Status on CCS projects in Norway

MGSC meeting 24th of April 2019. Kari-Lise Rørvik
Real world experience
BYGG CO₂-LAGER NA!
23 years of experience

22 Mill tonn CO₂ stored

The Norwegian Fullscale Project (2016-2023)

SLEIPNER CCS
Operation since 1996

SNØHVIT CCS
Operation since 2008

CO₂ Capture Test Centre Mongstad (TCM)
Operation since 2012

Broad political foundation
1990: CO₂ tax offshore
1997: Funds for CCS research
2005: Gassnova established
2008: Climate accord: Norway carbon neutral 2030
2014: White Paper on full-scale CCS
2016: Government Platform; CCS is one of five priority areas for action
The storage potential is there
Storage space – a natural resource
Geological storage

• The basic concept is to store CO₂ in reservoirs that would otherwise contain water, oil or gas

• Key storage issues for reservoir selection:
  • Capacity
  • Injectivity
  • Containment

• Northern Lights has been awarded an exploitation licence for CO₂ storage in Aurora
  • Large area ( > 1,000 sq.km.)
  • Aquifer that has been drilled below Troll, to the north
  • Drilling required to confirm reservoir in the storage area
AURORA

JOHANSEN FORMATION = PRIMARY STORAGE FORMATION

Depth
-3200
-2000

Areal geomodel 3500 km²
Gassnovas role

- Leading the overall project
- Provide state subsidies and manage the study contracts
- Integrate & optimize CCS chain, incl. interfaces between the industrial companies
- Evaluate the industrial projects after completed FEED
- Coordinate work on benefit realization
- Reporting to the government
Framework for the Full-scale Project in Norway

1. The Norwegian state gives subsidies to the industry
2. Each company shall develop their project according to their own procedures and methods
3. Each company will own and operate their facilities
4. The industry must contribute actively to benefit realization
Equinor, Total and Shell ("Northern Lights") are planning the CO₂ transport and storage in the North Sea.

- **Norcem AS, Brevik**
  - Cement plant
  - Onshore terminal with buffer storage, pump and heater
  - 110 km pipeline, 12 inches
  - One injection well

- **Fortum Oslo Varme AS**
  - Waste-to-energy plant

- **Onshore terminal in Øygarden, Hordaland**
  - Capture of 400 kt/y Norcem and Fortum Oslo Varme each
  - Amine technology
  - Includes CO₂ cleaning, liquefaction and buffer storage (4 days)

- **Transport by 1 or 2 ships**
  - 700 km distance
  - Liquefied state (15 barg, -26°C)

- **Equinor, Total and Shell ("Northern Lights")**
  - CO₂ transport and storage in the North Sea
Norway is open for business
Value of the Norwegian Full-scale Project

- Demonstrate CCS
- Contribute to cost reductions for coming CCS projects
- Enable business development
- Mitigate climate change

Increased probability for achieving climate goals

**Long term goal:**
Contribute to the development of CCS, in order to reach long term climate goals in Norway and EU, cost effectively
Significant CCS potential in Europe

Petrochemical industry

Iron and steel plants

Non-metal minerals

Source: Endrava
Design for onshore terminal in Kollnes, Øygarden
Northern Lights: Design concept overview

**Ship**
- One ship per capture site
- 7,500 m$^3$ of CO$_2$ per ship

**Pipeline**
- 110 km 12 inch pipeline

**Subsea injection well**
- Injection of CO$_2$ into reservoir at ~3000 m depth

**Capacity (Mt/y)**
- 5
- 1.5

- 2 x ship
- 1 x ship

- Onshore facilities
- Additional jetty, tank and pumping facilities
- Pipeline
- Additional well(s)
- 1 x injection well (tbc)
Estimated costs

- Concept studies out of phase in 2017 and 2018. Last official cost estimate is based on:
  - Norcem estimate after concept study
  - Fortum Oslo Varme estimate after concept study and additional improvements to reduce costs
  - Equinor estimate after feasibility study, adjusted based on early results from concept study

- According to updated KS2 report (Atkins/Oslo Economics, published June 2018), the estimated construction costs and 5 years of operation was (*):
  - CCS chain with one capture plant: ca. 11 500 MNOK (P50-value)
  - CCS chain with both capture plants: ca. 17 000 MNOK (P50-value)

(*) Capacity of storage terminal 1.5 Mt CO$_2$/year (pipeline ~4-5 Mt CO$_2$/year)
Regjeringen vil bla opp for CO₂-brønn i Nordsjøen

Tre oljegiganter vil deponere CO₂ i stor skala på norsk sokkel. Nå vil staten bla opp for å bidra til den første brønnen som skal bores allerede i år.
CCS chain in operation 2023/2024

- Pre-feasibility study
- Feasibility study
- Concept studies (CO₂ capture and transport)
- FEED studies
- Final Investment Decision
- In operation
Time magazine named Thunberg one of the world's 25 most influential teenagers of 2018.