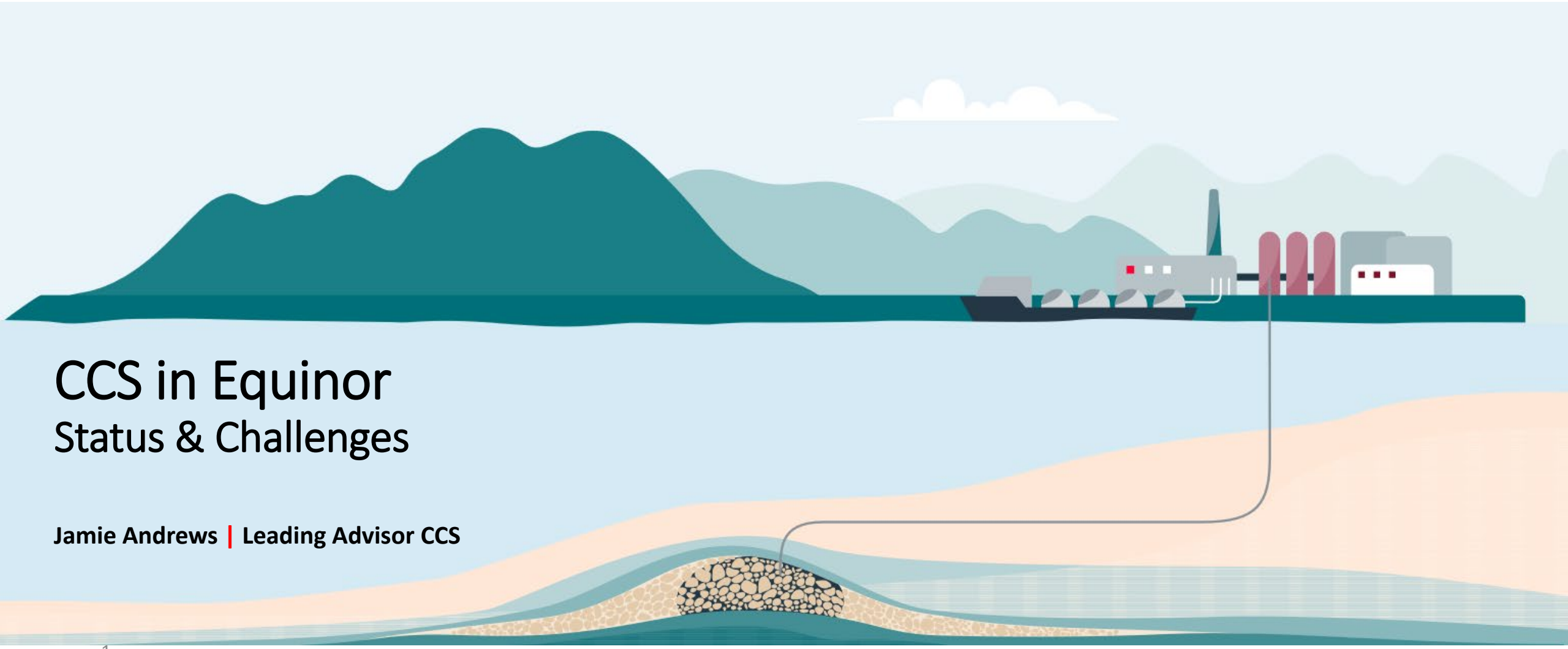


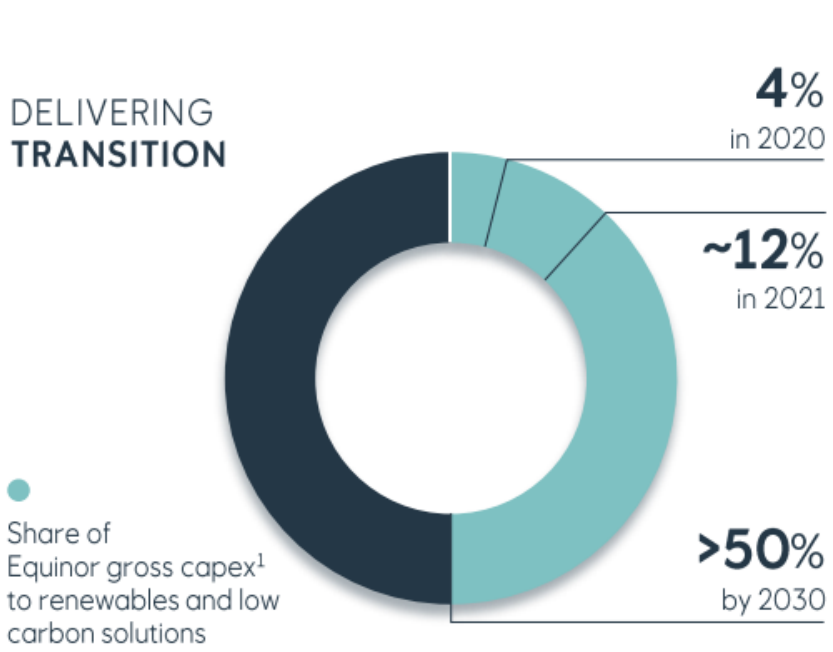
CCS in Equinor
Status & Challenges

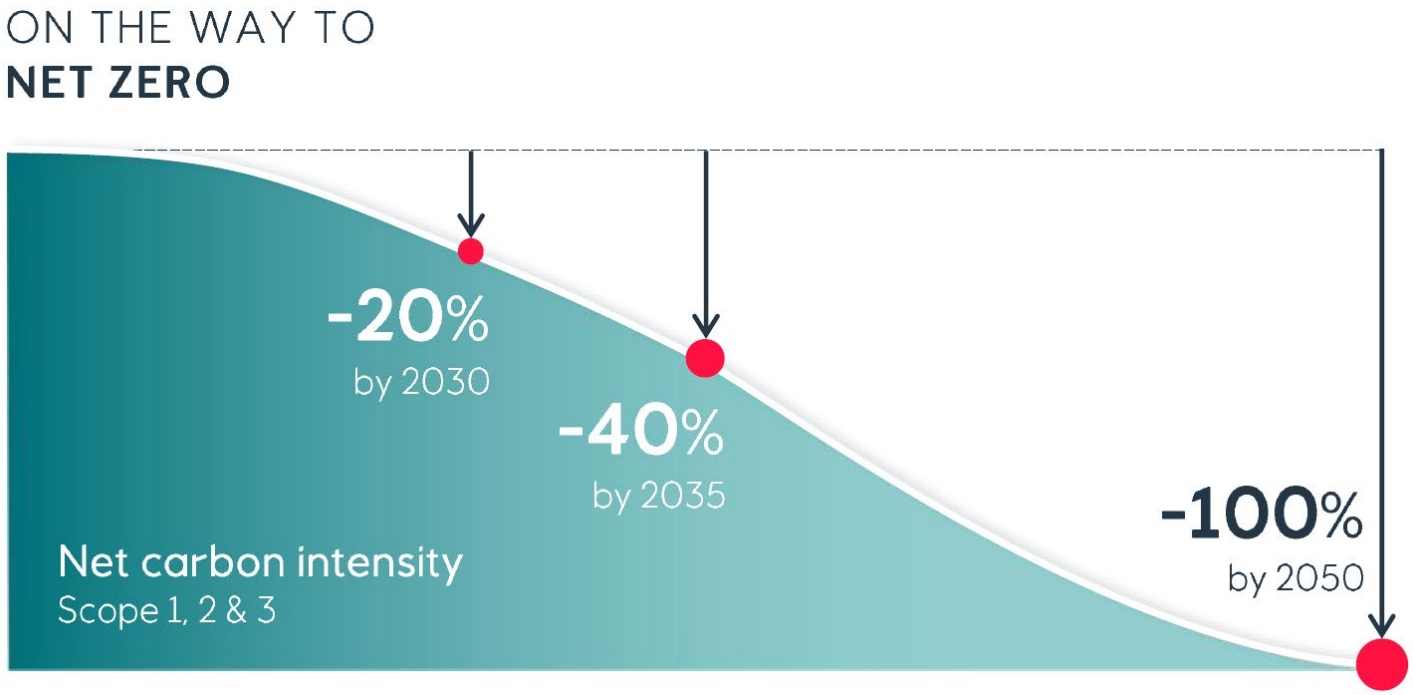
Jamie Andrews | Leading Advisor CCS

Outline

- CCS ambitions
- Legacy CCS projects
- CCS projects in pipeline
- Some of the challenges

Equinor’s energy transition ambitions





