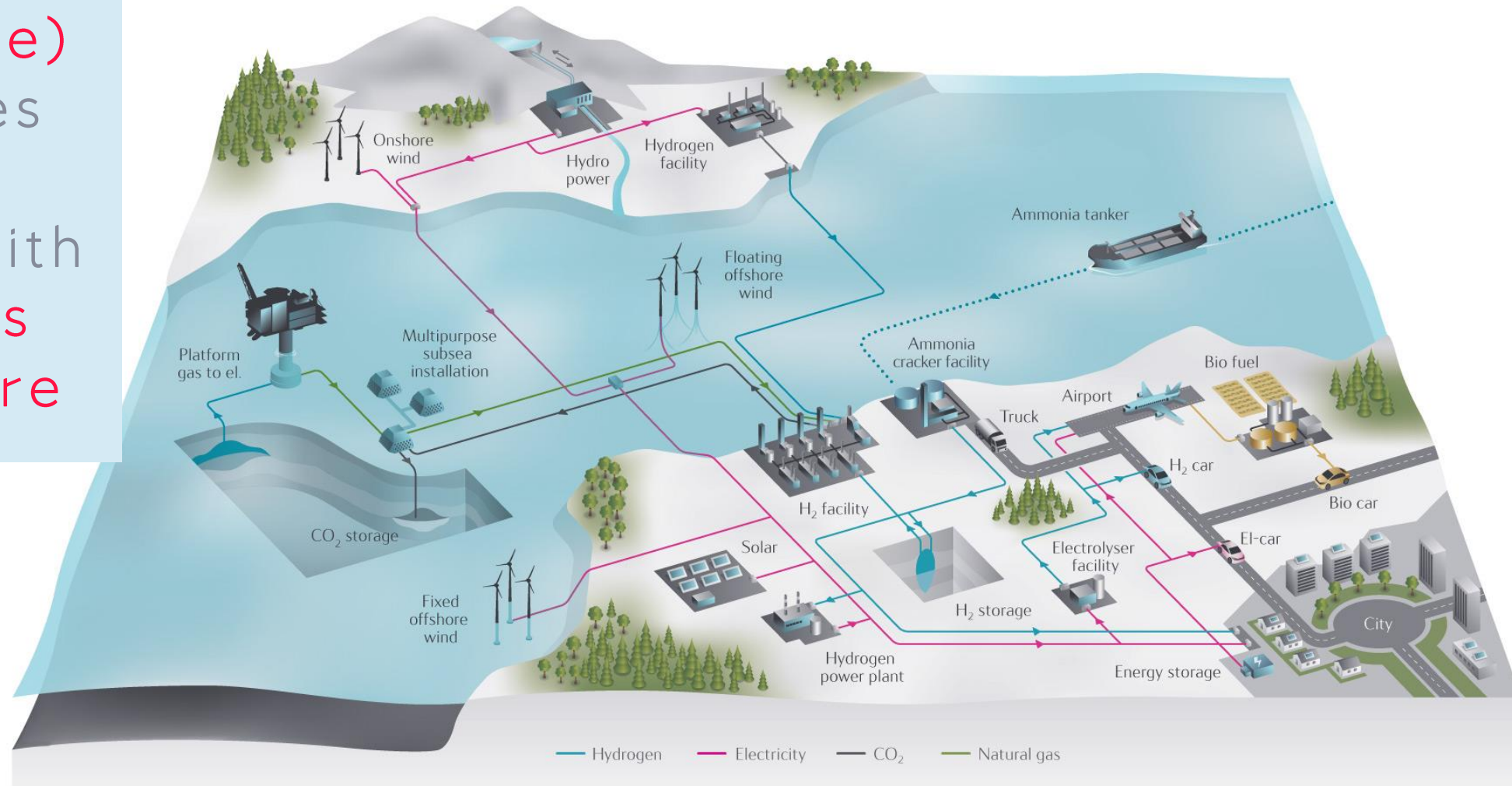


CCS and Decarbonisation

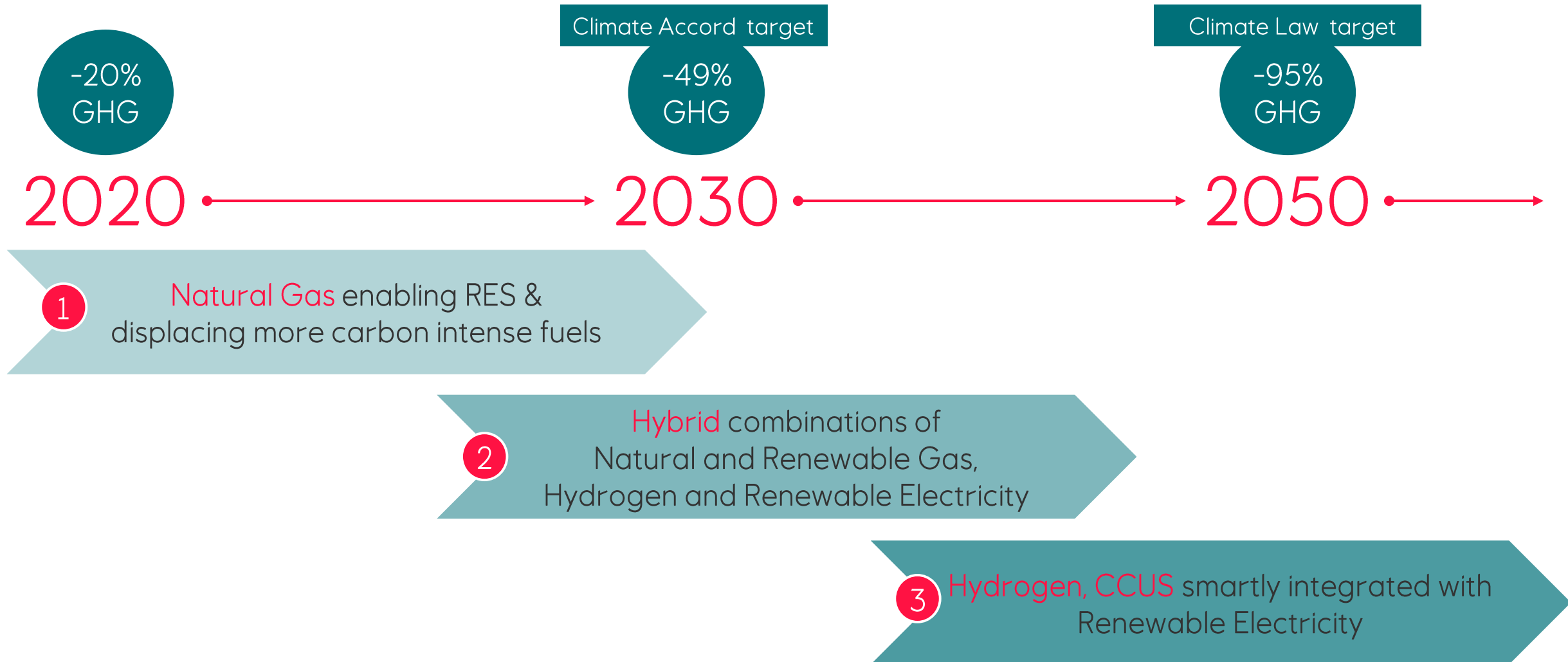
A Norwegian Perspective

What a low carbon energy system could look like

(Re)new(able)
technologies
smartly
integrated with
Existing gas
infrastructure

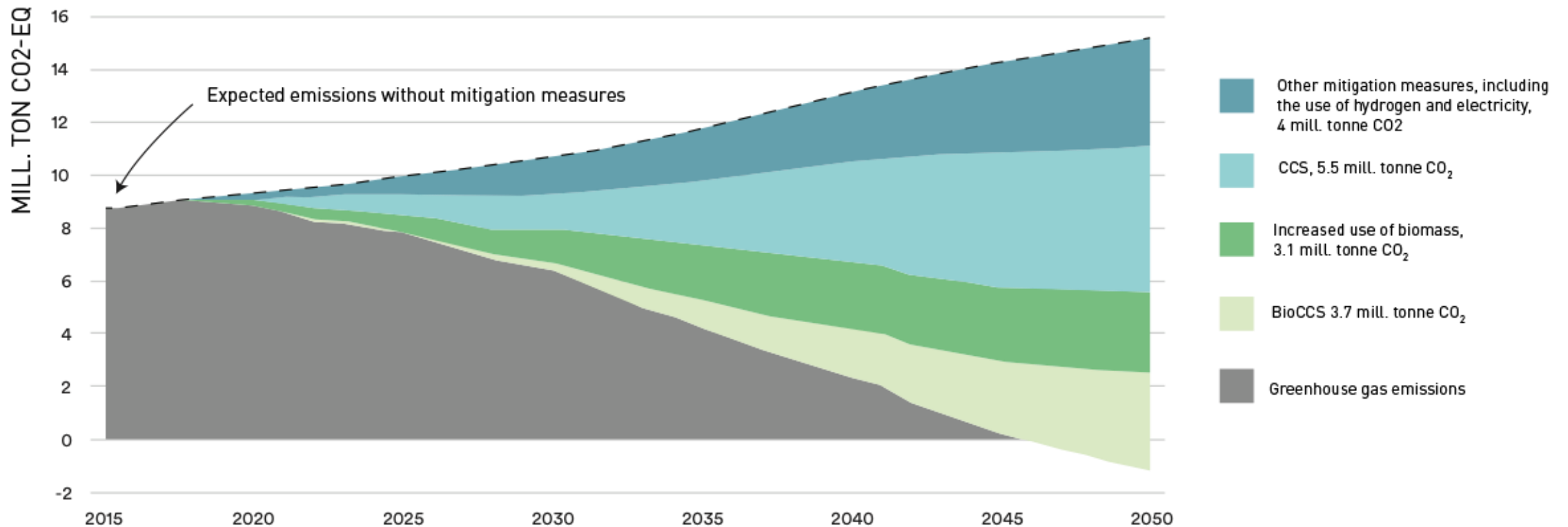


Gas, a cost efficient backbone of a Dutch low carbon energy system

