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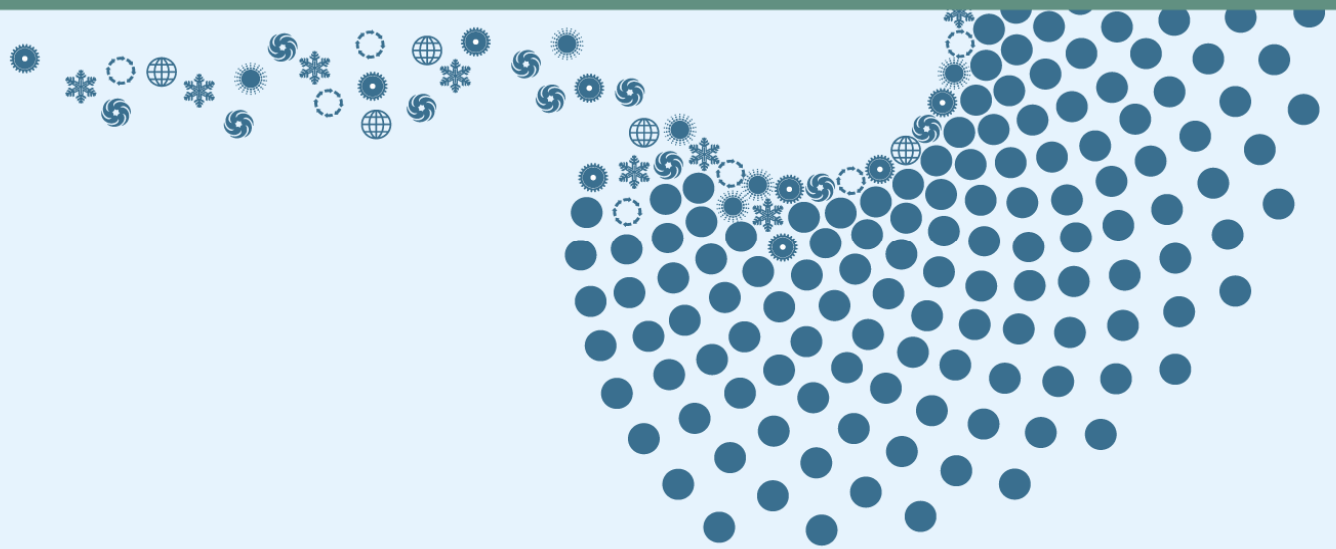
Norwegian Pollution Control Authority

Øyvind Christophersen, Berlin, June 17 2008

Carbon Capture and Storage (CCS) – Norwegian experiences



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Key issues for CCS projects

- Selection of a suitable site
- Project design
- Monitoring
- Reporting and verification

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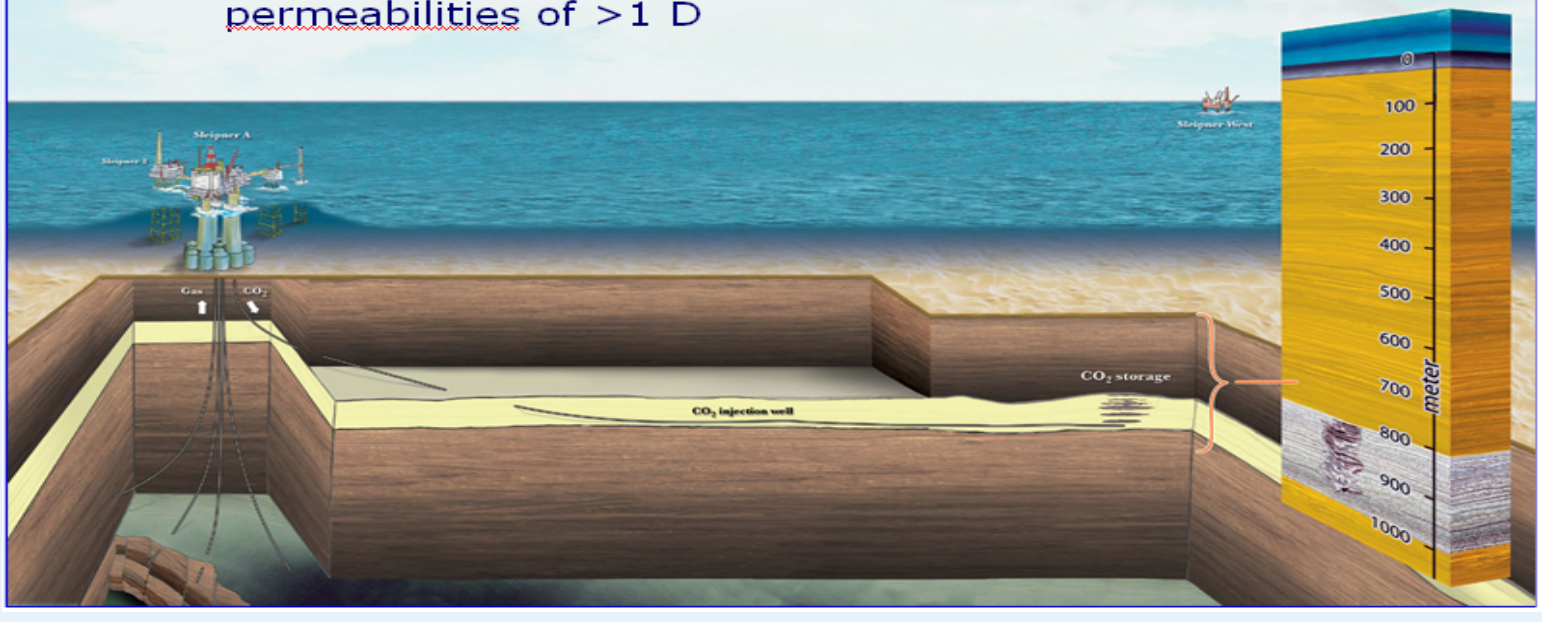
Norwegian Pollution Control Act