[Equinor Capital Markets Day, June 2021]

LOW CARBON SOLUTIONS

A leader in carbon management and clean hydrogen

NCS basin master within CO_2 transport and storage

15-30 MILLION TONNES PER ANNUM

CO_2 transport and storage capacity by 2035

Equinor share

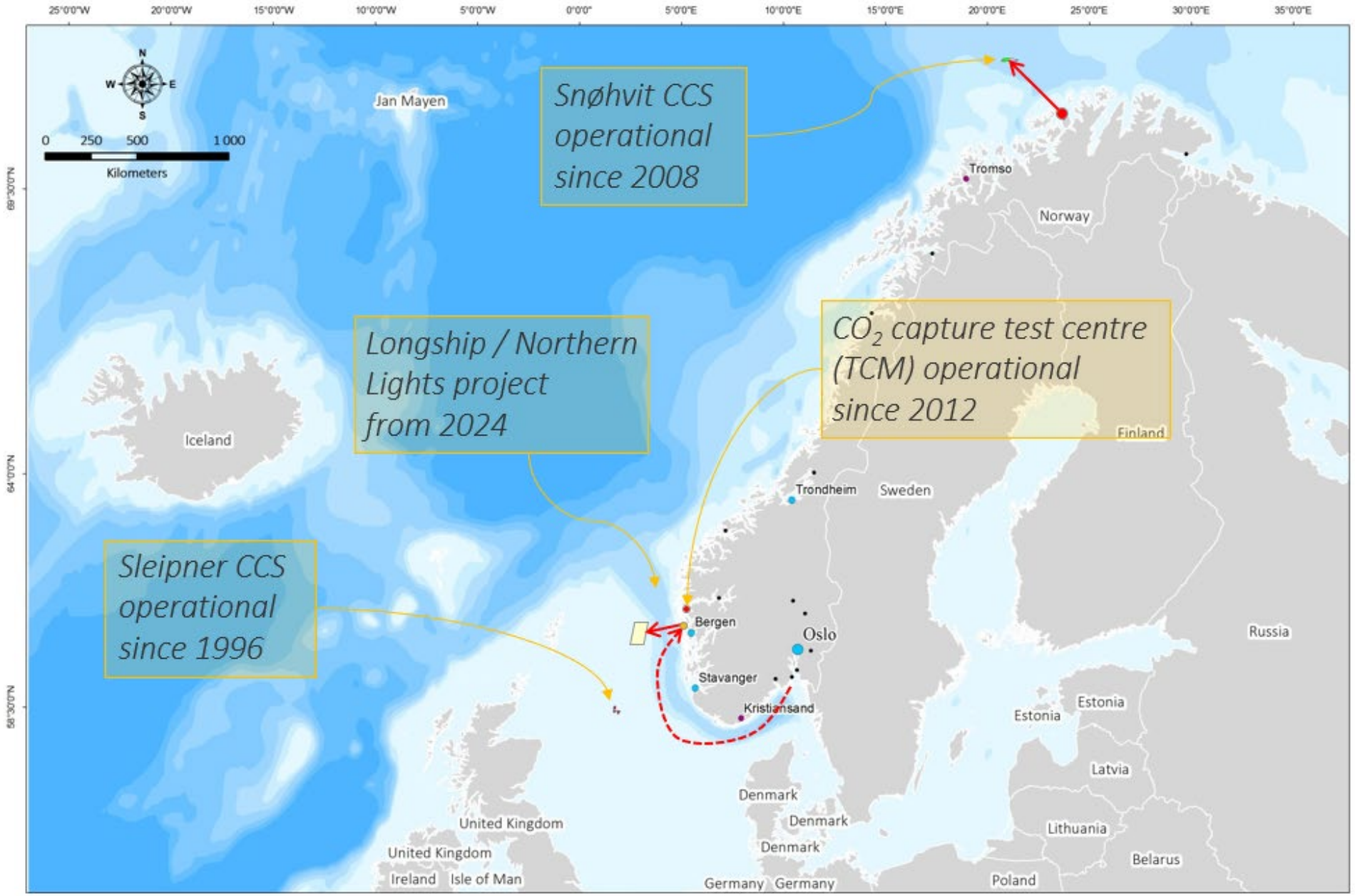
Becoming a major European supplier of hydrogen

