Governmental administrative agency and technical advisor to the Norwegian Ministry of Petroleum and Energy

Technical expertise within geology, engineering, economy and law

established in 1972, head office in Stavanger and office in Harstad

About 220 employees

NPD’s management group:

- strategic management
  - director general and four directors
- operative management
  - twelve assistant directors

The NPD has a national responsibility for data from the Norwegian continental shelf
Areas evaluated for CO₂ storage

Objectives and requirements

➢ Find the safe and effective areas for storage of CO₂
➢ No interference with the petroleum activity
➢ Build on the accumulated knowledge from the Norwegian petroleum activity
➢ Build on the experience we have with storage of CO₂
➢ Mapping and volume calculations should be verifiable
➢ The work will define relevant storage areas and estimated storage capacities
➢ The evaluation will form the basis for any terms and conditions set for a development of a storage site
CO₂ Storage Capacity
Norwegian Continental Shelf

How much is a Gigaton?

- 1 tonne = one metric tonne = 1000 kg
- 1 Mt = one megatonne = 10⁶ tonnes
- 1 Gt = one gigatonne = 1000 Mt = 10⁹ tonnes

<table>
<thead>
<tr>
<th></th>
<th>Volume/weight</th>
<th>Energy</th>
<th>CO₂ formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>532 GSm³</td>
<td>5300 TWh</td>
<td>1 Gt</td>
</tr>
<tr>
<td>Diesel</td>
<td>372 Mt</td>
<td>3800 TWh</td>
<td>1 Gt</td>
</tr>
<tr>
<td>Coal</td>
<td>413 Mt</td>
<td>2800 TWh</td>
<td>1 Gt</td>
</tr>
</tbody>
</table>
More than 20 years experience with CCS and CO₂ Storage in Norway, about 30 Mt CO₂ stored since 1996

The Sleipner gas field in The North Sea. CO₂ is captured on Sleipner T platform and injected and stored in the Utsira Formation.

The Gudrun platform is connected to the Sleipner field and to the Kårstø processing plant. At Sleipner T, carbon dioxide is removed from the gas.

The Snøhvit gas field in the Barents Sea. The well stream, with natural gas, CO₂, natural gas liquids (NGL) and condensate, is transported in a 160 km pipeline to the facility at Melkøya near Hammerfest. The gas is processed and cooled down to liquid natural gas (LNG). The CO₂ is separated and returned to the field by pipeline for reinjection into the aquifer (Stø reservoir).

These projects are living proof that storage of CO₂ is possible!
Our playground
NPD has access to all data collected offshore Norway
Type of storage sites

- Saline aquifers
- Water-filled structures (dry-drilled)
- Abandoned hydrocarbon fields
- Producing fields (EOR)

Evaluated leakage risk

- Faults
- Seal
- Old wells
- Injection wells
Chemical and Physical conditions for storage of CO₂
Enhanced oil recovery (EOR) by CO₂ injection

How does it work?

Source: DoE
CO₂ Storage in abandoned fields
Example from the Frigg gas field in the Norwegian North Sea

➢ Abandoned in 2004, after 27 years of gas production
➢ Transboundary field between Norway and UK
➢ Located 190 km west of Haugesund in Norway
➢ Gas in-place was 247 GSm³, 191 GSm³ gas has been recovered
➢ CO₂ injection study was done by NPD in 2010
➢ Simulation model shows that Frigg field has large potential for CO₂ storage
➢ Most optimistic amount of injected CO₂ is about 700 Mt with injection period of 85 years
Monitoring of injected CO₂ to detect leakages

Important to distinguish indication of leakage from natural seepage!!

- Continuous well pressure monitoring
- 4D seismic monitoring
- Scanning of water column to detect changes in release and gas bubbles from seafloor
- Acoustic imaging of seafloor to detect topographic changes (pathways)
- Imaging of bacterial mats and fauna to document environmental changes
- Chemical analyses of seawater to monitor changes in fluid composition
Future plans – Full scale CCS (Carbon Capture & Storage) chain in Norway by 2022
1.5 Mt CO₂/y for 25 years

Equinor, Shell and Total:
Ship transport from capture site to storage location – onshore facility with pipeline to offshore storage complex

Ship transport of CO₂

Fortum Oslo varme
Waste incineration 315 000 tonnes CO₂ per year

Norcem/Heidelberg
Cement production 400 000 tonnes CO₂ per year
Storage of CO\(_2\) is about:

- Geology
- Physics
- Politics
- Economy
- Chemistry
- Regulations
- Technology
The atlas can be downloaded for free on the NPD’s website www.npd.no
Safe CO$_2$ storage is proven, creates economical values and reduces CO$_2$ emissions!!

Thank you for your attention!

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