Application for an emission permit:

- Characteristics of the storage site
- Characterisation of the CO_2 -stream
- Documentation of the geological formation's suitability for CO_2 -storage, consequence assessment, risk assessment.
- Injection project design and operation
- Monitoring plan

- CO_2 is injected into a thick sandstone layer (Utsira Fm.) at 800-1100 m depth below sealevel
- The sandstones have porosities of 35-40 % and permeabilities of >1 D



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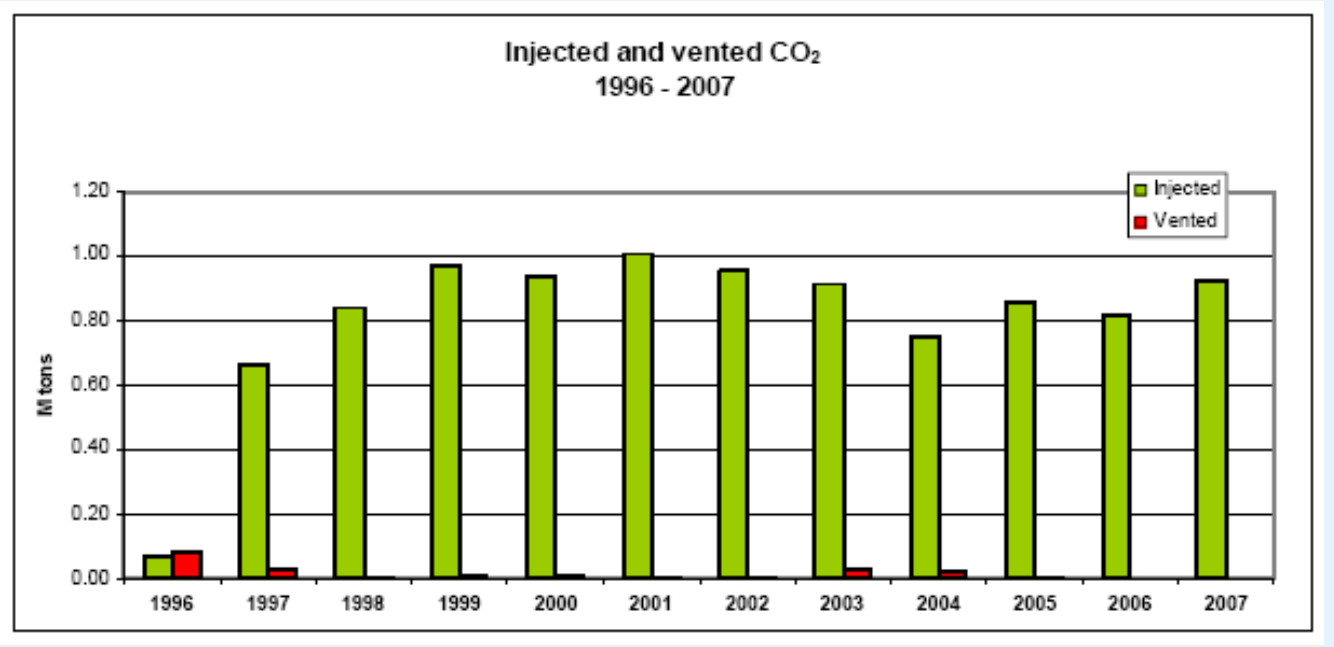
Sleipner CO2-storage

- Since 1996 Statoil has injected and stored CO_2 in the Utsira formation.
- The CO_2 has been separated from natural gas produced from the Sleipner field.
- The Norwegian tax on CO_2 made CO_2 storage profitable in this case.
- So far nearly 10 million tonnes of CO_2 has been stored in the Utsira formation.
- When the injection system is out of operation CO_2 is vented to the atmosphere. So far only 0,2 million tonnes of CO_2 has been vented.