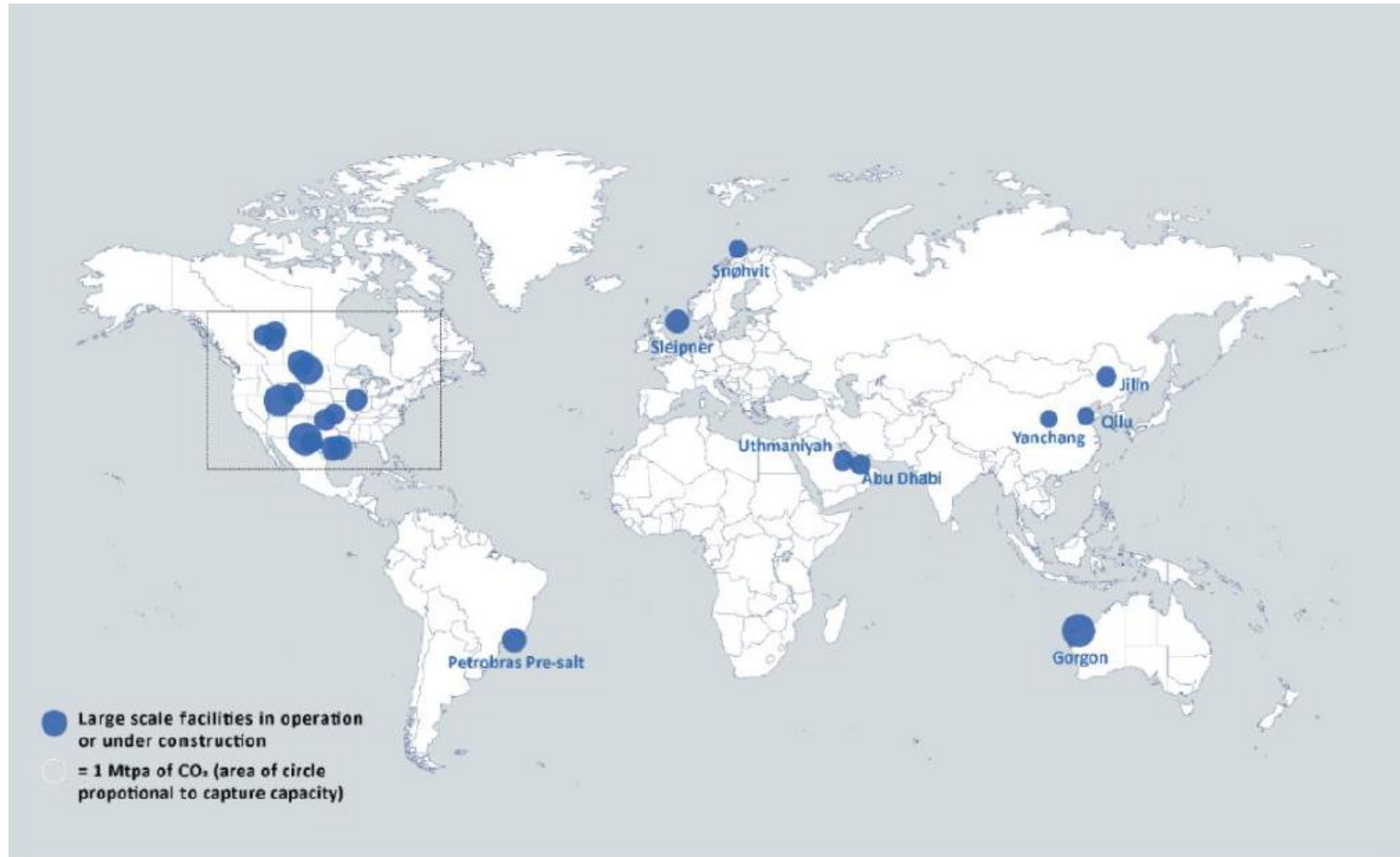


Norwegian processing industry roadmap, 2016

- Aims for double production & negative emissions in 2050
- Need ambitious, long-term technology development programs – Process21
- Requires CCS – national effort to build industrial CCS value chain should continue
- Requires sustainable biomass – opportunity for Norwegian industry