3-5 MAJOR INDUSTRIAL CLUSTERS

Clean hydrogen projects by 2035

[Equinor Capital Markets Day, June 2021]

Operational experience with CCS on the NCS



Northern Lights

Northern Lights

World's first third-party CO_2 storage

1.5 MTPA

CO_2 volumes phase 1

100% share

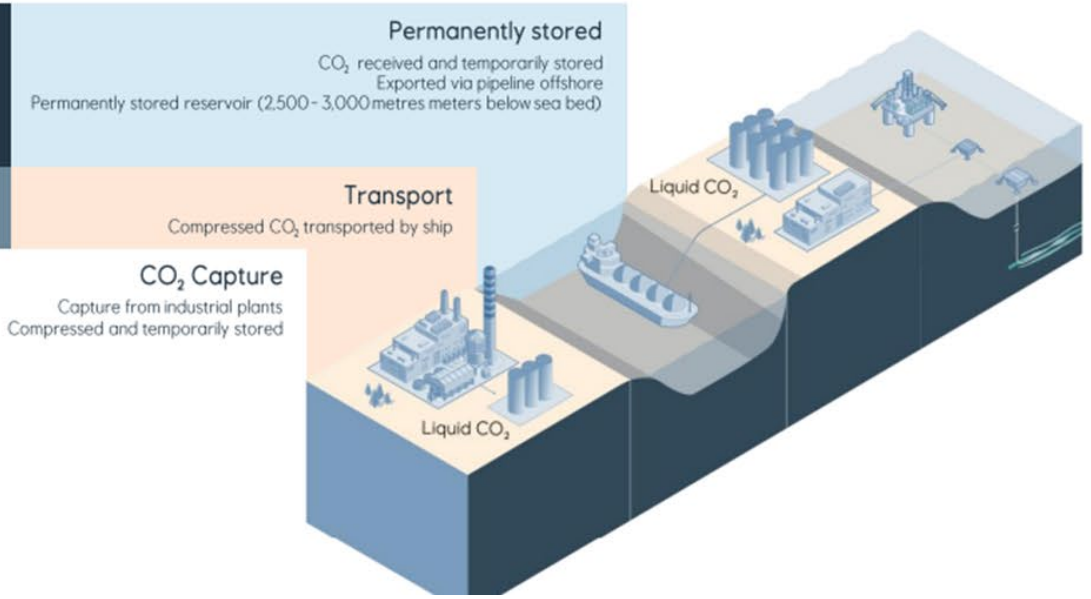
5 MTPA

CO_2 volumes including phase 2

100% share

2024

Start-up, phase 1



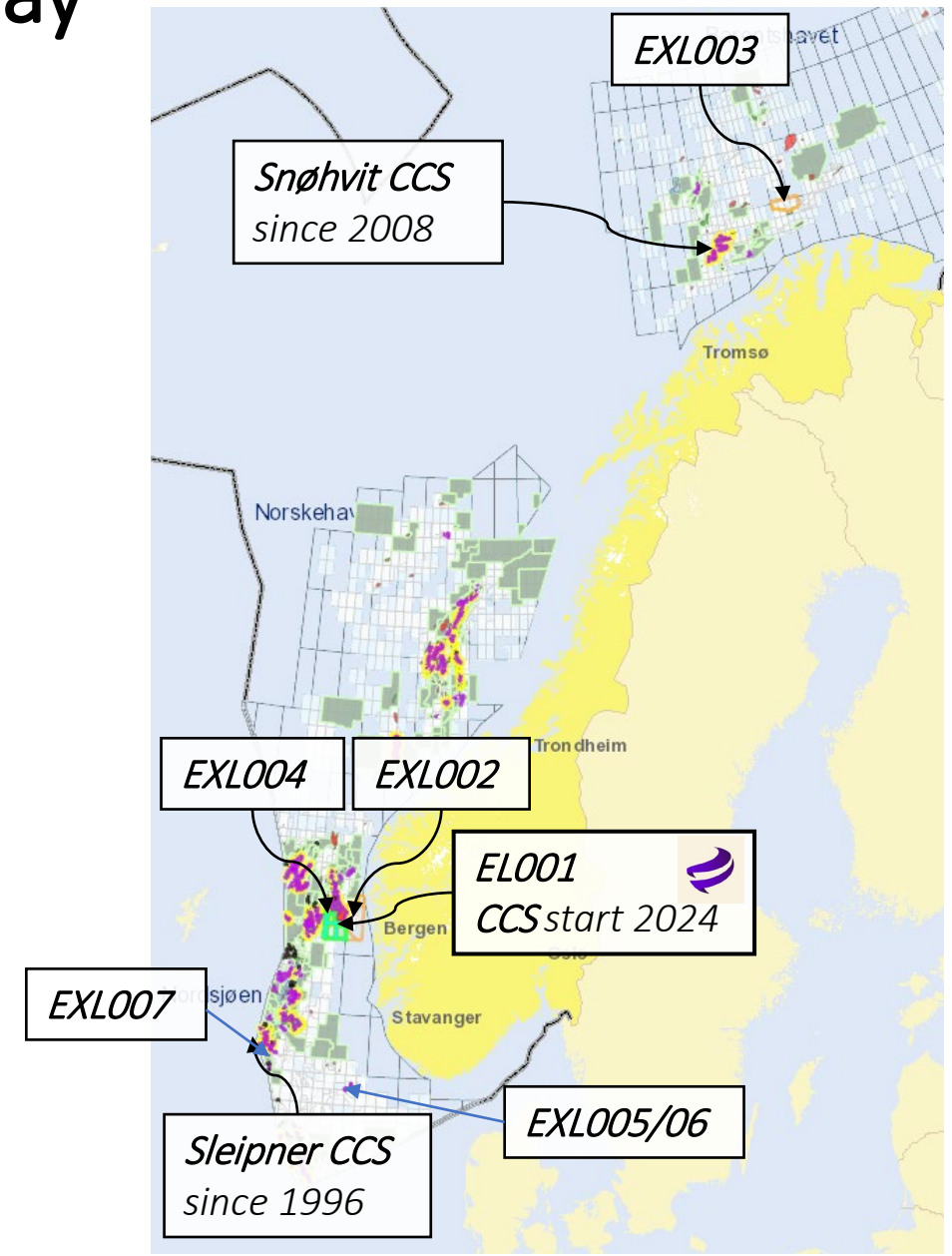
https://www.equinor.com/energy/northern-lights

Geological CO_2 storage offshore Norway

- 7 licenses + 2 legacy ccs projects ongoing
  - Equinor in NL/EL001 license (JV) and Smeaheia/ EXL002 (100%)

