Norwegian CCS Activities

Presentation to Japan Central Environment Committee

Ingvild Ombudstvedt
Senior Client Engagement Lead

Cover image: CO2 Technology Center Mongstad.
Image provided by Gassnova.
Agenda

- Norwegian CCS at a glance
- CCS Policies
- 20 years of Experience
- Full-scale CCS
- CLIMIT
- CO$_2$ Technology Center Mongstad
- CCS Regulatory Framework
- Governmental bodies and their roles
Norwegian CCS at a glance

- CCS for more than 20 years; Sleipner and Snøhvit
- The first CCS projects, a result of carbon tax and sale of natural gas
- Previous attempts of full-scale demo projects cancelled
  - Kårstø: 2005-2010
  - Mongstad: 2009-2013
- New CCS strategy in 2014
- Dedicated regulatory framework for CCS since 2014
- Ongoing full-scale project commenced in 2015
### Norwegian CCS policy

**Full-Scale CCS**
- By 2022

**R&D**
- CLIMIT
- FME

**Demonstration**
- TCM
International collaboration

- Collaboration with EU and member states of the EU
- MoU with the US to advance cutting edge technology
- CCS support in emerging and developing countries
- International co-operation fora
Sleipner

- **Operational** since 1996

- **Location:** Central North Sea, Offshore Norway

- **Industry:** Natural gas processing

- **Capture Type:** Industrial separation (1.0 Mtpa, new build)

- **Storage:** Dedicated geological storage in Utsira Formation, above the Sleipner East field

*Photo: Statoil*
Snøhvit

- **Operational** since 2008
- **Location:** Offshore Hammerfest, Barents Sea, Norway
- **Industry:** Natural gas processing
- **Capture Type:** Industrial separation
- **Storage:** Dedicated geological storage - offshore deep saline formation; Tubåen Formation and Stø Formation

Illustration: Statoil
GASSNOVA’s three initiatives in advancing CCS

‘CCS is an important part of the government’s climate policy, and our ambition is to realise at least one full scale demonstration project for CCS’,

Terje Søviknes, Minister of Petroleum and Energy

Slide provided by Gassnova
The Norwegian full-scale project

**CO₂ STORAGE**
- Statoil contract for concept and FEED studies
- Onshore hub
- Offshore storage

**CO₂ TRANSPORT**
Ship transportation

Illustration: Gassnova
Schedule for Norwegian full-scale

1Q: Concept select and initiate FEED (CO₂ Storage)

2Q: Start-up concept selection

4Q: Concept select and initiate FEED (CO₂ capture and transportation)

2Q: Final Investment Decision in the Storting

1Q: Concept select and initiate FEED (CO₂ Storage)

Full-scale CCS chain in operation

Illustration: Gassnova
CLIMIT: RD&D funding

• More than 300 projects
  - Annual budget approx. 23 M€
• Three focus areas:
  • Early full-scale CCS value chain in Europe
  • Large-scale storage of CO₂ on the Norwegian shelf in the North Sea
  • Future cost effective solutions for CCS
• International cooperation

Source: Gassnova
CO$_2$ Technology Center Mongstad

- Operational since 2012
- World’s largest test facility for capture
- Share expertise, knowledge and experience
- Owners: Gassnova, Statoil, Shell and Total

Photo: Gassnova
CCS regulatory framework

- Domestic/local Law
- Regional Law
- International Law

CCS Regulatory Framework
Norwegian regulatory framework for ccs

**International law***
United Nations Convention on Climate Change (UNFCCC)
KYOTO Protocol
PARIS Agreement
BASEL Convention
LONDON Convention, 1972
1996 Protocol to the London Convention
OSPAR Convention

**EU law***
Monitoring and Reporting Regulations – Commission Regulations (EU) No 601/2012

**Norwegian Laws***
The Continental Shelf Act
The Petroleum Act
Greenhouse Gas Emission Trading Act
Act relating to CO₂ tax in the petroleum activity on the continental shelf
The Pollution Control Act
The Public Administration Act
The Planning and Building Application Act

**Norwegian regulations***
The Pollution Control Regulations
Regulations for Transport and Storage
The petroleum regulations
The Greenhouse Gas Emission Trading Regulations
The Environmental Impact Assessment Regulations
The Planning and Building Application Regulations
The Framework Regulations
The Management Regulations
The Technical and Operational Regulations
The Activities Regulations
The Facilities Regulations

*A selection of relevant regulatory framework*
CCS Regulatory framework

• Norwegian Petroleum Act
  – Petroleum Regulations

• Norwegian Continental Shelf Act
  – Regulations for Transport and Storage of CO₂