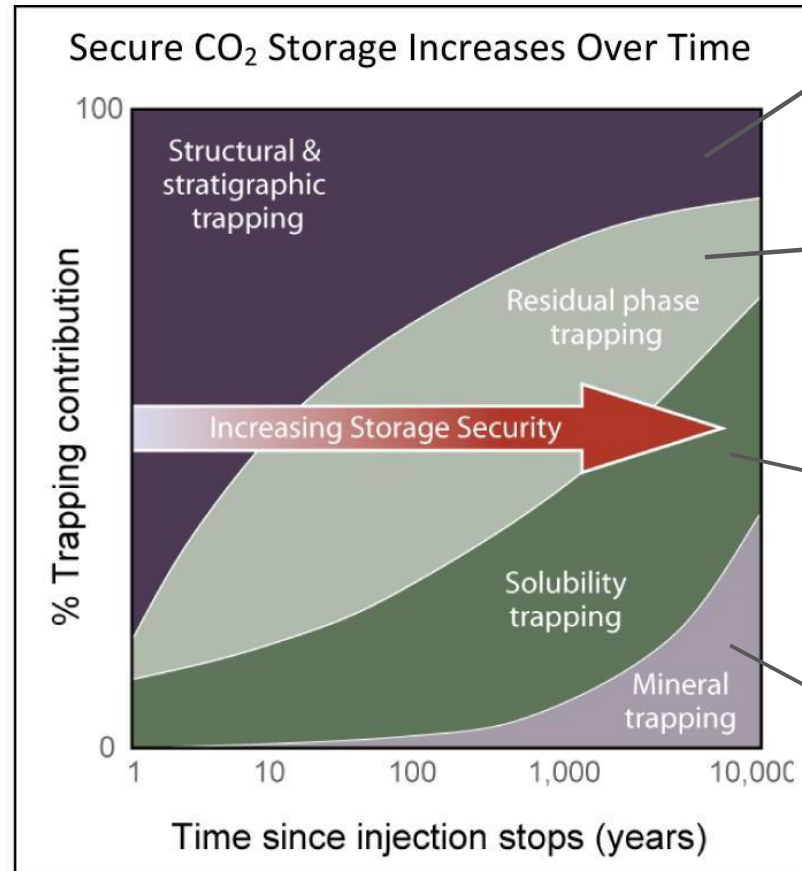


Large scale facilities in operation or under construction

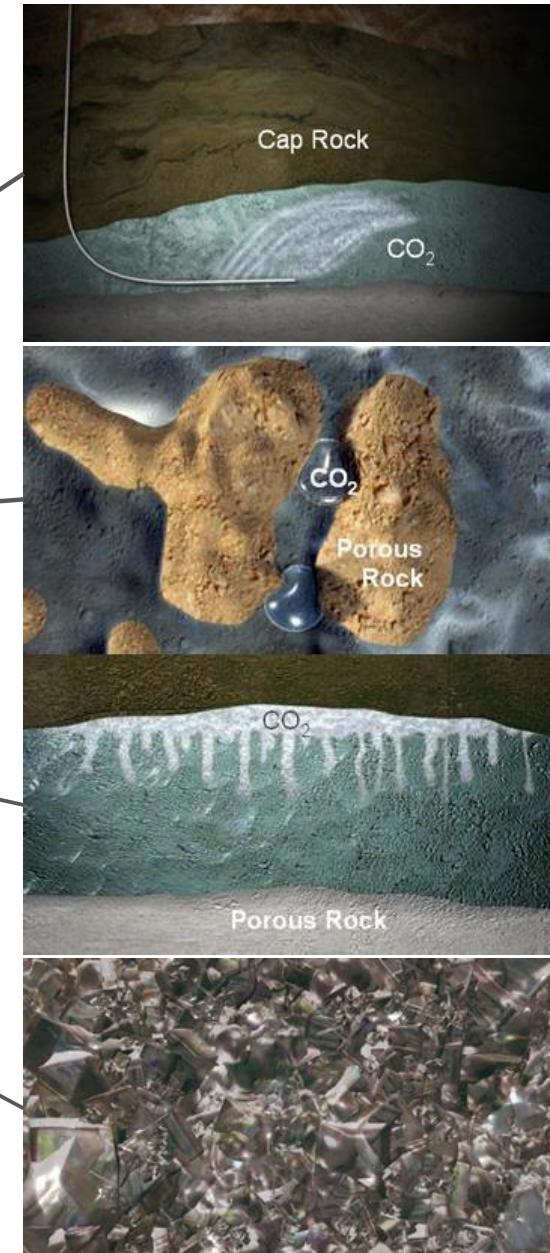


Reprinted from: Global CCS Institute (2018). *Global Status of CCS 2018*

Storage mechanisms – increasing safety over time

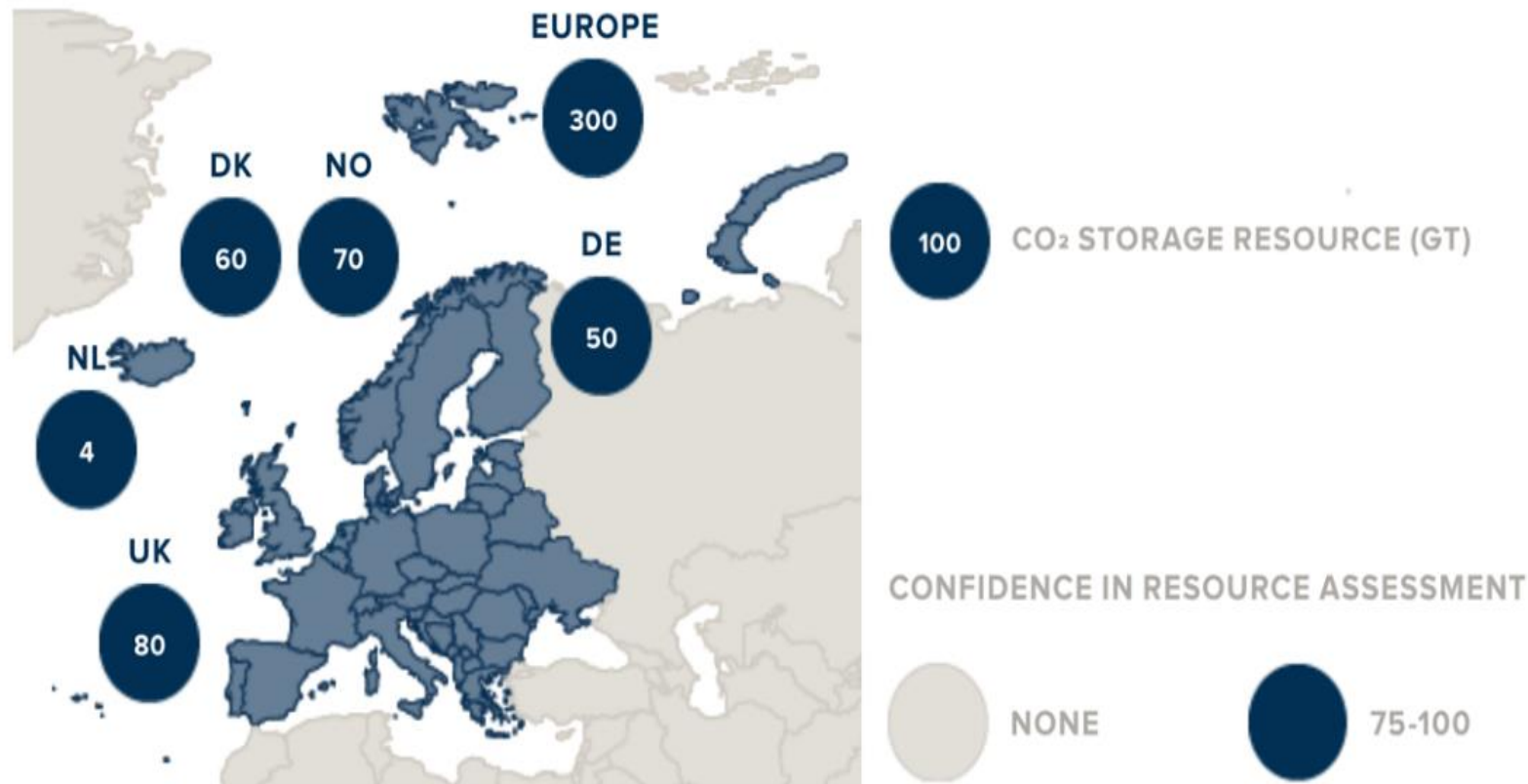


After IPCC (2005): Carbon Dioxide Capture and Storage



http://www.co2captureproject.org/co2_trapping.html

Estimated CO₂ storage capacity in Europe

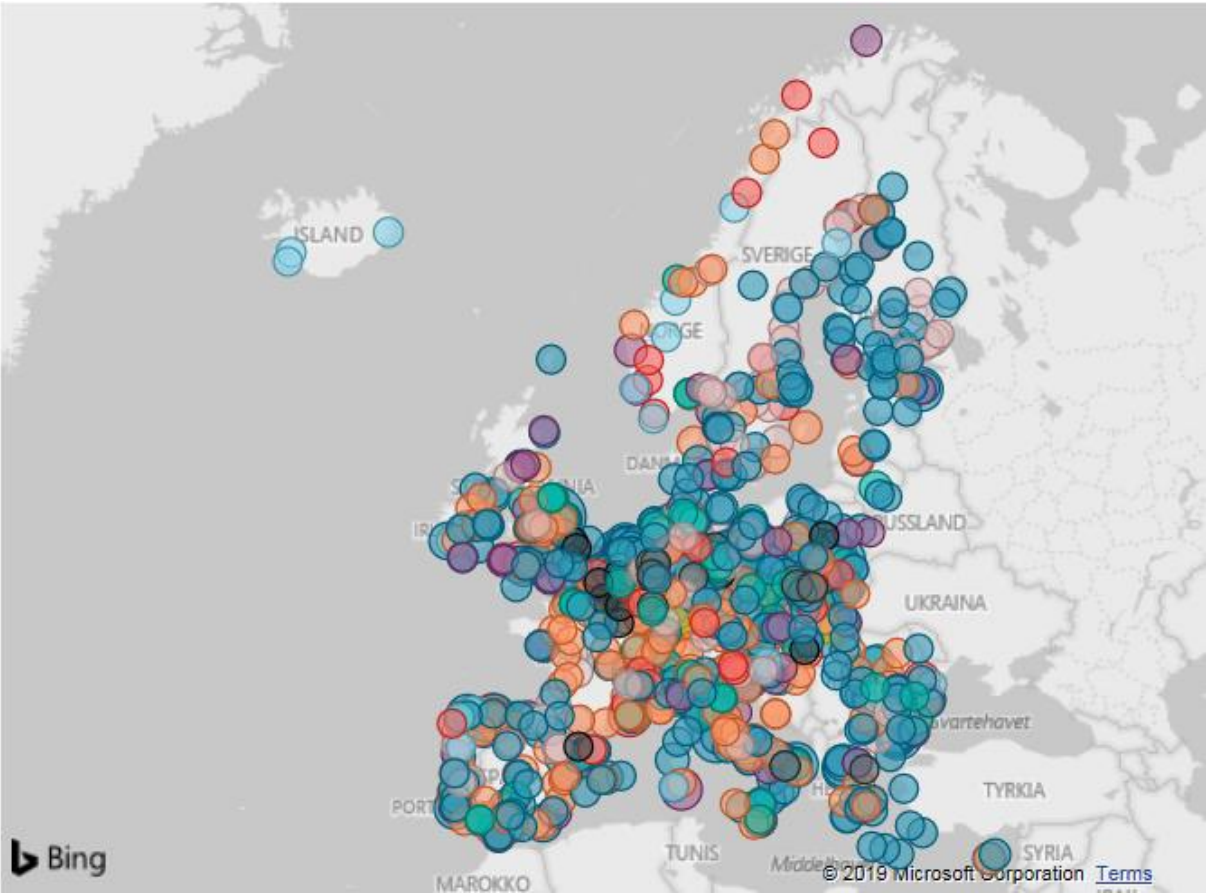
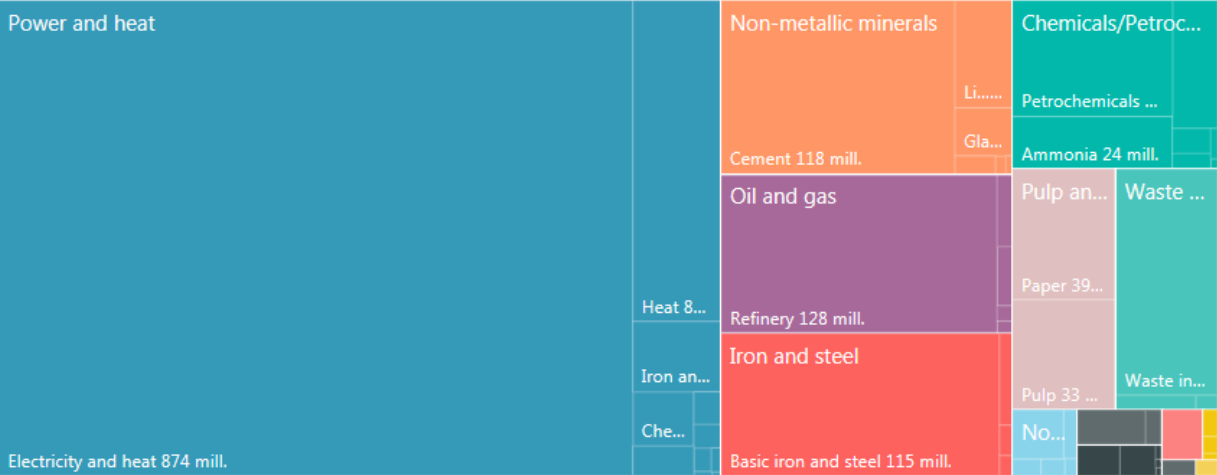


