Northern Lights

A European $\text{CO}_2$ transport and storage network

Workshop on Hydrogen Production with CCS, Paris, 6.11.19
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https://northernlightscs.eu/
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
Timeline for Northern Lights phase 1

- 2019: Technical studies
- 2020: Tendering
- 2021 - 2023: Execution
- 2021: Company decisions
- 2022: State decision
- 2023: Pre-execution
- 2024: Start-up
Concept Overview

**CO₂ Capture Sites**
- CO₂ captured by Fortum at Klemetsrud and Norcem in Brevik and stored locally on their sites.
- Storage volume at each site required to account for ship arrival every four days plus buffer for any upsets in the overall chain.
- Jetty operations are assumed to be by capture plant.

**Ship(s)**
- One ship per capture site.
- 7,520 m³ of CO₂ per ship.
- Pressure 13.1 barg at equilibrium temperature (approx. -30 °C).

**Onshore facilities**
- One jetty for ship mooring.
- Tank volume based on ship cargo size.
- Pump system to provide required export pressure.
- Evaporator to maintain top-surface liquid balance in storage tanks during injection.
- Heater to inject above pipeline minimum temperature.

**Pipeline**
- 110 km uninsulated pipeline.
- 12 ½ inch.
- Single phase (liquid) CO₂.

**Subsea facilities**
- Connecting pipeline umbilical and well(s).
- Water depth ~300 m.
- Connection for future step-out.

**Subsea injection well**
- Injection of CO₂ into reservoir at ~2-3000m depth.
- Pressure in reservoir ~2-3000 bar.
- Temperature in reservoir ~100 °C.

**Subsea injection**
- Connection from Oseberg field providing power and signal from DC/DC and tilts through umbilical system.

**Storage complex**
- Planned in the Johansen formation south of Troll (Aurora).
Visualisation of CO$_2$ storage hub
Subsea

• Early well → Integrated Satellite Structure & Wellhead System

• Tie-in (umbilical) to the Oseberg Field Centre

• Subsea Facility components
  • Subsea structure
  • Wellhead
  • Christmas tree
  • Control module
  • Protection structure
  • Control system
  • Umbilical/power cable (power, hydraulic, chemicals, signal)
Egersund Norway 8 October 2019
Drilling and Well

- Data acquisition – Eos well
  - Coring
  - Logging
  - Stress testing
  - Well test

- Keeper well
  - Temporary plug and abandon well in 2020
  - Re-entry, sidetrack and completion in 2022 or 2023
Enables “open source” offer for CO$_2$ emitters to establish capture

Large potential with long-life sectors:

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

- Northern Lights is relevant and within reach for about 350 facilities and 300 MTPA of these “most attractive candidates”
Northern Lights PCI application is the beginning of our contribution to a European network for CO₂ removal

EU PCI application submitted 1.3.19

PCI is Project of Common Interest

15 partners from 7 countries

Included on fourth PCI list by EU Commission, October ’19, together with 4 other CCS projects:
Seven MoU’s signed at CCS Conference 5.9.19

COMPANIES
• Fortum Group; Finland
• Ervia, Ireland
• Air Liquide, Belgium
• Stockholm Exergi, Sweden
• ArcelorMittal, Luxembourg
• Preem, Sweden
• Heidelberg Group, Germany

TYPICAL CONTENT
• Logistics studies
• CO₂ specifications optimized across value chain
• Roadmap towards potential start of operations
• Joint advocacy for CCS and its importance for decarbonization of European industry
• Initiate dialogue with National and Norwegian Governments
Air Liquide: – Vi kan bidra med flere millioner tonn CO2 i året i et lager i Nordsjøen


I forrige uke signerte François Jackow (til høyre) i Air Liquide en intensjonsavtale med Eldar Sætre og Equinor om at de vil lagre CO2 i lageret i Nordsjøen, dersom fullskaliprosjektet blir vedtatt. (Foto: Arne Reidar Mortensen/Equinor)
Some regulatory amendments needed to make ship-based 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

**The London Protocol:**
Together with the Netherlands, Norway submitted a resolution to the IMO/LP meeting 7-11 October 2019. The Northern Lights project also gave a presentation.

The resolution is based on Article 25 of the Vienna Convention on the Law of Treaties which states that if Parties to a treaty agree on something, they can act upon this agreement immediately pending administrative implementation in the treaty.

The resolution was approved 11.10.19, so ship transport of CO2 between two countries that agree will now be allowed.
Early Norwegian investment decisions can enable early European capture projects

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Norcem and FOV capture
3rd party capture
3rd party capture
Development scenario: 1.5 MT per annum
Development scenario: 5.0 MT per annum
Development scenario: 20 MT per annum
CCS as enabler for hydrogen production