Injected and vented CO_2
1996 - 2007
Injected
Vented
M tons
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

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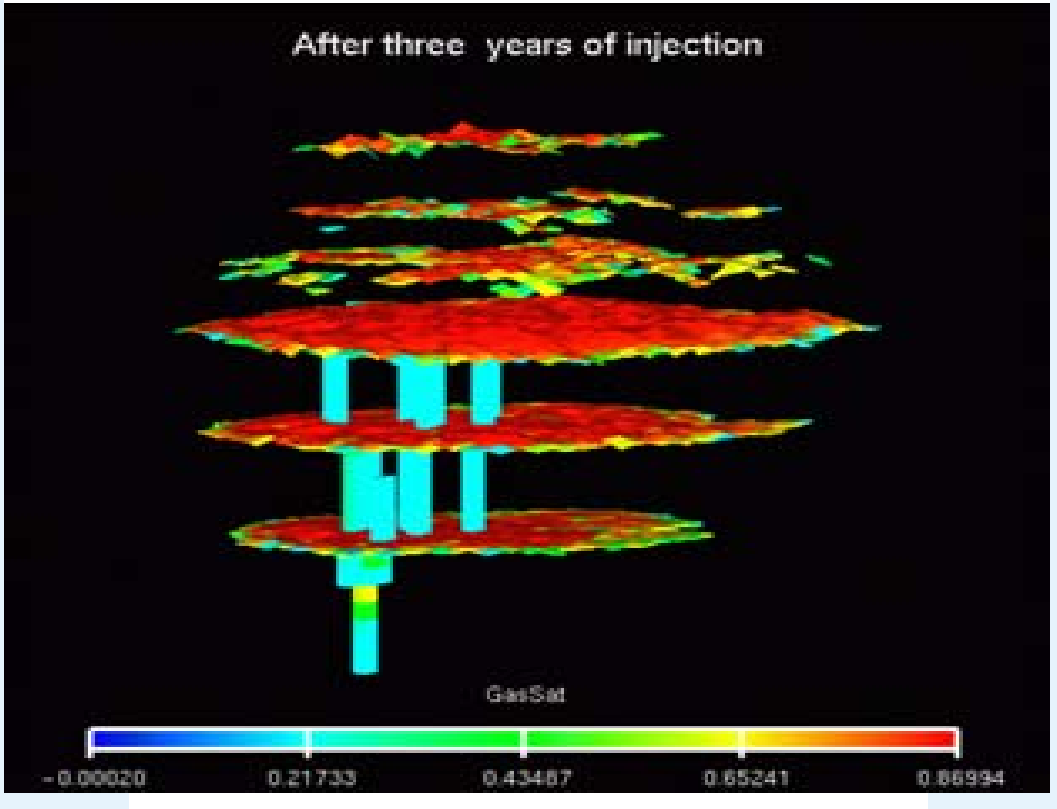
Monitoring of Sleipner CO2-storage