Adapted from: Global CCS Institute (2018). *Global Status of CCS 2018*

The European potential – understanding the scale

Location:
Emission Points:
Emitted CO₂

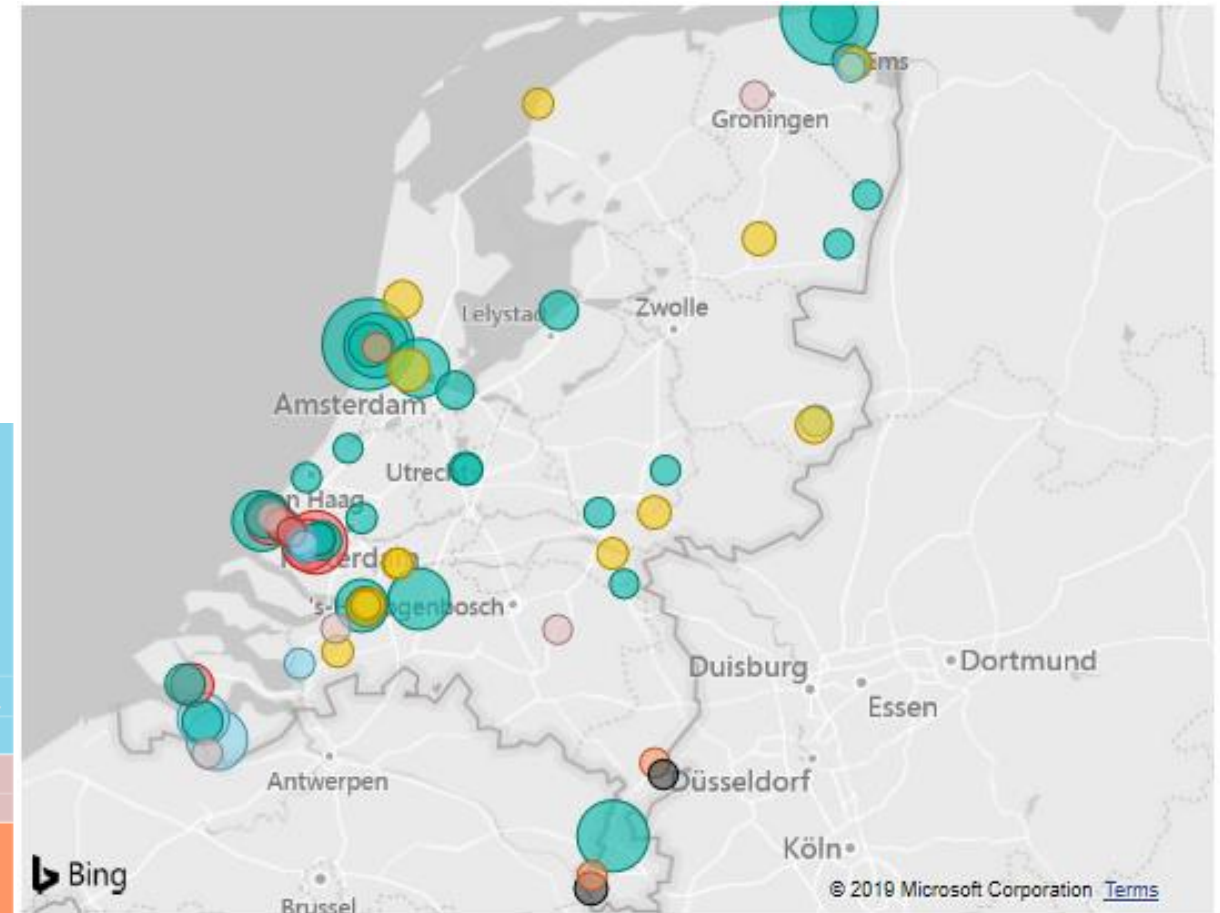
Europe
1994
1680 MTPA



Source:  endrava CARBON LIMITS

The European potential – understanding the scale

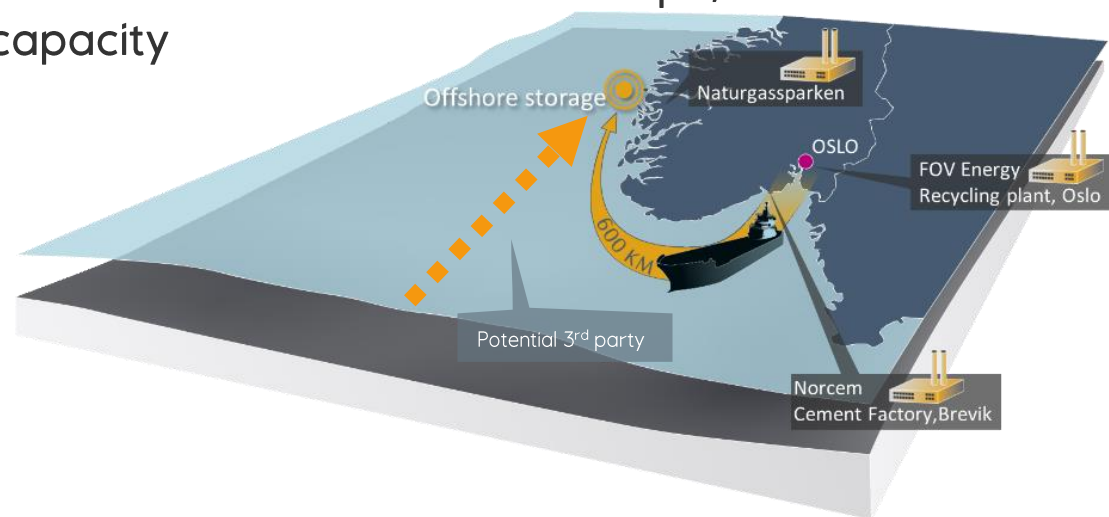
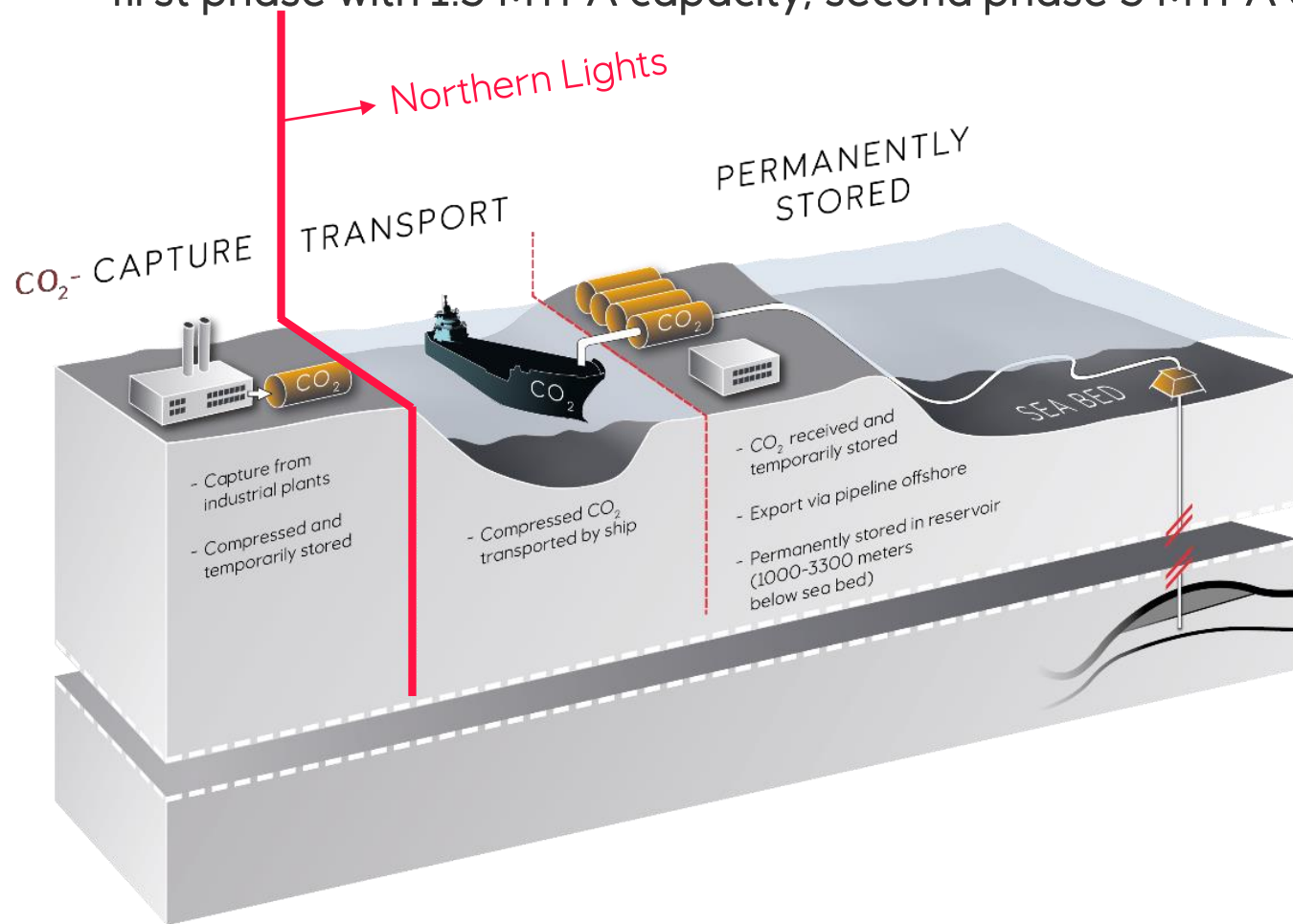
Location: The Netherlands
Emission Points: 83
Emitted CO₂ 86 MTPA



Source:  endrava CARBON LIMITS

Northern Lights is part of Norwegian full scale CCS demonstration project

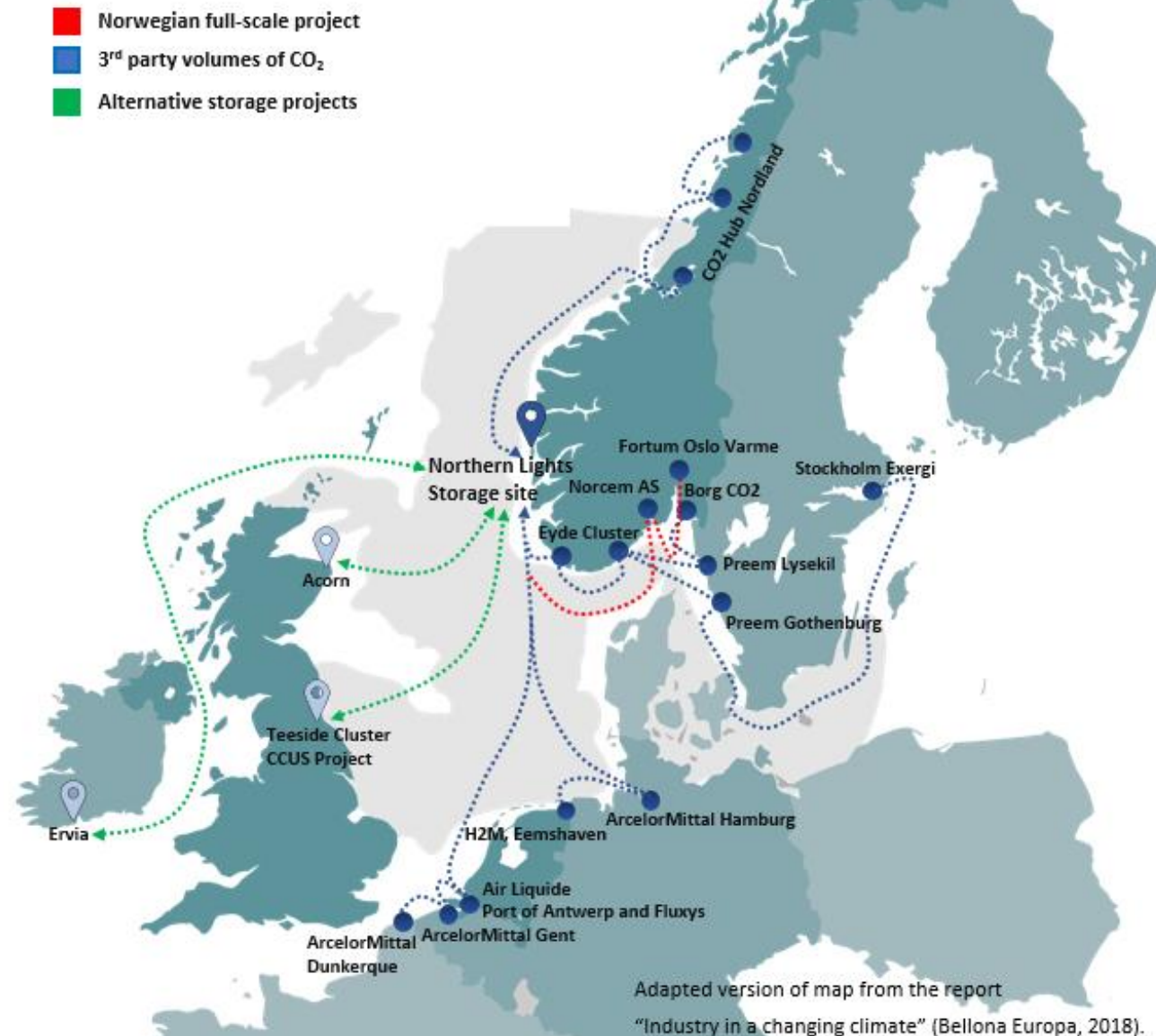
Ship-based transport & storage solution which enables industrial decarbonisation in Europe, first phase with 1.5 MTPA capacity, second phase 5 MTPA capacity



