Attributes of a CO2 storage complex

- Trap mechanism
- Capacity
- Injectivity
- Containment, seal

- CO2 in the subsurface, reservoir, seal, aquifer, fluids, pressure....
In the Norwegian atlas, an aquifer is defined as a body of porous and permeable reservoir rocks which are well connected, and with pressure communication throughout. It is separated from other aquifers by barriers or baffles.

What is a storage complex?
What is a storage complex

For a geologist:

Storage complex means the storage site and surrounding geological domain which can have an effect on overall storage integrity and security; that is, secondary containment formations.

For a regulator:

Storage complex: Subsurface volume delineated by the operator and approved by the regulator for the purpose of environmentally safe long-term containment of injected CO2 streams. (DNV.)
Trap mechanism: Different geological settings which can be utilized for CO2 storage
Three trapping mechanisms within the geometrical traps,

CO2 plume

Residual CO2

Dissolved CO2
Effective storage capacity

\[ M_{CO2e} = A \times h \times \phi \times \rho_{CO2r} \times S_{eff} \]

\[ = RV \times NG \times \phi \times \rho_{CO2r} \times S_{eff} \]

- \( M_{CO2e} \): effective storage capacity
- \( A \): area of aquifer
- \( h \): average height of aquifer \times average net to gross ratio
- \( \phi \): average reservoir porosity
- \( \rho_{CO2r} \): CO\(_2\) density at reservoir conditions
- \( S_{eff} \): storage efficiency factor

RV  Rock volume
NG  Net to gross ratio
CO2 in the subsurface: physics, chemistry, geology

Injection of large volumes of CO₂ requires a better understanding of regional aquifer behavior.

Density at 1 bar and 0 degC is 1.977
Mol weight almost 3 times methane
CO2 in the subsurface: physics, chemistry, geology

Injection of large volumes of CO2 requires a better understanding of regional aquifer behavior.

Density at 1 bar and 0 degC is 1.977
Solubility of CO2 in water (Eclipse 300 package)

Solubility 1.45 g/l at standard conditions

Density of water increases when CO2 is dissolved
Dissolution takes place mainly at the boundary between the CO2 plume and the water
At low temperatures, CO2 and water form hydrate, somewhat more stable than methane hydrate
Pressure limitation

In order to contain the CO2 in the subsurface, pressure build-up must not exceed the fracture pressure of the sealing rock.

Pressure build-up is commonly the limiting factor for the capacity of the reservoir of the storage site.

To quantify pressure build-up, the pore volume and permeability of the aquifer system must be estimated.

Pressure build-up can be mitigated by production of pore water.

How to estimate fracture pressure in an area with scarce or no data?
NPD storage atlas: use of regional pressure data base
Pore pressure
Fluid pressure in a permeable rock, measured by producing a small sample of fluid by RFT, MDT,.. Or by drill stem test DST

\[ P = \rho g z \]

Gas density 0.15-0.3 g/cm³ increasing with z (density in reservoir)
Oil density 0.6 – 0.85 increasing with GOR
Water density 1.00 – 1.10 increasing with salinity
Overburden density 2.1 – 2.5 increasing with depth

\[ g = 9.81 \, \text{m/s}^2 \]
10 m water is approximately equivalent to 1 bar

Lithostatic stress
The stress on the mineral grains caused by the weight of the overburden. Can be calculated from density logs.

Fracturing pressure
The amount of pore pressure necessary to create leakage. Calculated from LOT (leak-off tests).
The fracture pressure (blue curve) is a limit for injection.
Regional pressure database Norwegian shelf 250-500 m water

Pressure in MPa (10*bar)

Depth in m

Black: pore pressure
Colour: Leak off pressure
Reservoir permeability and pressure build-up

The permeability of a layered reservoir is different in the x, y and z directions. It can be measured on core plugs, test data and estimated from well logs.

Permeability (or permeability*thickness) is the key parameter for evaluation of the injectivity.

Norwegian Atlas check list: Poor quality <10 mD, good quality > 500 mD.

Connectivity: In a large, well connected aquifer with high permeability, fluid is free to flow in large volumes, and the pressure build-up caused by injection will be small. With poor connectivity, pressures can build up near the injection well.

