Clean Energy Ministerial CCUS Initiative Webinar
Approaching Final Investment Decision: CCUS Developments in Norway

Thursday 14 November 2019
08:00 EST  |  14:00 CET
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AGENDA

1. Welcome & Introductory Remarks
   - Juho Lipponen
     Co-ordinator
     CEM CCUS Initiative

2. Presentation
   - Kristin Myskja
     Assistant Director-General
     Ministry of Petroleum and Energy, Norway
   - Ole Martin Moe
     Project Manager
     Fortum Oslo Varme
   - Per Brevik
     Director, Alternative Fuels
     HeidelbergCement Northern Europe
   - Sverre Johannesen
     Overå
     Project Director, Northern Lights
     Equinor

3. Question and Answer Session

An initiative of the Clean Energy Ministerial
Mr. Juho Lipponen is the Co-ordinator of the Clean Energy Ministerial (CEM) Carbon Capture, Utilization, and Storage (CCUS) Initiative, working with the eleven member governments, observers and other partner organisations to ensure the day-to-day functioning of the Initiative.

Juho is based in Paris, France.
Kristin has worked in the Norwegian Ministry of Petroleum and Energy since 2006. She worked four years in the Oil and Gas department in the Ministry where her responsibilities included a portfolio of oil and gas fields on the Norwegian Continental Shelf, infrastructure development on the Norwegian Continental Shelf and ownership in the Norwegian gas transport system.

She has worked in the CCS-section since 2011 with the Norwegian government’s CCS-strategy and the Norwegian CCS demonstration project. She holds a Master’s degree in Economics from the University of Oslo, obtained in 2006.
Ole graduated as a civil engineer in marine engineering from NTH (now NTNU). He has enjoyed a long career in the shipping and offshore industries and has been fortunate to be involved in many interesting projects, both as project engineer and project manager.

"The most exciting projects are those that can take us a step further and provide good solutions to small and large challenges for our customers and society.

How to solve our climate problems is an interesting and huge task. Therefore, it is immensely inspiring to be part of the Fortum Oslo Varme’s carbon capture project, which is one of the areas that I believe should be invested in in order to fulfil the climate goals, which we said we would."
Per Brevik has a Master’s degree in Business Administration from the Norwegian School of Business Administration (NHH).

Since 1993, he has worked with alternative fuels development in the cement industry. From 2007 onwards, he has been responsible for alternative fuels, climate and sustainability at HeidelbergCement Northern Europe.

He has been responsible for the carbon capture project at Norcem Brevik since the launching of the project in 2011.
Sverre Overå has been managing large investment projects for Equinor for the last 20 years. He was project manager for TCM (Technology Centre Mongstad) in the design and construction phases from 2006 to 2012, before moving to Brasil and heading up Equinor’s portfolio of modification projects there.

After returning to Norway, he spent two years as deputy project director at the Nyhamna Expansion project for Ormen Lange – one of the largest oil & gas modification projects in the world at that time. In 2016 he returned to CCS when he became project director for the Northern Lights project, a key element of the Norwegian State’s full scale demonstration project.
Approaching Final Investment Decision
CCUS developments in Norway

Assistant Director General, Kristin Myskja
14 November 2019
CCS is a necessary part of the solution
Norwegian CCS-strategy – a broad approach
Large scale CCS in Norway

"...realise a cost-effective solution for full-scale CCS in Norway, provided that this incite technology development in an international perspective".

Solberg Government's Political Platform

Our aim for a CCS project in Norway:

– Demonstrate a full chain of capture, transport and storage of CO2
– Demonstrate CO2 capture in existing industry
– Establish a flexible storage solution with excess capacity
– Provide cost and risk reductions for subsequent CCS projects
The Norwegian CCS demonstration project

Ship transport from capture to storage terminal – pipeline to offshore storage complex

Waste-to-energy 400,000 tonnes CO₂ per annum

Cement production 400,000 tonnes CO₂ per annum
The way forward

- Start FEED - summer 2018
- Investment decision 2020/2021
- Operation - 2023/2024
- QA - prepare investment decision – 2019/2020
- Development 2020/2021
The Full-scale CCS project in Norway

Industries and the Norwegian state are working together to establish what could become Europe’s first industrial CCS project. This is the first step in a potential ship-based European CO₂
CCS from waste incineration
part of tomorrow’s climate solution