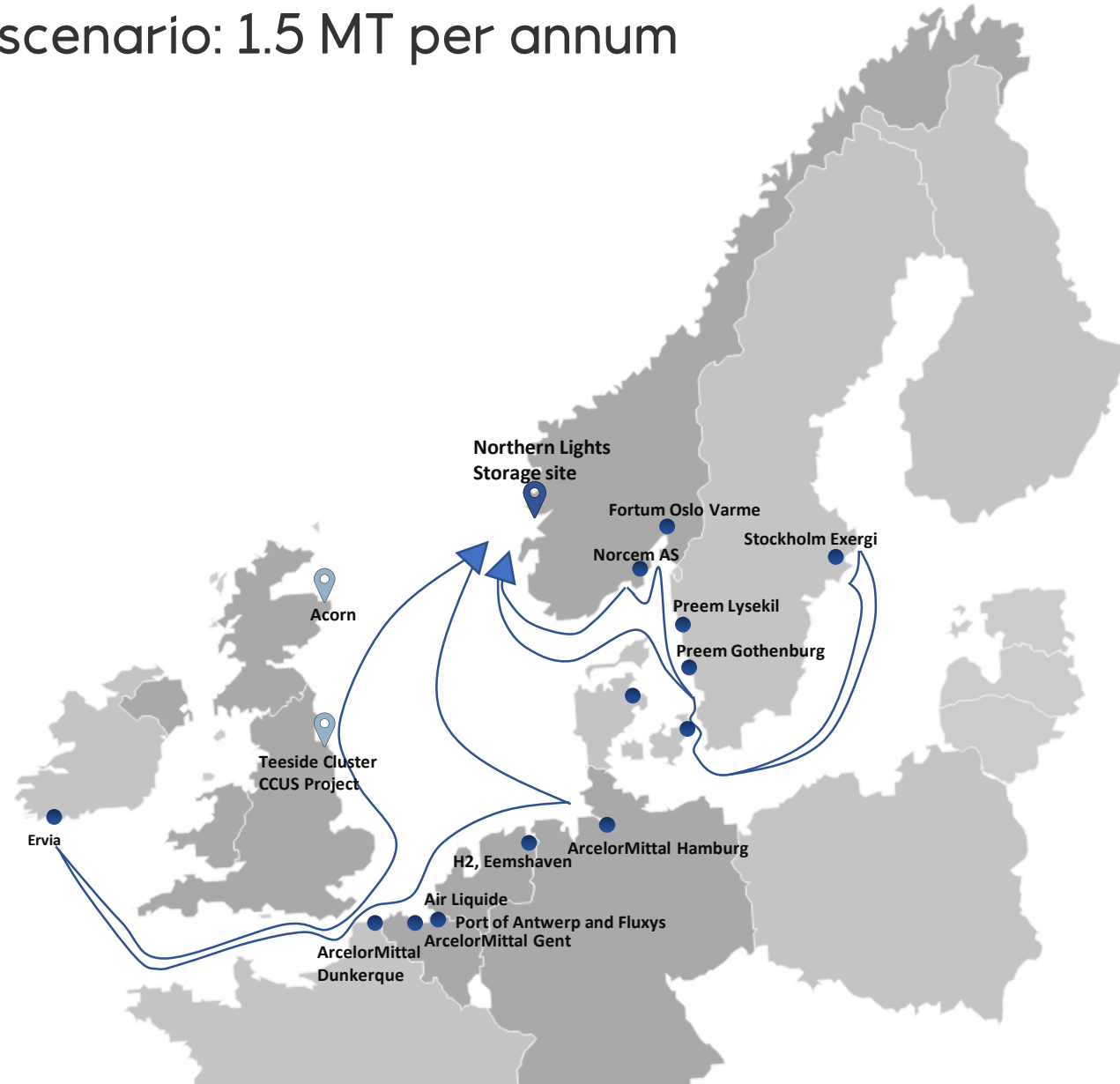
Beginning of a European network for CO2 removal

Key dates

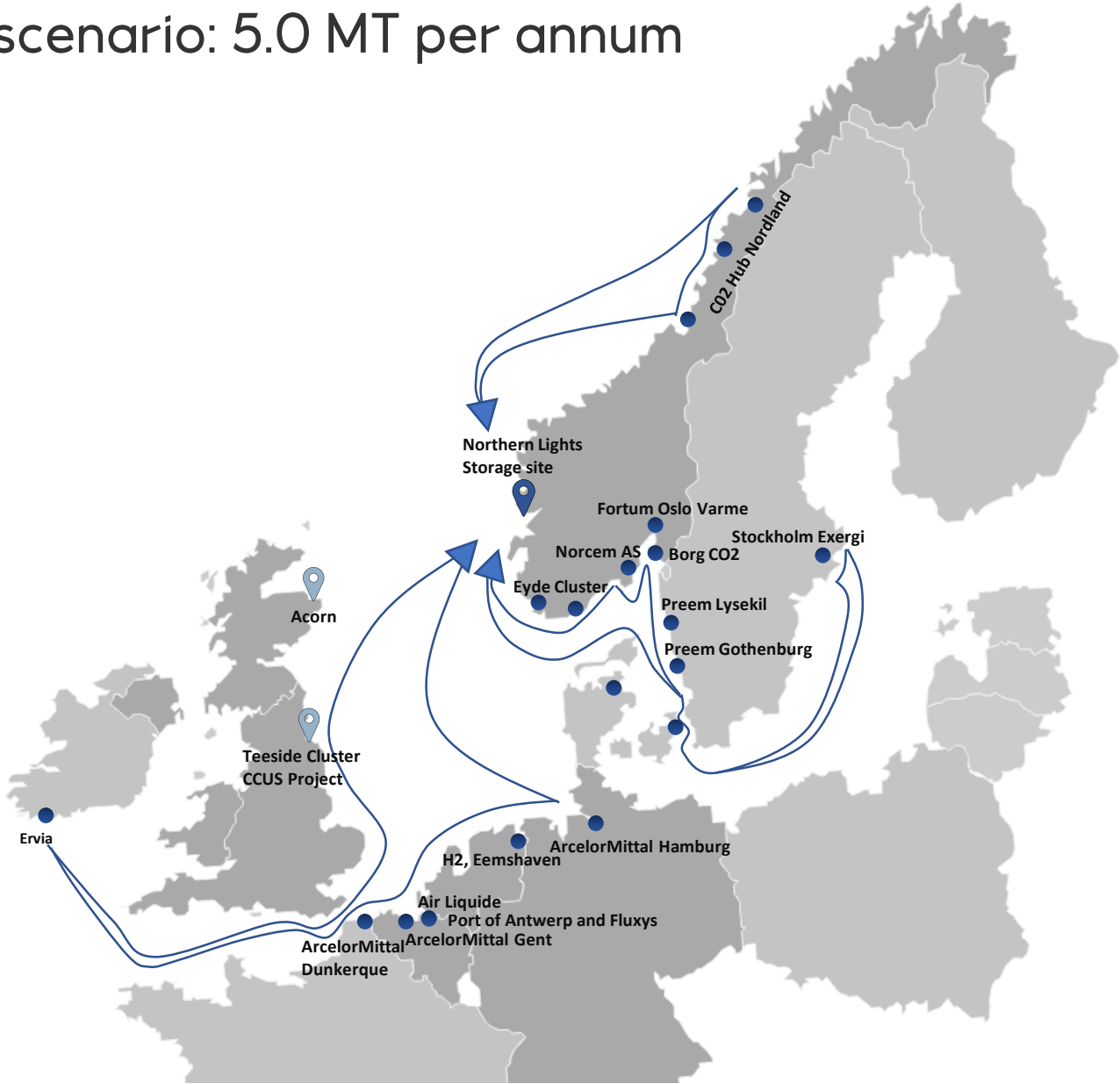
- March 2019 - PCI
- September 2019 - MOU
- Nov/dec 2019 - Aurora
- 2020-21 - FID
- 2023 - in operation