- Challenge from Norwegian perspective
  - Great geology with large storage potential offshore
  - Limited domestic emissions -> expensive transport
    - Speed, scale and simplification

- Advantages with offshore NCS storage
  - Extra “safety barrier” with water depths > 200m
  - Public acceptance / no direct exposure to people
  - Easier (cheaper?) monitoring



From Sleipner to large-scale CCS business

15-30 MILLION TONNES PER ANNUM

CO_2 T&S capacity by 2035

Equinor share

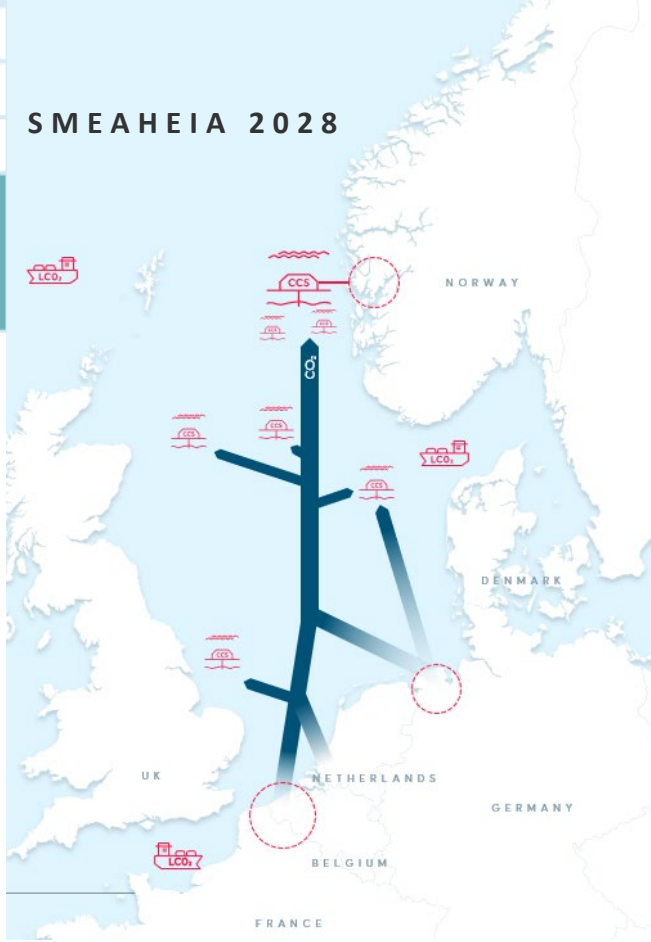
Cost down by bringing scale

Market opener

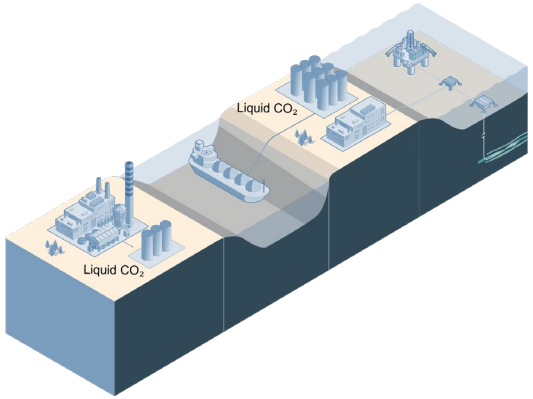
Operation experience - technology works!