Darcy’s law

\[ q = \frac{k}{\mu} \nabla p \]

\( k \) = permeability, \( \mu \) = viscosity of fluid \( q \) = volume of fluid flux

In a fully open reservoir volume, water can escape and the pressure build-up from the injection well can be calculated in a reservoir simulation model with open boundaries.
Pressure build-up in a closed system

Water compressibility, PVT-module in Eclipse 300

Because water compressibility is very low, injection of CO2 into a fully closed water volume will create a pressure increase according to the equation \( \frac{dV}{V} = -c_{w}dP \).
Pressure build-up in a closed system

Pore compressibility

When a fluid is injected into a closed aquifer, the pore pressure increases, consequently the reservoir grains are pushed closer together, and the pore volume will expand. Soft rocks and sediments will expand more than consolidated rocks.

In the Frigg study, the reservoir is poorly consolidated. Compaction was calculated as reversible compaction in the reservoir model

<table>
<thead>
<tr>
<th>ROCKTAB</th>
<th>Pressure</th>
<th>PV-multiplier</th>
<th>Trans-mult</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.945</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>1.0072</td>
<td>1.00</td>
<td>/ Frigg aquifer</td>
</tr>
</tbody>
</table>

- 100 bar pressure increase from 200 to 300 bar corresponds to 0.7 % volume increase of pore volume
- Total volume increase of 1 % corresponds to 100 bar overpressure in a closed system
Capillary forces occur between the grain surfaces and the fluids in the reservoir. In a hydrocarbon field, the capillary forces determine the height of the transition zone. Because of surface effects, two fluids will not flow simultaneously at the same rate through a reservoir or a baffle.
CO2 in the sedimentary formation

In a storage complex, the relative amount of CO2 trapped by these mechanisms will vary through time.
Residual trapping can be modelled, but there are large uncertainties

Residual trapping – relative permeability between CO2 and water

Relative permeability curves are different in different reservoir rocks. Mainly water will flow at high water saturation, leaving an immobile CO2 behind. No water flow above 70% gas saturation. In imbibition, CO2 will not move below 35% CO2 saturation. Injected CO2 is partly trapped as a plume of high saturation, partly as residual CO2, partly as dissolved CO2. Relative permeability curves are input into the reservoir simulation model to quantify the trapping mechanisms.
CO2 plume theoretical model

Model overview

- Regridding horizontally only
  - Cells 51 x 51 x 17
  - The outer cells for “fully open” scenario
  - Other cells
    - 12.5 km x 12.5 km x 100 m
    - Poro=0.2
    - PV=3125 Rm3
- Inj. Rate 6MSm3/d
- Max delta BHP=100bar
- 2 runs; Kv/Kh=0.1 and 0.001
- Only 1 well, injector in the middle

Porosity 0.2
Injection rate 6MSm3/day
Open boundaries
Summary- $kv/kh = 0.1$

- After 25 years reaching the **outer boundary** of the 12.5 km x 12.5 km. Then CO2 "disappears" into the infinite aquifer.
- $CO_2$ injected = 4.4% of PV

High degree of segregation
Good injectivity, moderate capacity
After 55 years reaching the **outer boundary** of the 12.5 km x 12.5 km
- CO₂ injected = 8.1% of PV

**Summary** - \( kv/kh = 0.001 \)

**Limited segregation:** Low injectivity, high theoretical capacity
Will theoretically store more CO₂, but with real geology will need more injection wells to contact all the reservoir volume
15/6-7 Skagerrak Fm
Mainly alluvial fans

6407/1-3 Garn fm Prograding delta

6508/5-1 Ile fm deltaic, tidal
Case studies with real geology

The significance of geological understanding - and cooperation between geologists and engineers

The capacity and injectivity of a CO2 storage prospect is estimated from a reservoir simulation model, and this model depends strongly on the geological input. The static model is typically a 3D grid with rectangular cells a few hundred meters across and a few meters thick. Each cell is given values for porosity, permeabilities, water saturation and net gross, based on geological data. The reservoir engineers convert the model to a dynamic model where different well locations can be tested and fluids can be injected and produced.

Different sedimentary environments create large differences in how permeable layers are distributed and connected.