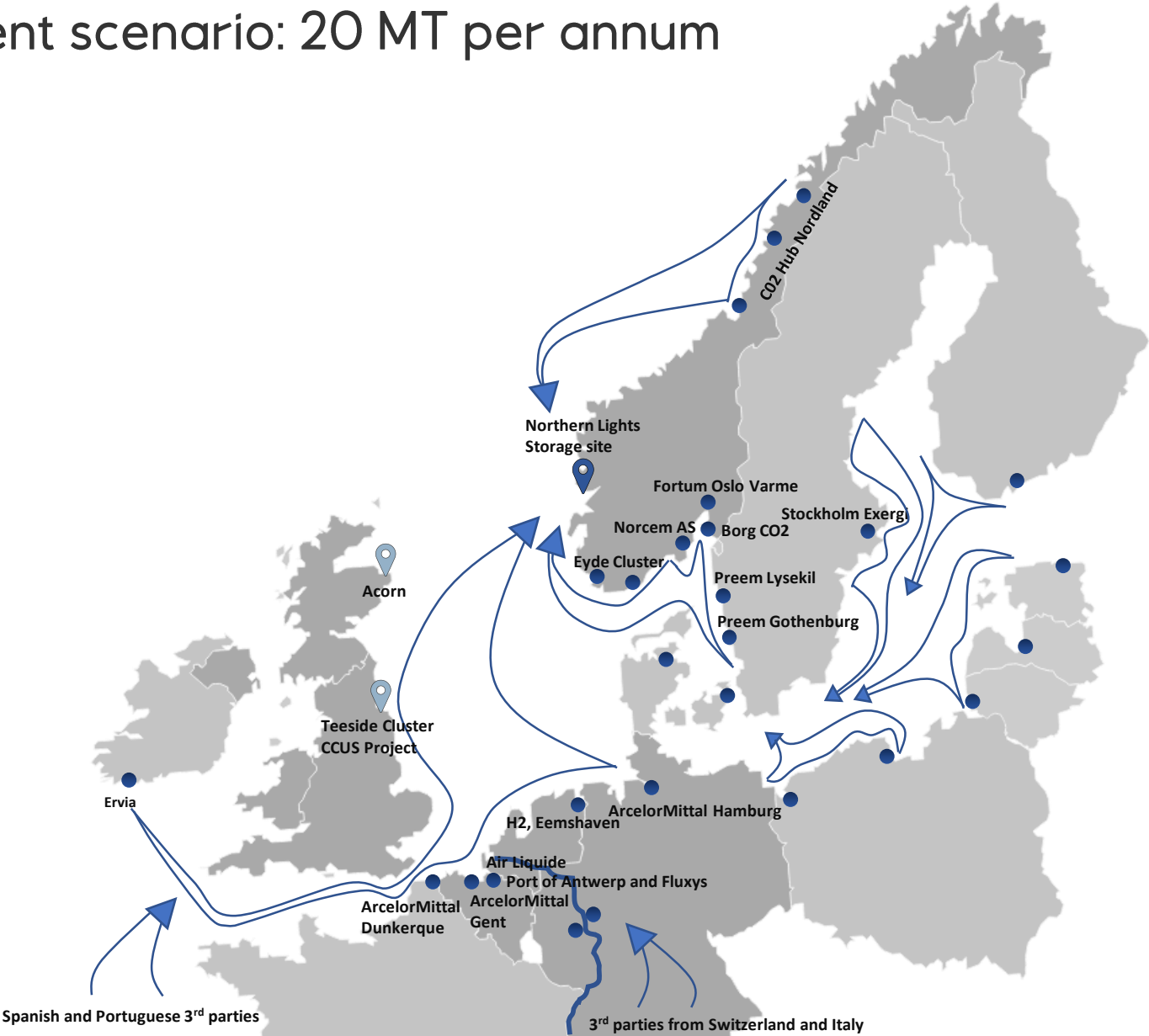
Development scenario: 1.5 MT per annum



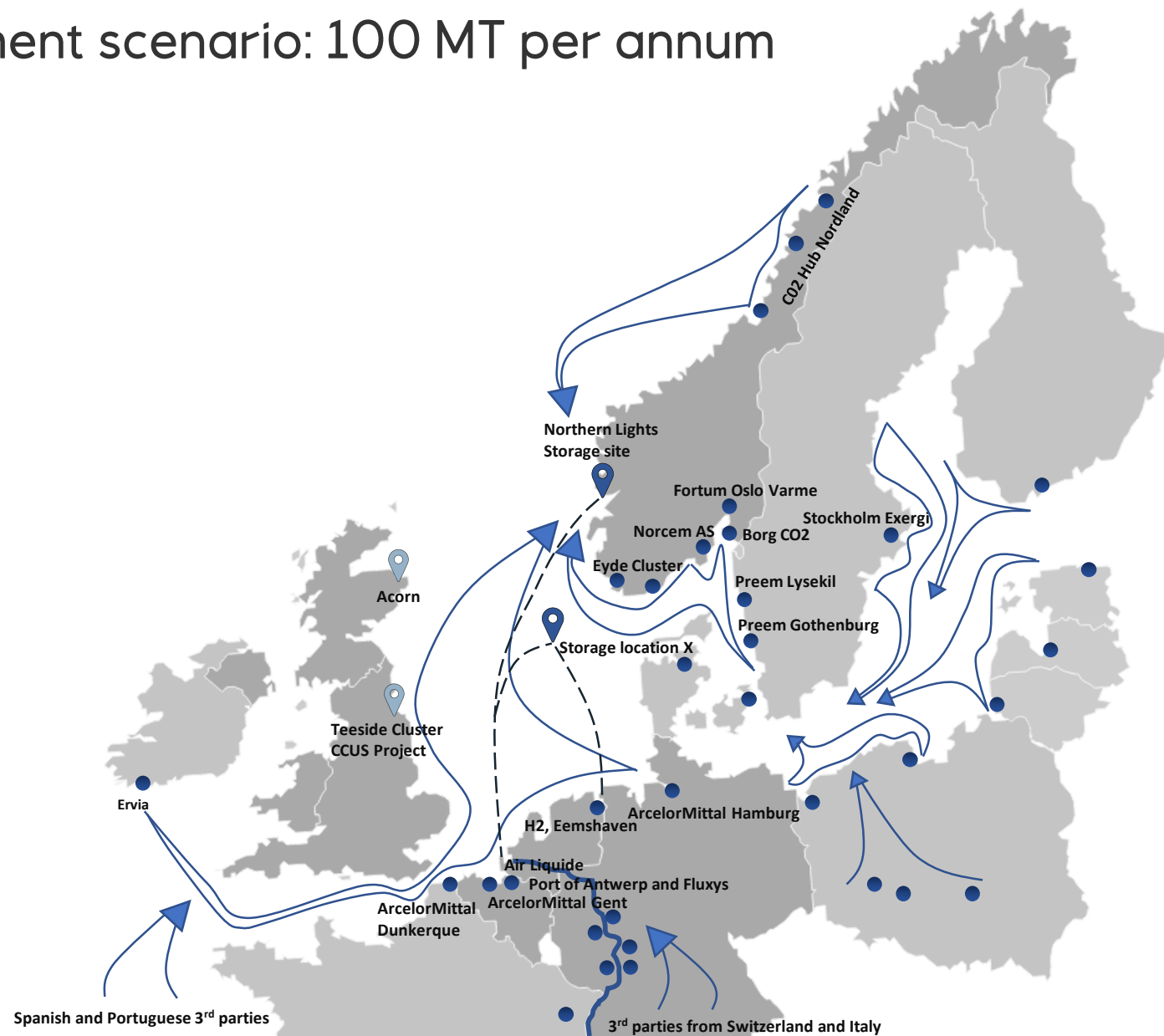
Development scenario: 5.0 MT per annum



Development scenario: 20 MT per annum



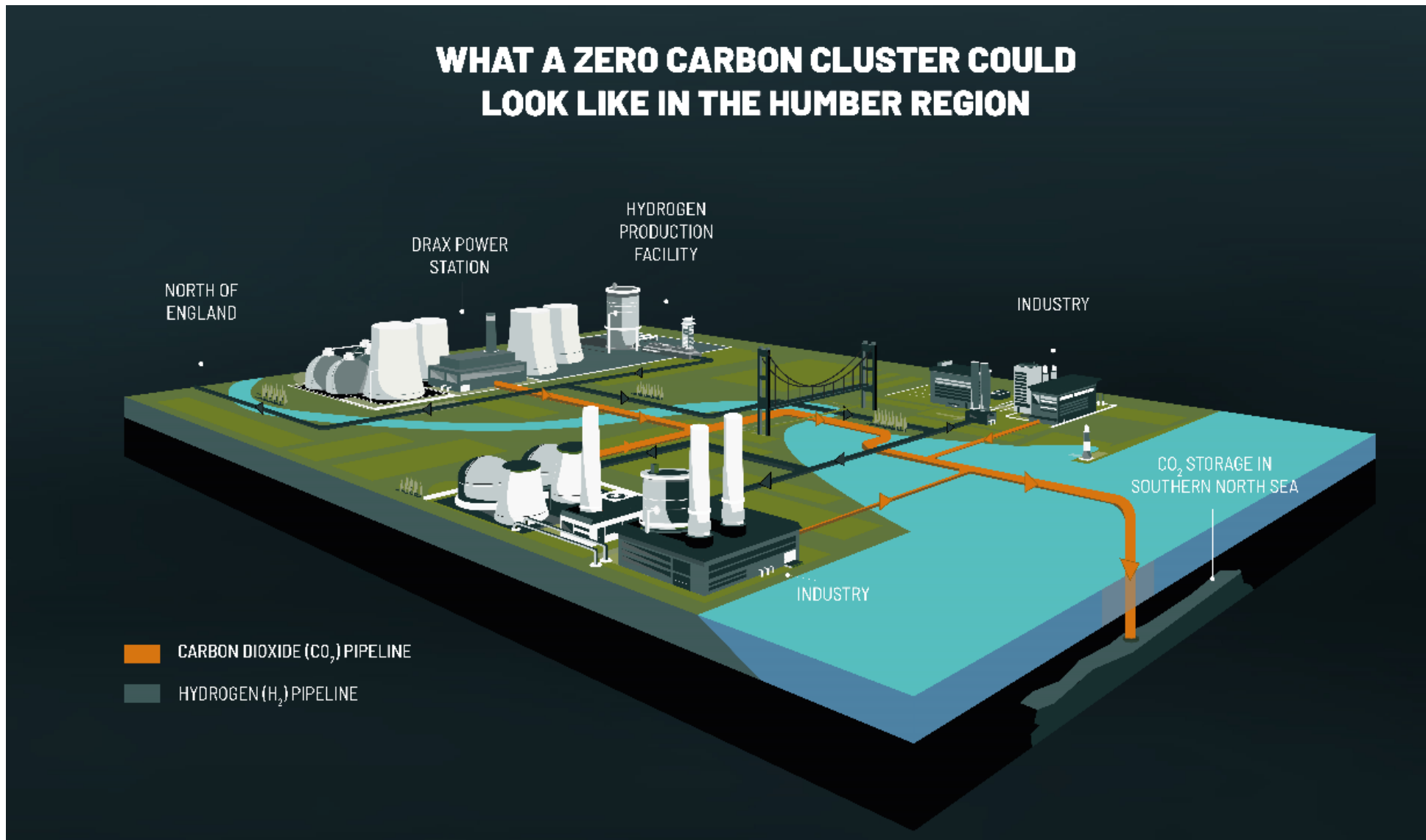
Development scenario: 100 MT per annum



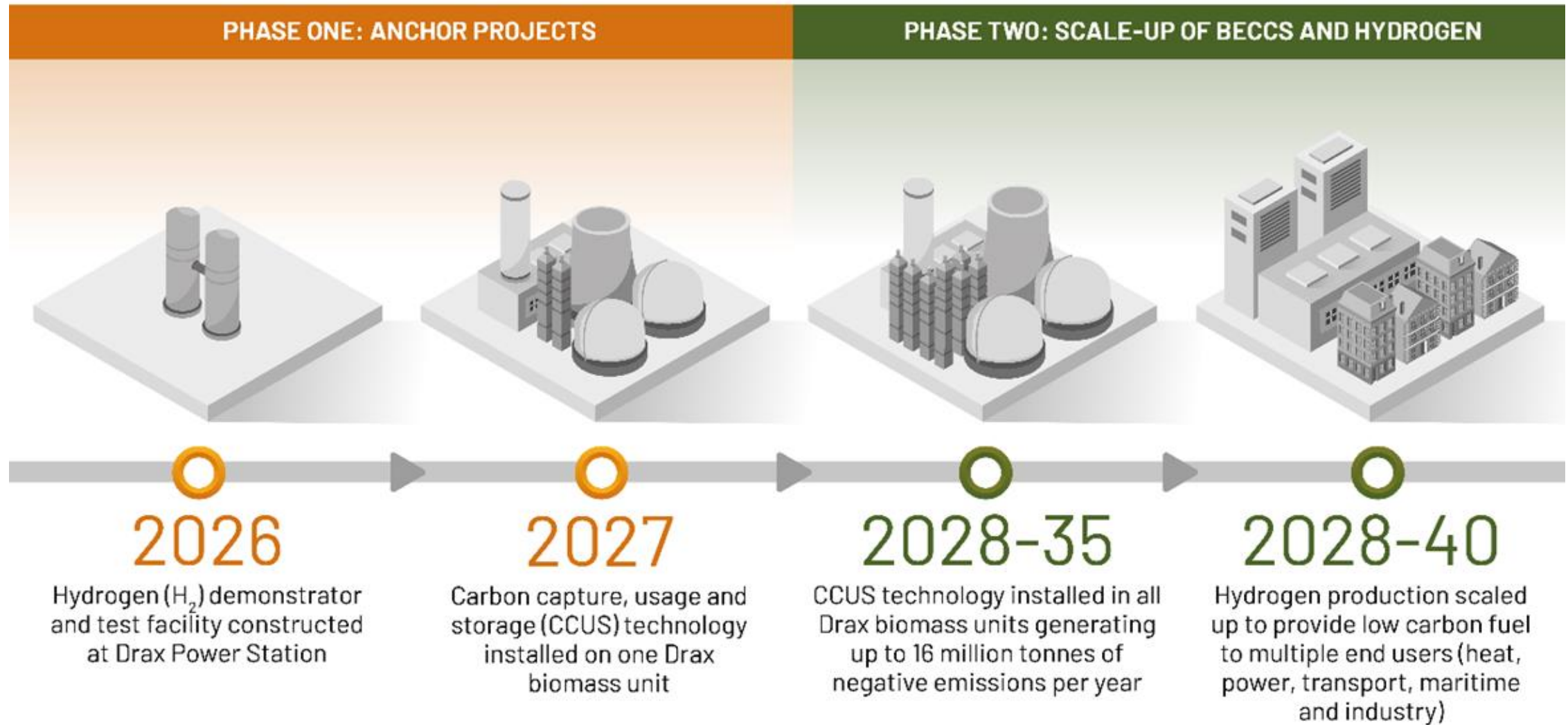
Several needs for regulatory amendments to make CCS happen

- **London Protocol** – to allow for cross-border transport of CO₂
