gas pipelines
- Available salt caverns for storage
- The Rhein with access to the North Sea
- Industrial heartland of Germany
- Industry well acquainted with H2
- Already a large market for grey H2
- Large CO2 emissions to be abated
- Strong will to retain industry & jobs
- Huge H2 market potential in other sectors
- More that 10 million people in pilot region
- Vantage point for further expansion to the south and southeast



CCS Projects:

Northern Lights - Decarbonising industry

H21 North of England – Decarbonising heat

H2M-Magnum – Decarbonising electricity

Zero Carbon Humber - Decarbonising industry

H2morrow – Decarbonising the Ruhr area

Steinar Eikaas/Bjarne L. Bull-Berg

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