1996	2008	2024	2027	2028 - 2030
Sleipner	Snøhvit	Northern Lights	Northern Endurance Partnership	Smeaheia / CO_2 Highway Europe

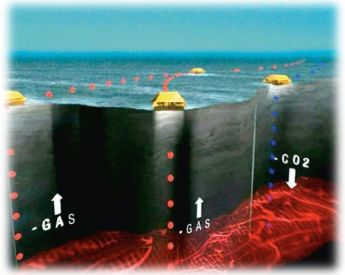
SMEAHEIA 2028



NORTHERN LIGHTS 2024



SNØHVIT 2008



SLEIPNER 1996

Smeaheia – Industrialisation of CCS

Northern Lights – Market opener

Snøhvit – Pipelined CO_2 from shore

Sleipner – pioneering offshore CCS technology

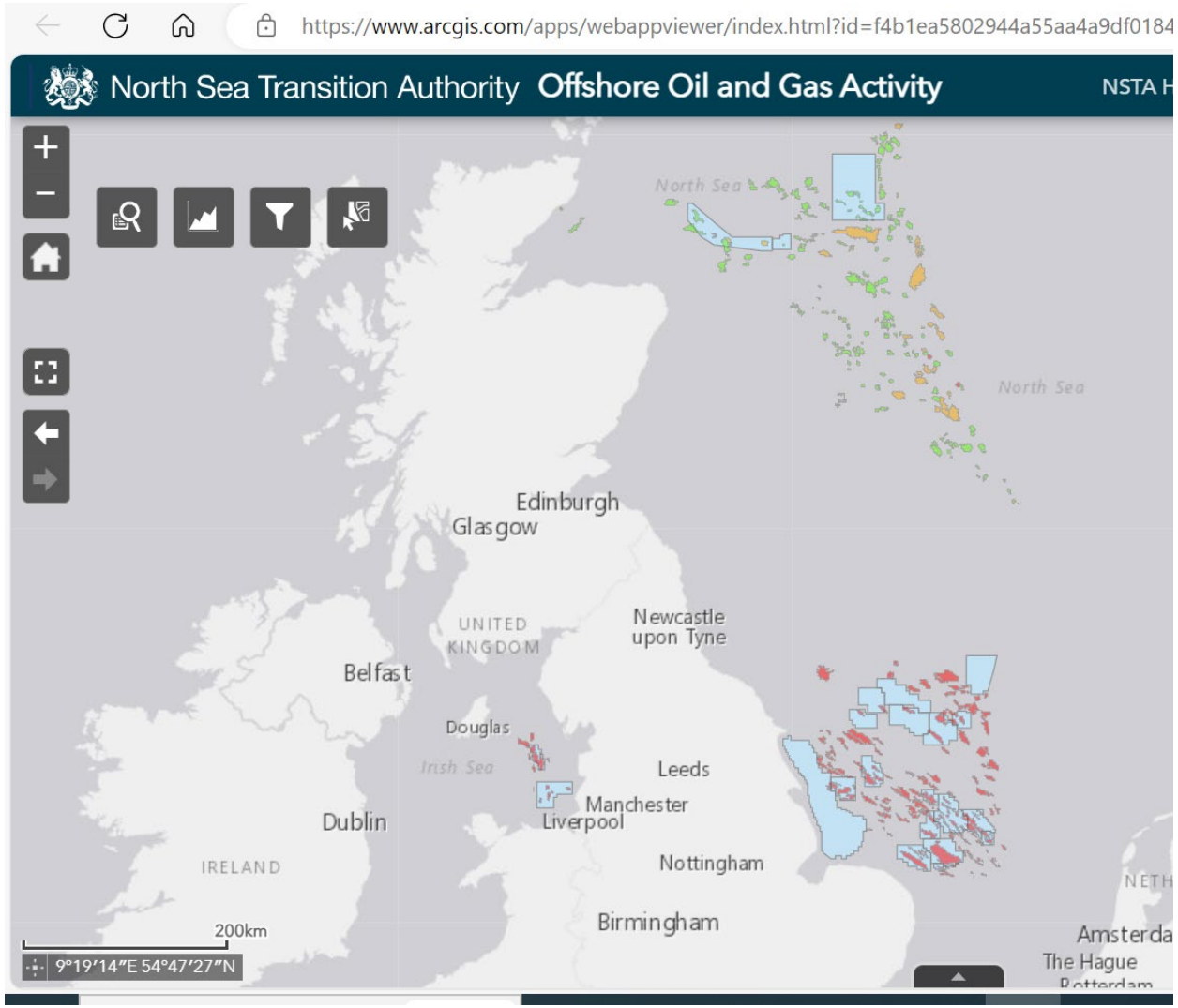
https://www.equinor.com/energy/smeaheia

UK perspective

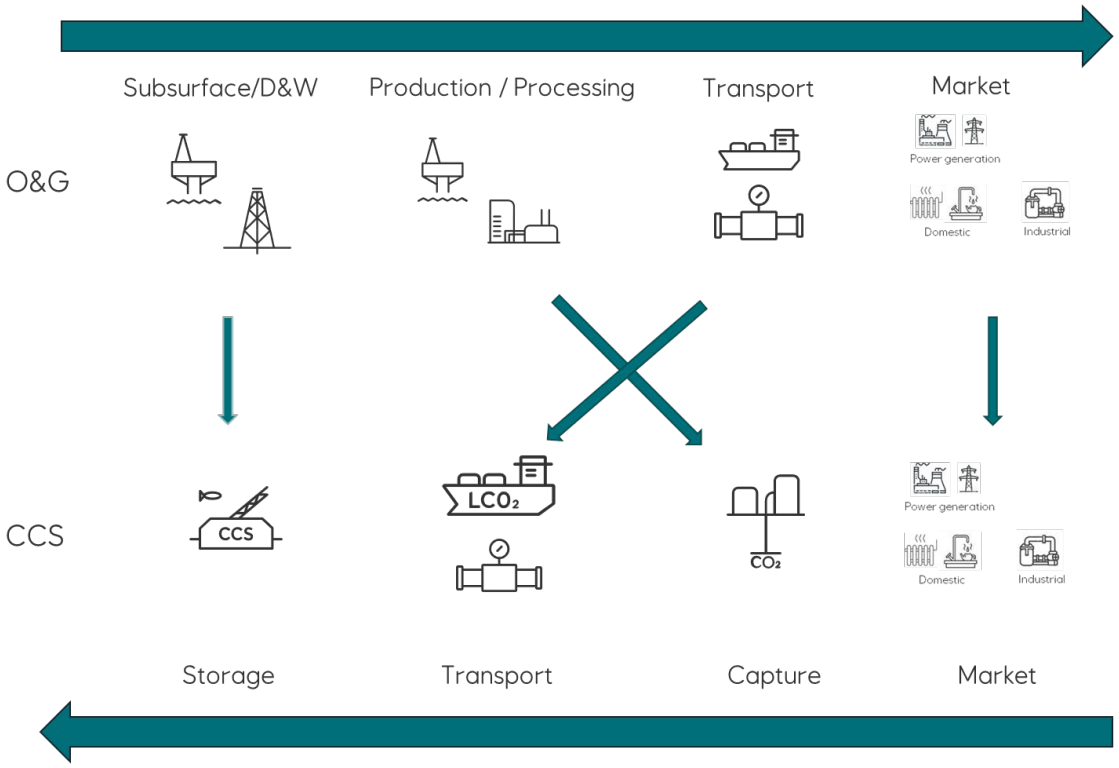
- 27 licences awarded as of Sept 2023
  - Equinor is partner on CS001/006/007/025

- 4 CCS Clusters
  - Reduced costs and investment risks
  - Increased flexibility
  - T&S solution for emitters
  - More rapid scale-up
  - Complexity

- Saline and depleted stores
  - Speed advantage for CCS in depleted stores