- **CCS Directive** – to include ships in definition of CO₂ transport network
- **EU ETS Directive** – to include ships in definition of CO₂ transport network
- **TEN- E (CEF) Regulation** – to make ships eligible for funding

Negative emissions



ZERO CARBON HUMBER PROJECTS TIMELINE



CCS and Decarbonisation

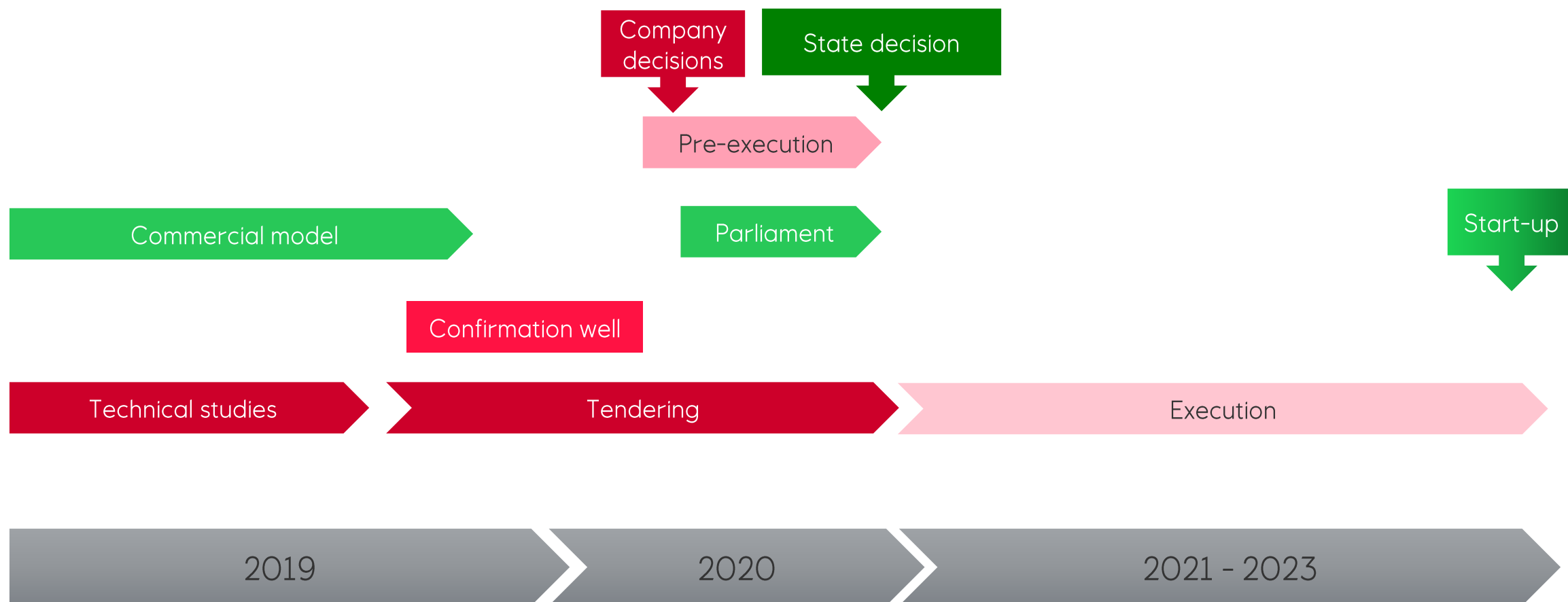
Lucie Boost

© Equinor ASA

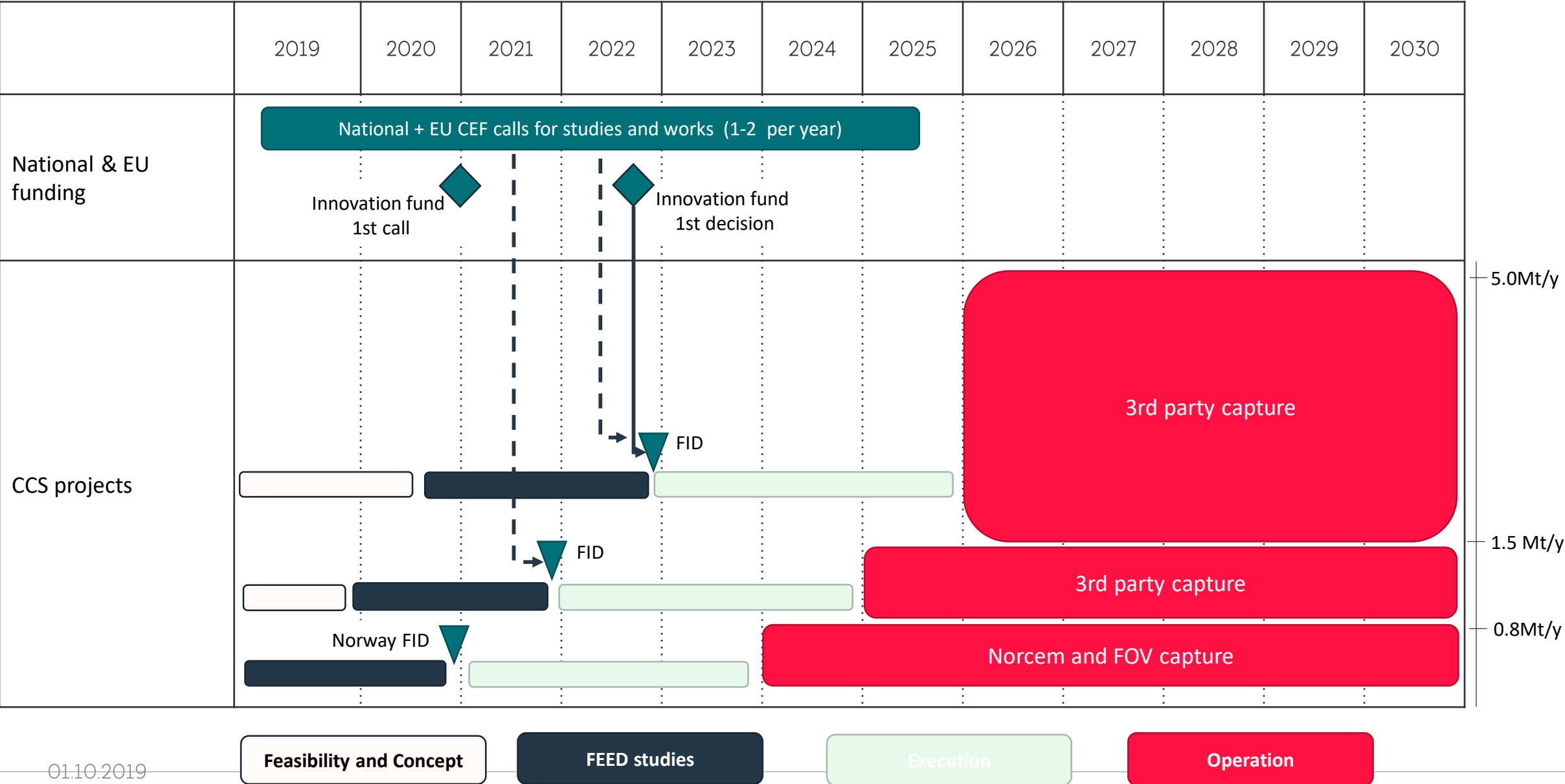
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Backup