• Norwegian Pollution Control Act
  – Pollution Control Regulations
Financial incentives for CCS

• Act relating to tax on discharge of CO2 in the petroleum activities on the continental shelf (1990)
  – Parliamentary Decision 2017: Tax of 525,25 NOK per ton of CO2 separated from petroleum and discharged

  – Approx. 6 EUR/7 USD per ton (Sept 2017)
• The Norwegian Ministry of Petroleum and Energy
  – Legislative
  – Grants permits for exploration, development, injection and storage

• The Norwegian Ministry of Climate and Environment
  – Legislative
  – International relations and climate agreements

• The Environmental Agency
  – Manage GHG framework and emission permits
  – Impact assessment and supervision of the industry
Lastly...

- Norway has more than 20 years of experience with CCS
- The industrial full-scale demonstration project will be operational by 202, and may pave the way for other projects through:
  - cost and risk reductions;
  - demonstration of technology; and
  - flexible storage solutions
- Research and development, and demonstration important parts of the Norwegian strategy
- International collaboration is essential
- The regulatory framework is developed in accordance with the EU framework
Back-up slides
• State-owned enterprise responsible for executing Norway’s CCS policies

• Three main tasks; R&D, Demonstration and Full-Scale CCS

• Further responsible for providing advice on CCS to the authorities; budget input, strategy, technical, commercial etc.

Managed by Gassnova in collaboration with the Norwegian Research Council
- CLIMIT Demo
- CLIMIT R&D

Promotes technologies and solutions to reduce costs and broad international dissemination of CCS

Coordinates with other national activities
- Research centres for environmentally-friendly energy (FME)
- Existing and planned infrastructure, like TCM and ECCSEL
- Financing partner for ACT
- Secretariat for a bilateral arrangement between the US and Norway
• Primary objective to support projects that will:

  – Develop knowledge, expertise, technology and solutions that can contribute towards cost reductions and international deployment of CCS.
  – Leverage national advantages and develop new technology and service concepts with commercial and international potential.
• Capture Type: Post-combustion

• Technologies: Two existing units designed to test different solvent-based technologies with the space available to add other units / technologies

• Capacity: Two units each approximately 12 MWe in size, combined capturing a total of 100 000 tons CO₂/year

• CO₂ contents are about 3.5 % and 13 %
US-Norway bilateral

• Memorandum of Understanding (MoU) between the United States Department of Energy and the Norwegian Ministry of Petroleum and Energy

• A key part of this cooperation is the development of CCS

• Under the MoU, four technology areas have been selected for cooperation in the field of CCUS:

  – Large-Scale Testing of Carbon Capture Technologies
  – CO$_2$ Storage and MVA (Monitoring, Verification and Accounting)
  – CO2-EOR
  – Crosscutting Research Program
NORCEM HEIDELBERGCEMENT PLANT IN BREVVIK

• 400 000 tonnes of CO₂/year (50% of CO₂ emissions)
• Capture CO₂ utilising excess heat from cement production
YARA PORSGRUNN FERTILIZER PLANT

- 805 000 tonnes of CO$_2$/year
- Three sources of CO$_2$ from the ammonia plant
- Yara sells 200 000 tonnes of CO$_2$/year by liquefaction and ship transport to the market
KLEMETSJRUD FACILITY WASTE-TO-ENERGY PLANT  
(OSLO MUNICIPALITY AND FORTUM)

- Ca. 400 000 tonnes of CO₂/year
- 60% is bio-fuel: a CO₂ negative project!
- Focus on heat integration to minimize energy loss
**CO₂ TRANSPORTATION**

- Plans envisage CO₂ being shipped by sea from capture facilities in eastern Norway to intermediate storage on the west coast
- The CO₂ would then be piped to a subterranean store
CO₂ STORAGE

- An offshore storage site in a saline aquifer
- The "Smeaheia" storage located 50 km from the coast
- Large storage capacity (project will utilize < 1%)
A catalyst for European CCS projects

Illustration: Statoil
<table>
<thead>
<tr>
<th>COSTS</th>
<th>One source 400 kt CO$_2$/y</th>
<th>Three sources 1300 kt CO$_2$/y</th>
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<tbody>
<tr>
<td>Planning and investment costs (€ millions)</td>
<td>791</td>
<td>1384</td>
</tr>
<tr>
<td>Operating and maintenance costs (€ millions/y)</td>
<td>39</td>
<td>98</td>
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