O&G and CCS = Same…



… but also different

Different business

Starts with emitters wanting to abate, not a discovery

Non-established, to-be marginal business

Different fluid

Usually injected in supercritical state – Not gas, nor liquid

Interacts and behaves differently in transport and in reservoir

Different risk picture

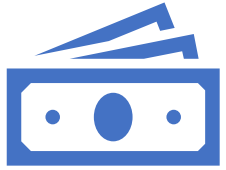
Non-explosive, less environmental impact, etc.

Liabilities and regulatory burden

CCS business-problems to solve with research and technology

Accelerate maturation

Build credibility



Reduce cost

Cost ($/tonne) reductions

Optimised Transport

Pipeline/trunkline and scale and correct concept selection

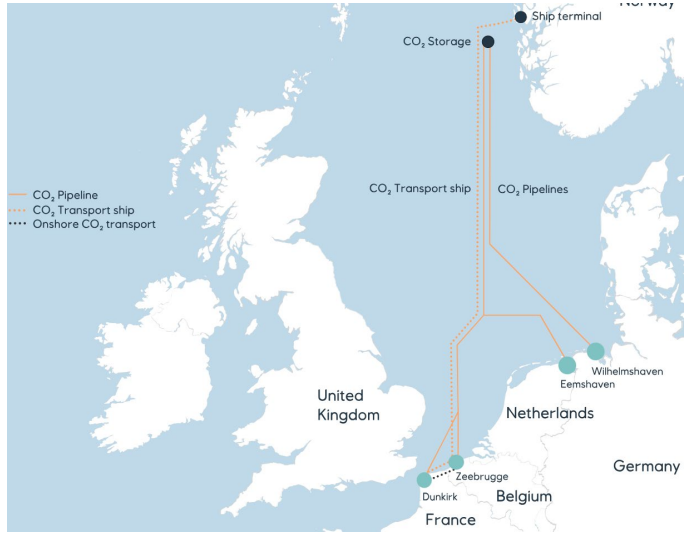
Low-cost shipping, smart offloading concepts such as direct injection from ships, LP ships

