15 Years of Industrial CO2 Storage Experience

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15 Years of Storage Experience

CONTENT:

• Challenge, Vision & History
• Sleipner, In Salah & Snohvit
• Ketzin, Longyear & Svelvik
• Legal Framework
Challenge, Vision & History
Simplified global energy flows 2007

Primary energy (million tonnes of oil equivalent per year)

- Coal 3136
- Crude oil 3906
- Natural gas 2654
- Nuclear 622
- Hydropower other renewables 709

Final consumption

- Coal
- Oil
- Gas
- Electricity

16800 TWh/yr
Potential for CCS – Power and Industry

Emissions to the atmosphere

Source: IEA

Worst case scenario is business as usual!

Need to get started now!
Vision

DECARBONISATION OF FOSSIL FUELS TO ELECTRICITY AND HYDROGEN
Sleipner, In Salah & Snohvit
- Industrial sites
Statoil’s CO₂ Storage Sites

Unique blend of
- offshore/onshore
- Shallow deep
- Horizontal/vertical wells
CO₂ Injection Performance

Accumulated injected CO₂
[million tons]

Year


Sleipner
In Salah
Snøhvit
Sleipner CO₂ injection:
- Decided in 1992
- In operation since 1996
- 1 million tonne CO₂/år
CO₂ Injection well in "Utsira"
The Utsira Formation
Simulated picture of the distribution of CO$_2$ after three years. Radius of largest bubble 800 m and the total plume 200 m high.

Ref: SINTEF Petroleum 2001
Dissolution of CO2 in the Utsira Brine

Source: Gemini No. 1, 2004 (NTNU and Sintef)
CO₂ finnes ”lagret” naturlig i undergrunnen.

Figure 5.9  Storage security depends on a combination of physical and geochemical trapping. Over time, the physical process of residual CO₂ trapping and geochemical processes of solubility trapping and mineral trapping increase.
In Salah Gas Project Location, Algeria

- Hassi R'Mel: <0.3% CO2
- Teguentour: 5-10% CO2

BP Logos

Map of Algeria showing the In Salah Gas Project.
In Salah in Algeria

- Carboniferous Reservoir ~20 metres thick
- Carboniferous Mudstones ~950 metres thick
- Cretaceous Sandstones & Mudstones ~900 metres thick (Regional Aquifer)

- 4 Gas Production Wells
- 3 CO$_2$ Injection Wells
- Processing Facilities
- Amine CO$_2$ removal

The CO$_2$ storage scheme at Krechba
In Salah Satellite Monitoring

First TRE dataset (2003-2007) PSInSAR™ revealed ~5mm uplift over the CO2 injectors

Vasco et al.
Snøhvit, implement CO$_2$ storage offshore in North Atlantic
Snøhvit - All subsea

Depth: 330 m

160 km
Snohvit CO₂ Injection
Snøhvit CO₂ monitoring

Modelled CO₂ saturation and pressure increase

Amplitude changes

4D seismic acquisition

10 bar

Pressure

Time

Cumulative injected mass [tons]

Increasing amplitude

Gas saturation

1.5 km

100 000

200 000

300 000

400 000

500 000

600 000

Cumulative injected mass [tons]

200 000

300 000

400 000

500 000

600 000

200 000

300 000

400 000

500 000

600 000

10 bar
Ketzin, Longyear and Svelvik - Pilot test sites
CO2SINK - First European On-shore CO$_2$ Storage Project at Ketzin (Germany)

Coordinator: GFZ, Potsdam
Industry: E.ON, RWE, Schlumberger, Shell, Siemens, Statoil, Vattenfall, VNG
Ketzin - Facilities at Wintertime
Regular Operations (3)
Rates & Pressures

Source: GFZ, Potsdam
LONGYEAR CO₂ - Storage on Svalbard

Svalbard islands

Norne
Heidrun
Åsgard
Tyrhans

Statfjord
Gullfaks
Veslefrikk
Troll
Sleipner
Yme

Greenland
Svalbard
Norway
Sweden
Finland
Denmark
Great Britain
CO2 Storage on Svalbard

Drill hole target - 900 m

Longyearbyen

Drilling 1+2
Drilling 4
Drilling 3

Source: UNIS, Svalbard
Longyear CO2 - Drill rig at winter
CO2 Field Lab

Objectives:

1. Determine requirements for monitoring of industrial CO2 storage
2. Quantify unforeseen migration and leakage into the atmosphere or ocean

Courtesy SINTEF Petroleum
CO2 Field Lab - Svelvik site

Courtesy: SINTEF Petroleum
Legal Framework
Legal Framework – Present status

- **Ownership to site** - Ground owner
  - **Ownership to subsurface** - State*

- **Petroleum law** - Injection of fluids

- **Environmental Protection law** - Emissions to air and sea

- **EU Water Directive** - CO2 excluded
- **EU Landfill Directive** - CO2 excluded
- **EU CCS Directive** - Regulates “from birth to grave”
  Under implementation in Member States and Associated Norway

*USA special – Subsurface owned by ground owner
Further monitoring at Sleipner


Seafloor mapping 2006

In-situ CO₂ density:
720 +/- 80 kg/m³

Maximum dissolution rate:
1.8% per year

(Alnes et al. poster session Wednesday 15:40)
THANKS for your attention!

QUESTIONS?