Presentation CPMR North Sea Commission Transport group in Vestfold and Telemark

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Norcem’s zero-vision

Energy efficiency
Alternative fuels
New cement products
Carbon Capture (CCS)
Carbonatization (Reverse calcining, $\text{CaO} + \text{CO}_2 \rightarrow \text{CaCO}_3$)

CO$_2$ emissions over time:
- 1990: 800 kg CO$_2$/ton cement
- 2000: 700 kg CO$_2$/ton cement
- 2010: 600 kg CO$_2$/ton cement
- 2020: 500 kg CO$_2$/ton cement
- 2030: 300 kg CO$_2$/ton cement

Already world class level
Zero net emissions of CO$_2$ in 2030

kg CO$_2$/ton cement
Fuels

2. Existing situation plant

- Anode waste coal: 15 972 tons
- Animal meal: 9 988 tons
- RDF: 63 203 tons
- Solid haz. waste: 48 729 tons
- Liquid haz. waste: 11 275 tons
- Waste oil: 11 501 tons
- Coal: 32 667 tons
6-8% of man-made CO₂ emissions come from the cement industry.
Maturing the project

>7500 hours of testing with Aker’s MTU

3000 hours of testing with pilot boiler

2005
Full scale desk study

2011
Pre-engineering

2013
Kick off TCB (2013-17)

2014-15
Technology testing

2016
Feasibility study

2016-17
Concept study

2018-19
FEED Study
29/8-18 – 31/10-19
✓ 450 reports
✓ 500 drawings
✓ 3D-model

2019-20
Decision process
Government
✓ Press conference by
government 21/9-20
✓ State budget
release 7/10-20
✓ Decision in
Parliament
20/12-20

2021-2023
Realization
✓ Start performance
testing 1/7-24
✓ Regular operation 31/8-24

Development-
and negotiation of
contracts
Government’s launching of «Langskip»

- Government presented the «Langskip» project 21st of September 2020
  - Full scale CCS plant at Norcem Brevik
  - Northern Lights responsibility:
    - Develop transport solution
    - Intermediate storage at Øygarden (Western cost of Norway)
    - Permanent storage in the Aurora formation in the North Sea
  - Partly support of the FOV project in Oslo if EU is contributes through Investment Fund
  
⇒ Total cost 25,1 BNOK (2,5 B€) incl 10 years of operation
  - Gov.’s share: 16,8 BNOK (1,7 B€)

- «Final decision made by Parliament 14th of December 2020

- Project startup January 4th, 2021
The unique elements of «Langskip»

- The world’s first CCS complete value chain
- The world’s first full-scale CO₂ capture plant from cement- and waste industry
- The world’s first network for shipment transport of CO₂
- Establishment of centralized storage for CO₂ at Norwegian shelf
Equinor, Total and Shell (“Northern Lights”) are planning the CO₂ transport and storage in the North Sea.

Onshore terminal with buffer storage, pump and heater
- 110 km pipeline, 12 inches
- One injection well

Norcem AS, Brevik
Cement plant

Fortum Oslo Varme AS
Waste-to-energy plant

Onshore terminal in Øygarden, Hordaland
- Transport by 1 or 2 ships
- 700 km distance
- Liquefied state (15 barg, -26°C)

Capture of 400 kt/y Norcem and Fortum Oslo Varme each
- Amine technology
- Includes CO₂ cleaning, liquefaction and buffer storage (4 days)
Northern Lights onshore facility Øygarden
Drilling of well completed 15/1-20

2600m below seabed.
How “Northern Lights” see it

- A ship based solution means access for CO₂ emitters across Europe

Norway’s emissions: 51 Mt/y
Brevik is first out of many CCS projects in pipeline

4 HEIDELBERGCEMENT PLANTS IN EUROPE HAVE LAUNCHED CCS (STUDY) PROJECTS

Brevik, Norway
Full scale CCS. Ongoing
Capture 400 000 tons CO2/y

Slite, Gotland, Sweden
Feasibility study ongoing
Potential capture rate 1 500 000 tons CO2/y

Lixhe, Belgium
LEILAC-project
Potential capture rate 1 200 000 tons CO2/y

Hannover, Germany
Feasibility study starts now
Potential capture rate 640 000 tons CO2/y
Cement production is carbon intensive

Global

36.600 Mio. t CO₂

Cement industry

2.300 Mio. t CO₂ *)

76.7 Mio. t CO₂

*) China approx. 50 %
CCS is key for cement industry

Huge scaling effect in cement industry

CO$_2$ emissions from European cement industry is more than twice of Norwegian total emissions
Overview of project

- Demonstration plant
- 400,000 tons per year
- 55 tons per hour
- 50% capture rate
  - Limited by available waste heat
- Waste heat recovery: 46 MW
- $\approx 300 \text{ M€}$
- **Storage capacity:** 5000 m$^3$
  - 4 days of production
  - Ship load capacity: 7500 m$^3$

- **State of CO$_2$**
  - Liquid
  - -26°C, 16 bar

- **Insulated tanks**
  - No active cooling
  - Natural evaporation (return to capture plant)

- **Return of displaced gas from ship back to capture plant during ship loading**
Liquid CO₂ classified as dangerous cargo (ICG code)
- Tug escort required (local regulation)

SIGTTO*) MEG4**) requirements apply

Ship simulation made by Kongsberg Maritim in Trondheim

Mooring analysis made by Norconsult

*) Society of International Gas Tanker and Terminal Operators
**) Mooring Equipment Guidelines
Cement industry is very well suited for CO₂-capture

- **Large, stationary units**
  - Typically 500,000 – 2,000,000 tons CO₂ per year
  - Often clusters of cement plants close to large limestone deposits
  - Long lifetime (>100 years)

- **Often located close to sea**

- **Process emissions represents 2/3 of CO₂ emissions**
  - Fuels only 1/3

- **A lot of waste heat available**

- **High concentration of CO₂ in flue gas (22-24% CO₂)**

- **Enormous global potential**
  - (~ 5-8% of worlds entire CO₂ in 1 industry)