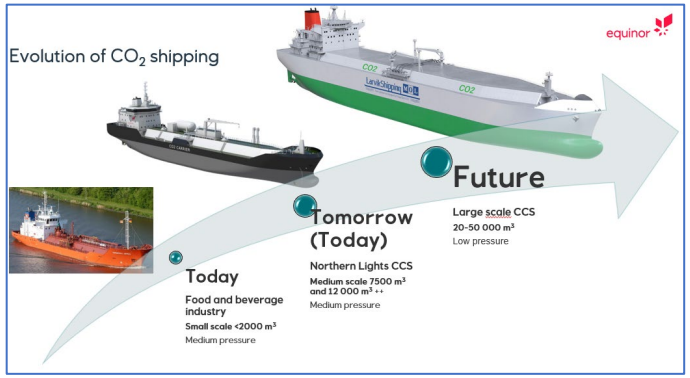
Storage Costs

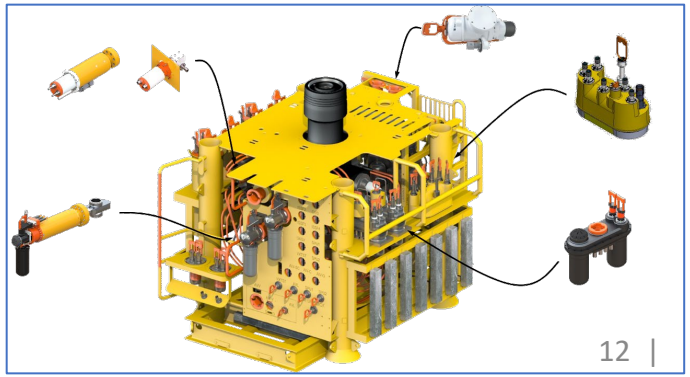
Simplified solutions, cost efficient MMV, accelerate maturation, staged development, unlocking legacy well issues

Simplified well and subsea designs

- No umbilical solutions
- All electric subsea control system
- Low-cost wells
- High flowrate wells / smart wells







Credibility/reliability in integrity and capacity evaluations

- **Pressure management**
  - Need for large connected hydraulic pore volume (“aquifer”)
  - How formation brine moves
  - Pressure interference
    - Pressure budget
    - Brine production

- **Large structures & large integrated models**
  - G&G characterization of such large regions
  - Methods for large-scale modelling/simulation
  - Model size & runtime, integration & multiphysics, population of realistic properties (AI, seismic inversion)
  - Integrated models with 100’s realizations

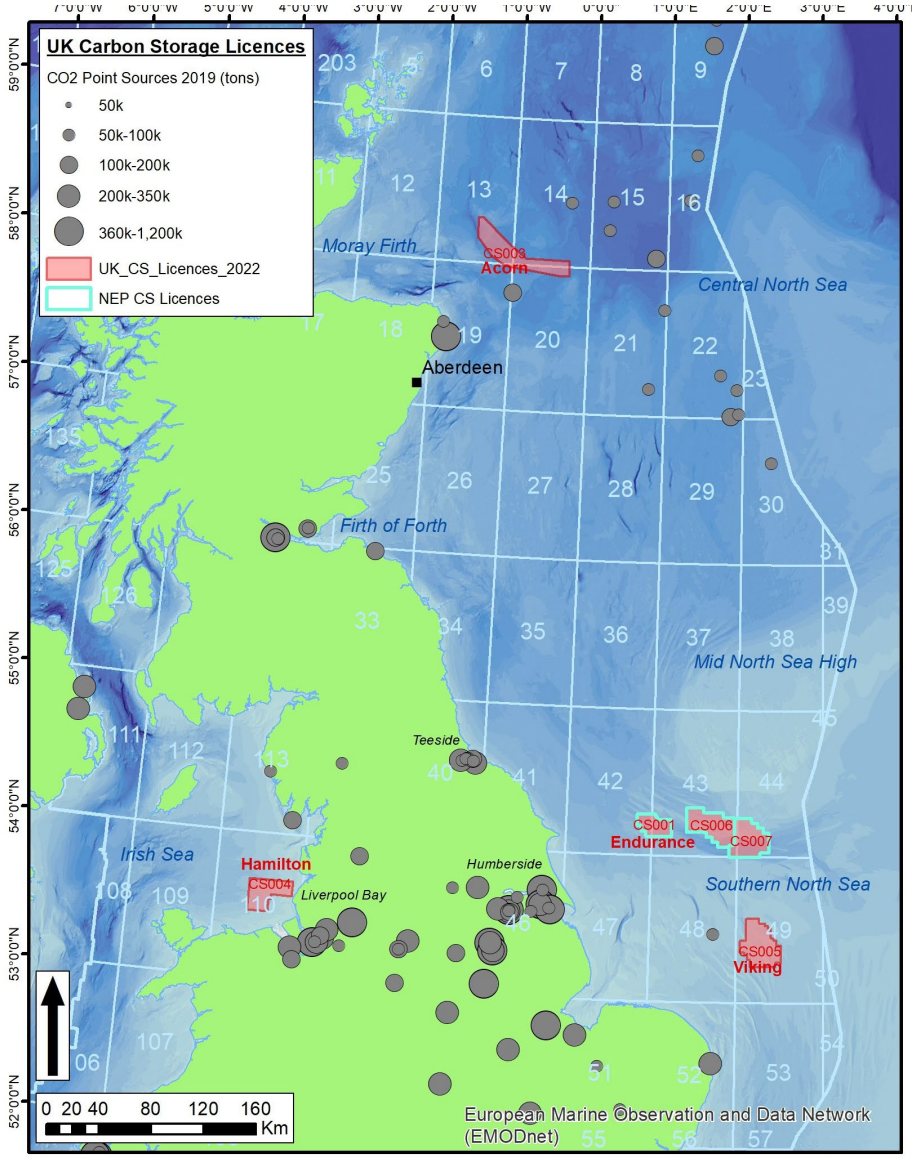
- **Legacy wells**
  - Quantify leakage risk / rates. What is acceptable limit?