Low permeable baffles and impermeable barriers can control the distribution and migration of the CO2 plume. (Example: Snøhvit injection in Tubåen Formation)

Geologists and reservoir engineers must work in one common team and cooperate closely throughout the evaluation project.
**Snøhvit and Sleipner CO$_2$ plume monitoring**

Sleipner: Large aquifer, permeable sands, plume is controlled by surface topography, very small pressure build-up

Snøhvit: Plume and pressure build-up is controlled by permeable channel which is poorly connected to other high permeable sandstones

![Sleipner 4D seismic amplitudes relative to 1994 baseline](image)

Plume is controlled by structure and pressure build-up

![Snøhvit 4D seismic measured 2009 after pressure build-up](image)

Snøhvit 4D seismic measured 2009 after pressure build-up. The 4D anomalies are interpreted to correspond to the plume and to increased pressure. Note the shape of the main anomaly, which reflects a high-permeability channel in tighter rocks.

*Source: Statoil, printed in North Sea Storage Atlas*
From plume to dissolution:
Change of CO2 trapping mechanisms through time, Skade-Utsira model

Relative distribution of CO2 in plume (green), residual CO2 (black) and CO2 in solution (blue) from year2000 to year10000 in the Utsire-Skade aquifer model. Note the increasing proportion of dissolved CO2 and large uncertainty in the amount of residual trapping.

130 Mt

Bennion et al
Singh et al

Pham et al., 2013
End of part 1
Site selection and characterization

- Capacity
- Injectivity
- Caprock strength
- Uncertainty, Data coverage
- General risk, maturity
- Interference/impact on other activity
- Monitorability
- Economy/strategy, Cost, possibility of utilization of CO2
Characterization of aquifers – at least 5 criteria

Volumetrics and injectivity

Risk: Quality of storage volume and seal

Uncertainty: Data quality and interpretation

Maturation: How far from development

Economy of storage project
Characterization of aquifers and potential storage volumes

<table>
<thead>
<tr>
<th>CHARACTERIZATION OF AQUIFERS AND STRUCTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>Reservoir quality</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Injectivity</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Sealing quality</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Fracture of seal</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Other leak risk</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

Data coverage

- **Good**: 3D seismic, wells through the actual aquifer/structure
- **Limited**: 2D seismic, 3D seismic in some areas, wells through equivalent geological formations
- **Poor**: 2D seismic or sparse data

Other factors:
How easy / difficult to prepare for monitoring and intervention. The need for pressure relief. Possible support for EOR projects. Potential for conflicts with future petroleum activity.
# Checklist for Norwegian shelf atlas

## Checklist for Reservoir Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical high and low scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Properties</td>
<td>High</td>
</tr>
<tr>
<td>Aquifer Structuring</td>
<td>Mapped or possible closures</td>
</tr>
<tr>
<td>Traps</td>
<td>Defined sealed structures</td>
</tr>
<tr>
<td>Pore pressure</td>
<td>Hydrostatic or lower</td>
</tr>
<tr>
<td>Depth</td>
<td>800–2500 m</td>
</tr>
<tr>
<td>Reservoir</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>Net thickness</td>
<td>&gt; 50 m</td>
</tr>
<tr>
<td>Average porosity in net reservoir</td>
<td>&gt; 25 %</td>
</tr>
<tr>
<td>Permeability</td>
<td>&gt; 500 mD</td>
</tr>
</tbody>
</table>

## Checklist for Sealing Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical high and low scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sealing Properties</td>
<td>High</td>
</tr>
<tr>
<td>Sealing layer</td>
<td>More than one seal</td>
</tr>
<tr>
<td>Properties of seal</td>
<td>Proven pressure barrier/ &gt; 100 m thickness</td>
</tr>
<tr>
<td>Composition of seal</td>
<td>High clay content, homogeneous</td>
</tr>
<tr>
<td>Faults</td>
<td>No faulting of the seal</td>
</tr>
<tr>
<td>Other breaks through seal</td>
<td>No fracture</td>
</tr>
<tr>
<td>Wells (exploration/ production)</td>
<td>No drilling through seal</td>
</tr>
</tbody>
</table>

## Unacceptable values

- No known sealing layer over parts of the reservoir
- < 50 m thickness
- Silty, or silt layers
- Tectonically active faults
- Sand injections, slumps
- Active chimneys with gas leakage
- High number of wells
Evaluation for selection of site (not complete)

How large injection volumes are planned for?