Timeline for Northern Lights phase 1



Early Norwegian investment decisions can enable rapid European capture



CCS projects in Europe

Overview of existing and planned CCS facilities

Norway

- 1. Sleipner CO₂ Storage*
- 2. Snøhvit CO₂ Storage*
- 3. Northern Lights*

Republic of Ireland

- 4. ERVIA

UK

- 5. Acorn
- 6. Caledonia Clean Energy
- 7. H21 North of England*
- 8. Liverpool-Manchester Hydrogen Cluster
- 9. Teesside Collective
- 10. OGCI Clean Gas Project*

France
11. Lacq*

Belgium
12. Leilac

Sweden

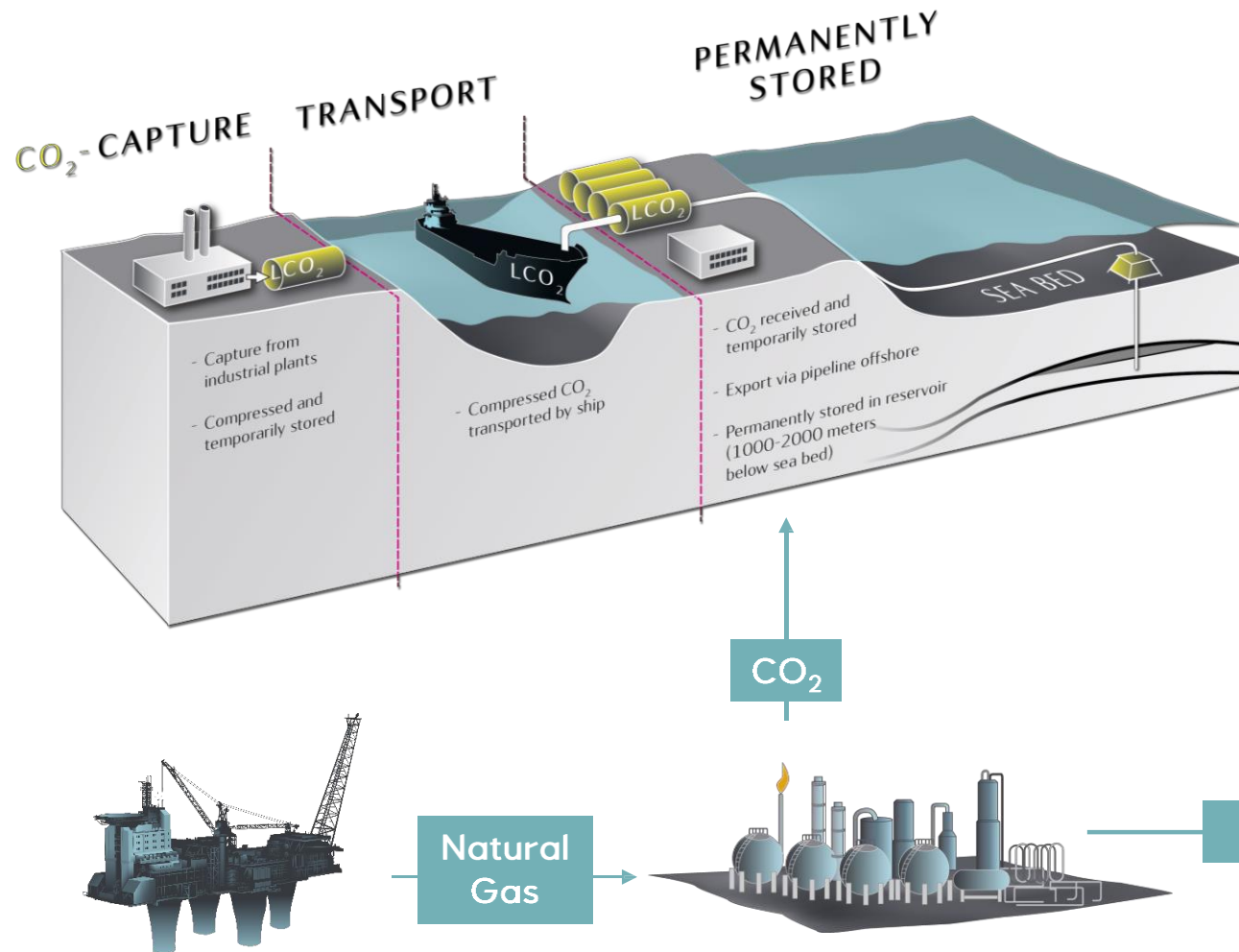
- 13. Preem CCS

The Netherlands

- 14. Port of Rotterdam*
- 15. Magnum*

* Project where IOGP members are involved

CCS as enabler for hydrogen production



H₂

Clean Hydrogen



for power generation

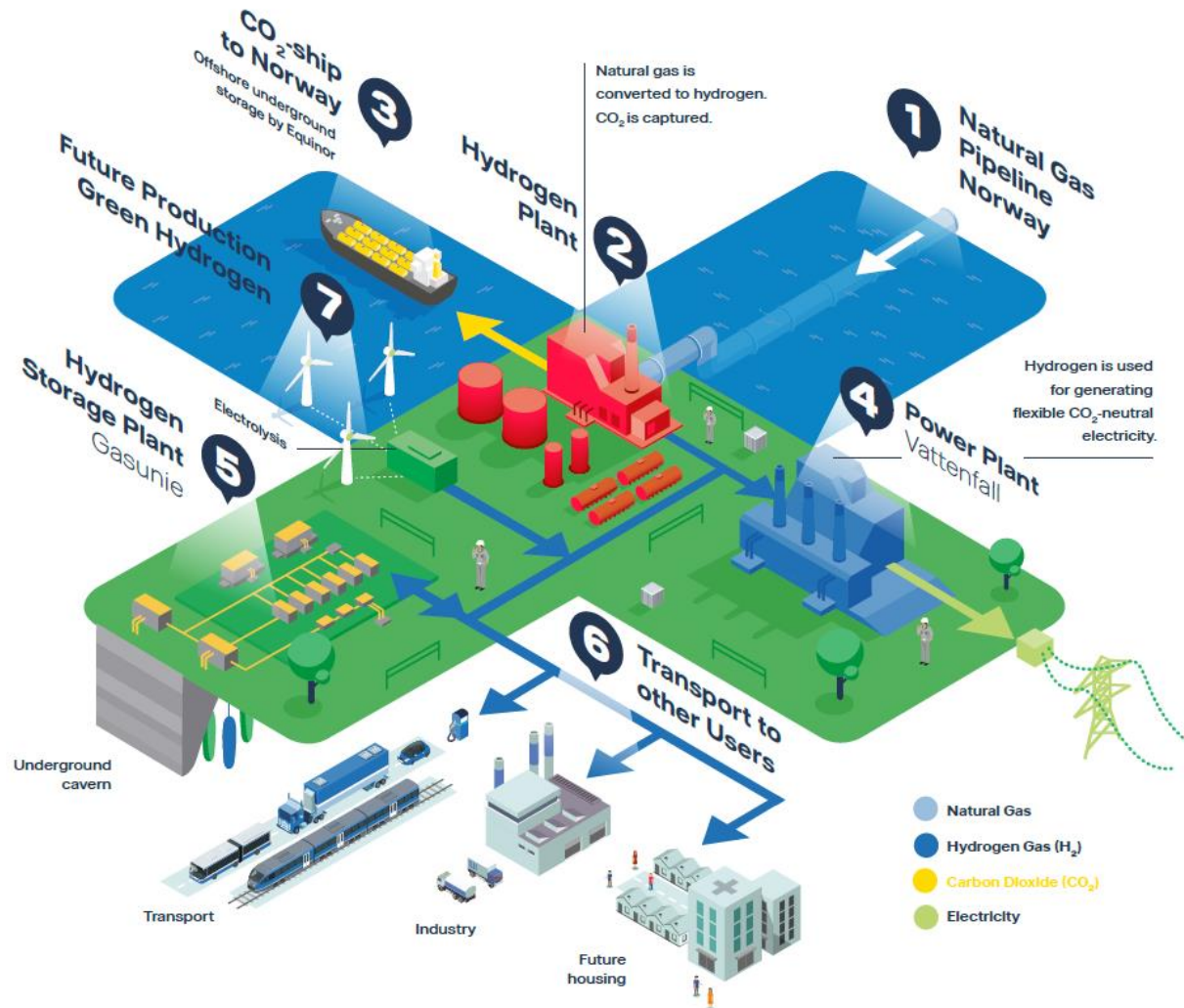


for heat



for maritime transport

H2M – Magnum, Netherlands

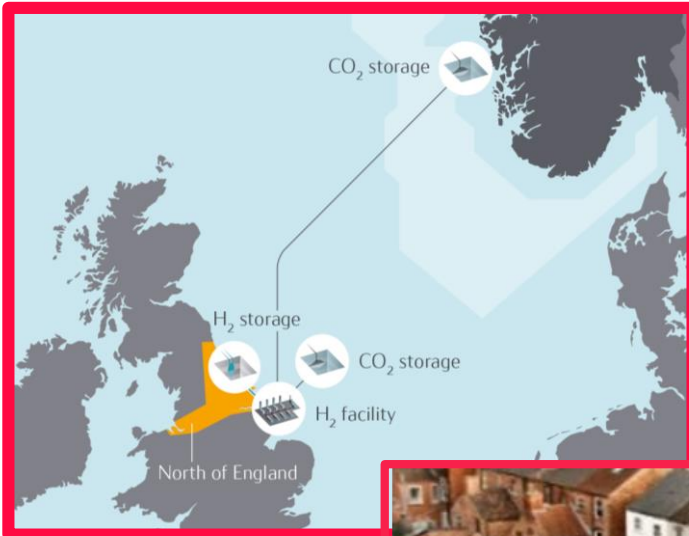


- Energy: 8-12 TWh
- CO₂ emissions reduction of 2 Mton/year
- Utilise existing gas power plants and gas infrastructure
- Switch fuel from natural gas to clean H₂
- Clean, flexible electricity as back-up for solar and wind
- Launch large-scale H₂ economy

Partners:



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