Ole Martin Moe
14 November 2019
District heating

Energy sources:
- WASTE HEAT
- ELECTRICITY
- HEATPUMP/SEWER
- DATACENTER
- WOOD PELLET
- BIOFUEL
- FOSSIL OIL
- LNG

Energy recovery from 400,000 tonnes waste/Year

Production approx 150 GWh electricity (est. 2017)

Fortum Oslo Varme AS

600 km district heating network

30 mill liters hot water distributed throughout Oslo

District cooling

3289 Domestic housing

952 apartment building

1141 commercial building

District heating possible to ships
Carbon Capture in Oslo

- Goal to capture about 400,000 tons CO₂ per year
- CCS at Waste-to-Energy plants will capture both fossil and biological CO₂ (appr. 50% BIO-CCS)
- CO₂ transport to port via emission free cars
- Pilot testing on real flue gas
- 90% cleaning of CO₂, technology supplier with full scale experience (Shell), EPC contractor TechnipFMC
Waste is one of the world’s biggest climate challenges;

- 2.2 billion tons of waste produced yearly and 5% of global emissions is from household waste alone
- Landfilling has to reduce and waste-to-energy is the best solution for waste that cannot be recycled
- Significant BIO-CCS potential; waste-to-energy with CCS can contribute to achieve negative emissions
- EU’s targets for recycling and reduced landfills; 40 mill. tons missing capacity of waste-to-energy
- 1 ton waste is equivalent to 1 ton CO₂
Integration of a CO2 Capture Plant in Brevik

Per Brevik
14 November 2019
Cement and concrete

- Hard to imagine a future without it
- Lasts for hundreds of years (even thousands)
- The main elements: Limestone, Iron, Aluminium and Silica are the four most dominant elements in the earths crust. Practically unlimited resources
Cement industry is very well suited for CO$_2$-capture

■ Large, stationary units
  – Typically emitting 500,000 – 2,000,000 tons CO$_2$ 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 CO$_2$ emissions
  – Fuels only 1/3
■ A lot of waste heat available
■ High concentration of CO$_2$ in flue gas (22-24% CO$_2$)
■ Huge total potential (5-8 % of the entire CO$_2$ emissions from cement)
We have worked with CO2-capture in Brevik since 2005
Integration of a new CO₂ capture plant in Brevik

Demonstration plant

- 400,000 tons per year
- 55 tons CO₂ per hour
- 50% capture rate
Northern Lights

A European CO₂ transport and storage network

Oslo, 2019-11-14
Sverre Overå, Project director
Northern Lights – Concept

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

**Ship(s)**
- One ship per capture site
- 7,500m³ of LCO₂ per ship
- Pressure 13-18 barg at equilibrium temperature (approx. -25 ºC)

**Onshore facilities**
- One jetty
- Tank volume based on ship cargo size
- Pump system to provide required export pressure
- Evaporator to maintain vapour/liquid balance in storage tanks during injection

**Pipeline**
- 100km un-insulated pipeline
- 12.75 inch
- Single-phase (liquid) CO₂

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

**Subsea injection well**
- Injection of CO₂ into reservoir at ~3000m depth
- Pressure in reservoir ~300 barg
- Temperature in reservoir ~100 ºC

**Umbilical**
- Connection from Oseberg field providing power and signal from DC/FO and fluids through umbilical system. Spare capacity for additional wells.

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

**Ocean Liner X 2**
- Capture X 1
- + pump capacity
- + heater capacity
- + jetty
- + tanks

**1 x Injection well**
Subsea equipment installed
Why drill?

1. Confirm we have suitable sandstone
   - Capacity
   - Injectivity
2. Confirm strength and presence of seal
3. Confirm ability to monitor injected CO₂
QUESTION AND ANSWER SESSION

Kristin Myskja  
Assistant Director-General  
Ministry of Petroleum and Energy, Norway

Ole Martin Moe  
Project Manager  
Fortum Oslo Varme

Per Brevik  
Director, Alternative Fuels  
HeidelbergCement Northern Europe

Sverre Johannesen Overå  
Project Director, Northern Lights  
Equinor

Webinar recordings provided on YouTube  
https://www.youtube.com/user/cleanenergypolicy
Interested? Want to get involved?

If you want to learn more about the initiative, please reach out to Mr. Juho Lipponen, CEM CCUS Initiative Coordinator: juho.k.lipponen@outlook.com

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