Reservoir simulation, including uncertainty

Evaluation of risks, in particular of seal failure

Plans for monitoring and mitigation of risks

Present needs and future strategy

Present and future price of storage of CO2 volumes

Present and futures options for utilization of CO2

Investments and operational costs
Case studies of characterization and site selection, from North Sea Atlas

North Sea Atlas, the three most mature aquifers for injection.
Neogene aquifer (Utsira – Skade Formations)

Half-open aquifer with several structural traps
Utsira and Skade aquifer

Pore volume 526 E+9 m³
Storage efficiency 4 %
Storage capacity 16 Gt
Depth: 200 to 1200 m
Pressure increase from Sleipner injection < 1 bar
Very good permeability and communication,
Probabably communication to sea floor
Continues as a shallow sand deposit in UK sector

Pressure: Hydrostatic
Temperature: Normal/slightly low? gradient
What are the properties of the UK sector part of this huge aquifer? UK-Norwegian cooperation initiated
Since 2007, the NPD has investigated the Utsira – Skade aquifer by regional mapping of 3D seismic data, biostratigraphical and geological studies.

Pham et al. (2013) Reservoir modelling of the southern part of the Utsira-Skade aquifer. Central part is not suited due to shallow burial.
How much CO2 can be stored in the southern part adjacent to the Sleipner injection site

Maturation of storage capacity in a large, half-open aquifer with closed structures

Utsira-Skade aquifer model
Top surface of model after injection of approximately 130 Mt CO2, after 8000 years, 3 cases with different vertical permeability
Conclusions Utsira-Skade aquifer study

The Utsira and Skade aquifers have excellent reservoir conditions and high injectivities. The model is based on 3D seismic mapping where several structural culminations are identified. Structural trapping prevents CO2 to migrate further into the area where CO2 may continue to leak to shallower levels where there will be a change to gas phase.

In the model, 170 Mt were injected in 50 years with 10 bar pressure increase. The segment only represents a fraction of the total possible injection area of the aquifer, but even so the calculated volume is small relative to the total theoretical capacity of the aquifer calculated in the Storage Atlas.

The main uncertainties related to CO2-injection in the Utsira-Skade aquifer are considered to be the sealing capacity of the caprock and to the integrity of old exploration wells drilled through the formation. There is no leakage from the Sleipner site.

For the operational storage capacity it is important to understand the degree of communication between the different sandy formations within the aquifer. Regional horizontal barriers at shale layers within the aquifer will help to increase the operational storage capacity.
Presentation of aquifer evaluation

<table>
<thead>
<tr>
<th>Utsira and Skade Fm</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>3,5 E+12</td>
</tr>
<tr>
<td>Injectivity</td>
<td>5,26 E+11</td>
</tr>
<tr>
<td>Caprock strength</td>
<td>900 m</td>
</tr>
<tr>
<td>Data coverage</td>
<td>&gt;1000 mD</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>4</td>
</tr>
<tr>
<td>Interference/impact</td>
<td>16 Gigatons</td>
</tr>
<tr>
<td>on other activity</td>
<td>0,5-1,5 Gigatons</td>
</tr>
<tr>
<td>Monitorability</td>
<td>3</td>
</tr>
<tr>
<td>General risk, maturity</td>
<td>3</td>
</tr>
<tr>
<td>Economy/strategy, Cost, possibility of utilization of CO2</td>
<td>level 2-4</td>
</tr>
</tbody>
</table>

- Capacity
- Injectivity
- Caprock strength
- Data coverage
- Uncertainty
- Interference/impact on other activity
- Monitorability
- General risk, maturity
- Economy/strategy, Cost, possibility of utilization of CO2
Storage in abandoned gas field (Frigg field)
**Case:** Simulation of CO2 injection in the abandoned Frigg Field

- Top of reservoir sand, Frigg Field
- Frigg Fm outline
- Heimdal Fm outline
- Colors: Mid Jurassic depth
- UH Utsira High