- **Saline stores with faulted traps**
  - Along-fault and across-fault flow
  - Initial sealing and mechanical induced changes

Technology implementation example

- UK area model
  - Area: 130 x 85 km^2 (~half of the surface area of Wales)
  - 21 million active cells and 35 injectors

Thermal simulation performed by Pflotran-OGS



Scale: CO_2 rates and storage potential - perspective

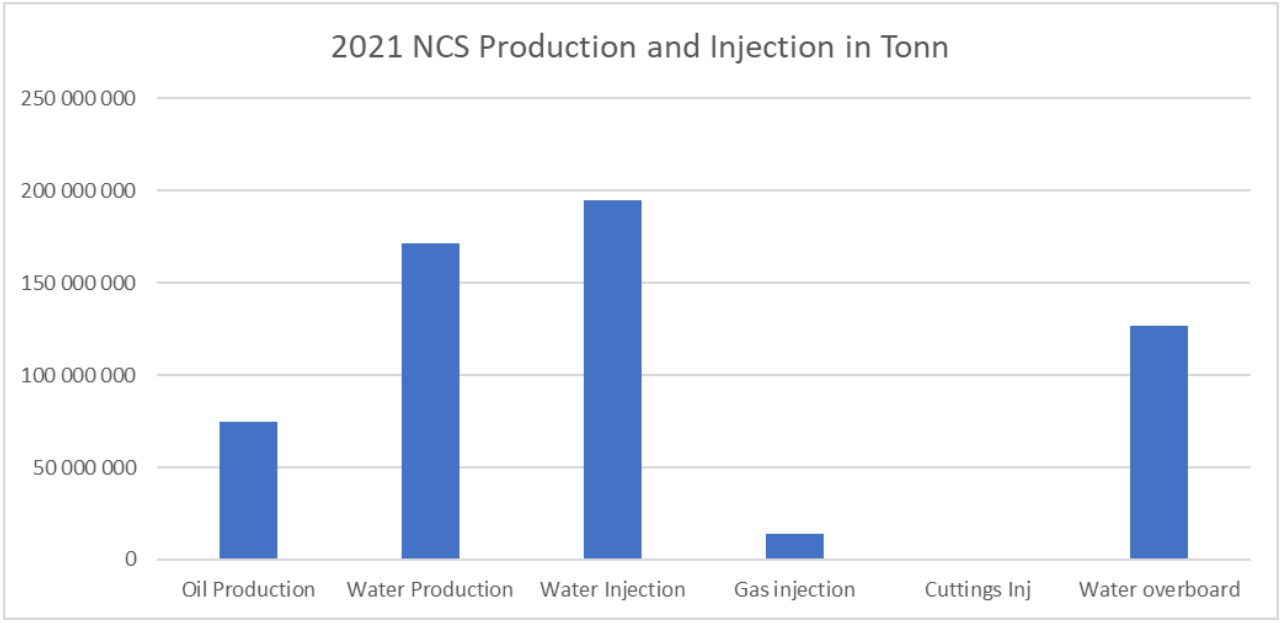
- **Equinor** equity ambition is to reach 15-30 Mtpa CO_2 storage capacity by 2035
  - Significant step-up but compare Equinor operated O&G injection of 110 Mtpa of H_2O and 24 Mtpa of CH_4 in 2022

- **Norwegian** oil and gas production/export of around 4 million b/d oil equivalent results in around 400 Mtpa of CO_2 emissions (OIES report link)

  - Less than 70 Gt theoretical storage potential on Norwegian North Sea (NPD Storage atlas 2011)
    - 25 years at 0.4 $GtCO_2/yr$ = 10 Gt CO_2

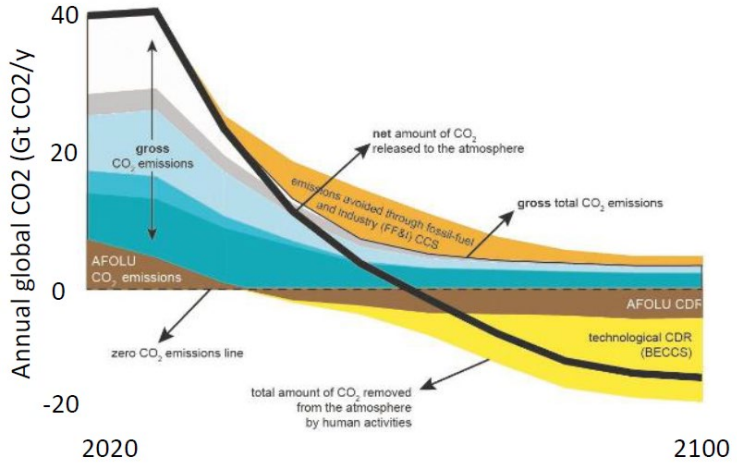
  - Current NCS injection quantities

- Rule of thumb, one NCS CO_2 injector has a injection capacity of 1 Mton/yr
  - 7200+ wells already drilled NCS
  - 20500+ wells drilled in North Sea



Conclusion

- Marginal business due to (high) cost of solutions and (cheap) price for emitting – expect this to change in 2030/35
  - First wave of projects will be dependent on public support schemes



Source: 'Global warming of 1.5˚C', IPCC

- To reach volumes required and be an effective mitigation tool in the climate challenge, this needs to become a commercial business
  - Reliant on industrialization and economy of scale and technology developments
    - Develop multiple storage sites within CCS hubs
    - Optimize CO_2 delivery per well
    - Pressure management will be a key issue
    - Use advanced and cost-effective monitoring systems

- Technology development will be a significant driver of improved economics for CCS (cost of capture, CO_2 transportation, cost effective monitoring)

Thank you

Jamie Andrews