Aquifer includes:
- Frigg Formation
- Balder Formation
- Hermod Formation
- Heimdal Formation
- Ty Formation
Case: Simulation of CO2 injection in the abandoned Frigg Field

Model built by AGR for the NPD. Field model provided by the previous operator, Total.
Very coarse grid covering the Frigg-Heimdal aquifer, finer grid in the Frigg Field.
• Confined aquifer: 55 years of injection (3xMongstad) before the field (aquifer) pressure reaches its initial value
• For a half open aquifer it takes 85 years for the same point

Pressure response with limited and half open aquifer

440 Mt injected CO$_2$ – 17 bar pressure increase
Corresponds to 210 $10^9$ Sm$^3$ CO$_2$, 1/Bg approximately 350
Conclusions

The abandoned Frigg field reservoir has a large capacity and good injectivity.

Possibly remaining methane gas could be produced before injected CO2 reaches the remaining gas cap.

The risk of leakage through the cap rock of the field is considered to be low as long as the pressure is not exceeding hydrostatic. One natural seepage area has been observed east of the field, but the plume will not migrate into that area.

The main risk of leakage/seepage is considered to be the integrity of the exploration and production wells of the field.

The Frigg field straddles the boundary between Norway and UK, good cooperation is necessary.

Consequences of repressurization of aquifer?
Characterization and maturation of Johansen site

December 2006: MPE request to the NPD to suggest and evaluate storage sites for CO2 from Mongstad, up to 3 Mt annually. The costs of capture and storage to be covered by the state.

NPD decided to evaluate the Johansen Formation and compare with a site close to the existing Sleipner site, which was considered to have a proven capacity.

The proposed injection area was located south of Troll, at 2500-3000 m depth, 600 m below the Troll aquifer and separated by several shale layers.

The Johansen Formation was considered to be water bearing, and the knowledge of the formation was limited. 2D seismic coverage and no wells in the proposed injection area south of the Troll field, but 3D and several well penetrations in the Troll Field. Petrophysical properties were estimated from logs.
Reasons to initiate the Johansen study: Why not just go for the simpler Utsira case?

- Shorter distance to the CO2 supply (70 vs 300 km), lower transport costs
- Good seal, virtually no risk of leakage to the sea floor
- Strategic: Possibly a large storage capacity for the future
- Proximity to fields which might use CO2 for EOR in the future
- There were some concerns about the sealing capacity of the Utsira Formation, and a parallel study was initiated to map the Utsira Formation for alternative injection sites closer to Mongstad.
Case: Maturation of Johansen site

Based on geological models of the injection area and the regional aquifers, SINTEF Petroleum Research constructed a reservoir simulation model in ECLIPSE and ran several cases. The geo-model was also made available to the universities, and several studies were performed.

Main conclusion and uncertainties

Capacity: Sufficient for the high case of CO2 supply. Uncertainty related to the size of the connecting aquifer. In the low case, pressure build-up could become a problem.

Injectivity: Uncertainties related to burial depth and possible shaling out of the formation towards the south

Seal: Uncertainties related to possible leakage through faults and up into the formations above, which form the water zone of the Troll Field. Possible conflict of interest with the Troll Field owners.
Results from simulations 2007

- Annual injection 3Mt
- Injection period 110 y, 330 MT

510 years
Case: Maturation of Johansen site

Follow-up studies by consultants and industry

**Fault seal analysis:** Mapping of fault geometries, development of fault rocks and their possible sealing capacity

**Detailed reservoir study** of Johansen and Cook Formations
Core analyses, petrophysics, correlations

**Seal rock lab study.** Wettability of shales

**Reservoir modelling** (based on the same geological model)

Main conclusions:
Johansen and Cook formations appear to be connected, should be treated as one aquifer.
Migration of CO2 vertically along faults is not likely. Fault geometries may allow migration of CO2 into the overlying formations, but only after a long way of plume migration. Based on 2D data.
Case: Maturation of Johansen site

New data acquisition
In 2010, the state agency Gassnova acquired and interpreted 3D seismic data in the southern part of the Johansen area in order to reduce uncertainties related to reservoir capacity and fault seal. The whole injection site and large parts of the aquifer are now covered with 3D data of high quality.

**Main conclusions:**
Interpretation of the new data results in a detailed map of the fault pattern in the south, and makes it possible to suggest an injection site to the south, almost 30 km away from the Troll Field. This reduces significantly the risk of conflict with the petroleum industry. Simulations indicate no plume migration into sensitive areas the first 500 years.

The 3D data interpretation supports a sedimentological model where reservoir rocks were developed with a high sand-shale ratio in the south. Because the suggested injection site is at 3000 m depth, there is an uncertainty that injectivity could be low. The capacities estimated in the previous studies were confirmed.

A well is needed to test the injectivity and reservoir properties before the Johansen-Cook aquifer can be qualified. Drilling of a well must be performed by an oil company which is qualified for this operation.
- Capacity
- Injectivity
- Caprock strength
- Data coverage
- Uncertainty
- Interference/impact on other activity
- Monitorability
- General risk, maturity
- Economy/strategy, Cost, possibility of utilization of CO2

<table>
<thead>
<tr>
<th>Cook Johansen aquifer</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage system</td>
<td>half open</td>
</tr>
<tr>
<td>Rock volume, m³</td>
<td>5.91E+11</td>
</tr>
<tr>
<td>Pore volume, m³</td>
<td>9.14E+10</td>
</tr>
<tr>
<td>Average depth</td>
<td>1700 m</td>
</tr>
<tr>
<td>Average permeability</td>
<td>400 mD</td>
</tr>
<tr>
<td>Storage efficiency</td>
<td>3</td>
</tr>
<tr>
<td>Storage capacity aquifer</td>
<td>2 Gigatons</td>
</tr>
<tr>
<td>Storage capacity prospectivity</td>
<td>150 Mtons</td>
</tr>
<tr>
<td>Reservoir quality</td>
<td>capacity injectivity</td>
</tr>
<tr>
<td>Seal quality</td>
<td>3</td>
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<tr>
<td>seal</td>
<td>2</td>
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<tr>
<td>fractured seal wells</td>
<td>3</td>
</tr>
<tr>
<td>Data quality</td>
<td>3</td>
</tr>
<tr>
<td>Maturation</td>
<td>3</td>
</tr>
</tbody>
</table>
CCUS: Possible first step to utilize associated CO2 from methane production
CO2 wells (measured CO2 > 3%) and BCU, with continental-ocean boundary
Storage of CO2 combined with EOR
Techno-economical infrastructure model
Possible second or third step for CO2 utilization

- SINTEF has developed a **techno-economical infrastructure model** for large scale deposition of CO2 in oil reservoirs and aquifers (Holt & Lindeberg, 2007). In the model, 70 Mt of CO2 was injected in the North Sea annually in 40 years. Part of it was used for EOR in waterflooded oil fields, the remaining was stored in a saline aquifer.

The study has been updated by NPD and SINTEF
Snøhvit injection, phase 1, limited connected aquifer

This injection site was abandoned due to pressure build-up. A new location is evaluated in the reservoir formation.
Snøhvit Field new injection location

Depth map with CO2 migration path

Minimum connecting aquifer

Sta Fm thickness map. Gray areas indicate shallow gas. AA' shows the location of the log correlation profile.

Snøhvit Central Sta

<table>
<thead>
<tr>
<th>Summary</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage system</td>
<td>Half open</td>
</tr>
<tr>
<td>Rock Volume, m³</td>
<td>6.05E+09</td>
</tr>
<tr>
<td>Net volume, m³</td>
<td>4.84E+09</td>
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<tr>
<td>Pore volume, m³</td>
<td>6.77E+08</td>
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<tr>
<td>Average depth, m</td>
<td>2320-2400</td>
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<td>Average net/gross</td>
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<td>Average porosity</td>
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<td>Average permeability, mD</td>
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<td>Storage efficiency, %</td>
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<td>Storage capacity aquifer</td>
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<td>Reservoir quality</td>
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<tr>
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<tr>
<td>• Uncertainty -</td>
<td>• Uncertainty</td>
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<tr>
<td>• Interference/impact on other activity +</td>
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<tr>
<td>• Monitorability +</td>
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References


**Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide**


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