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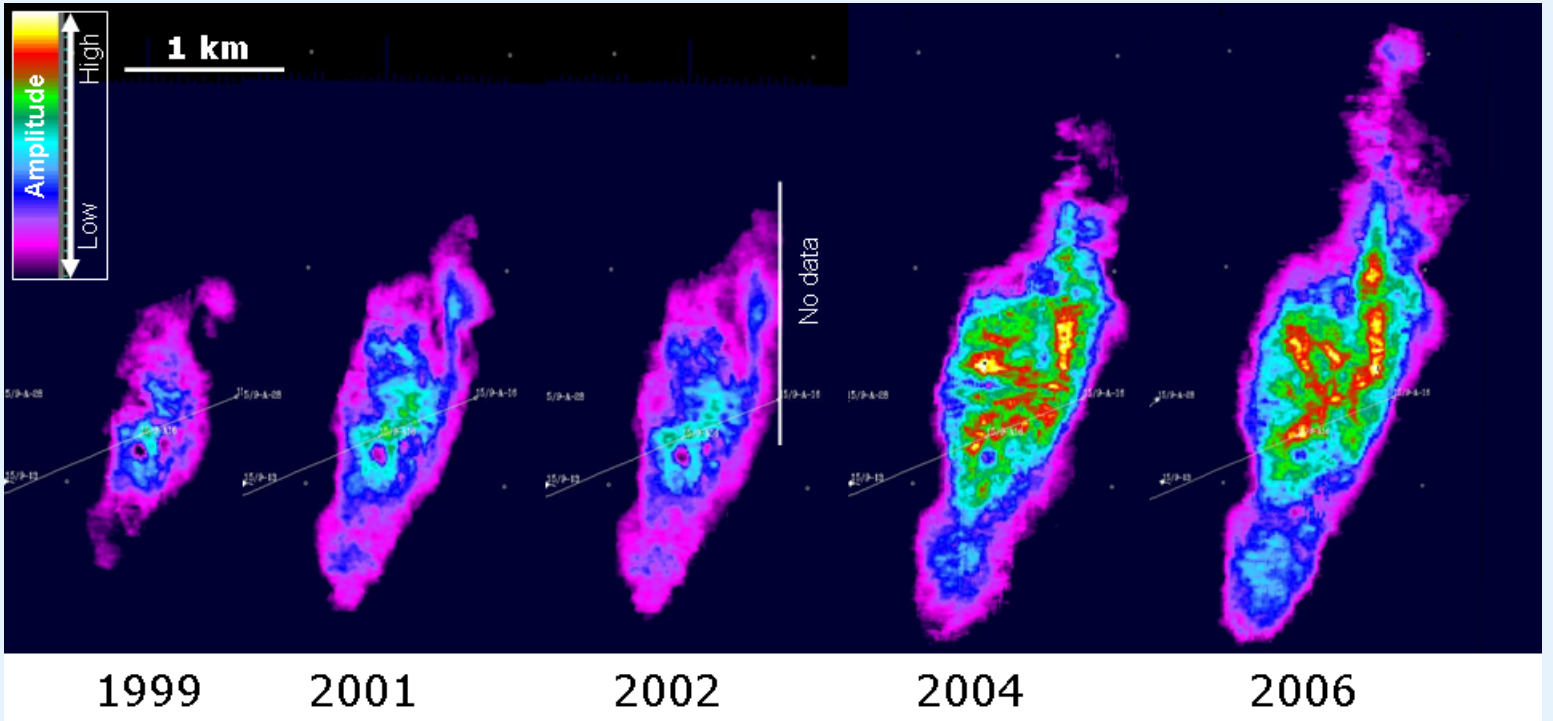
Sleipner CO_2 plume extension in 1999, 2001, 2002, 2004 and 2006



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Captured and stored CO_2 is considered not emitted

- All evidence and monitoring indicate that CO_2 stored in the Utsira formation is not reaching the atmosphere.
- Hence: When reporting to UNFCCC, CO_2 stored in the Utsira formation is not reported as an emission.

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Describing the Sleipner-case in the national inventory report to the UNFCCC

- Storage site selection and characterization
- Methods for modeling and monitoring the injected CO_2
- Results from monitoring
- The reports are reviewed by review teams from the UNFCCC

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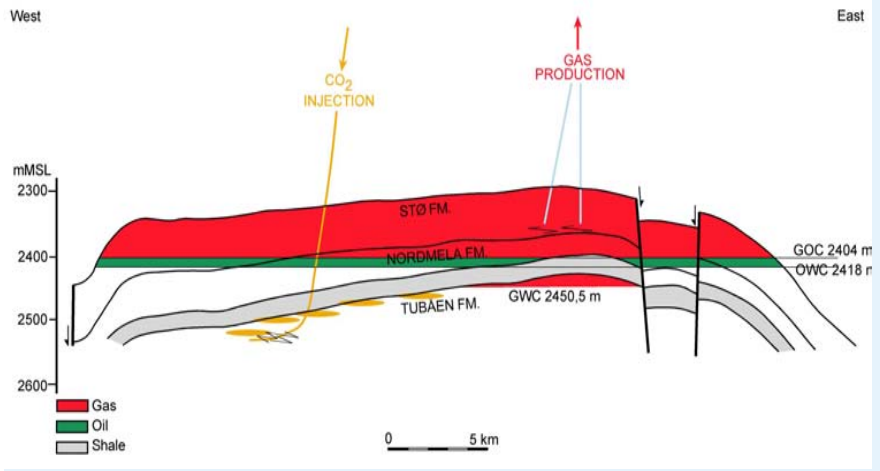
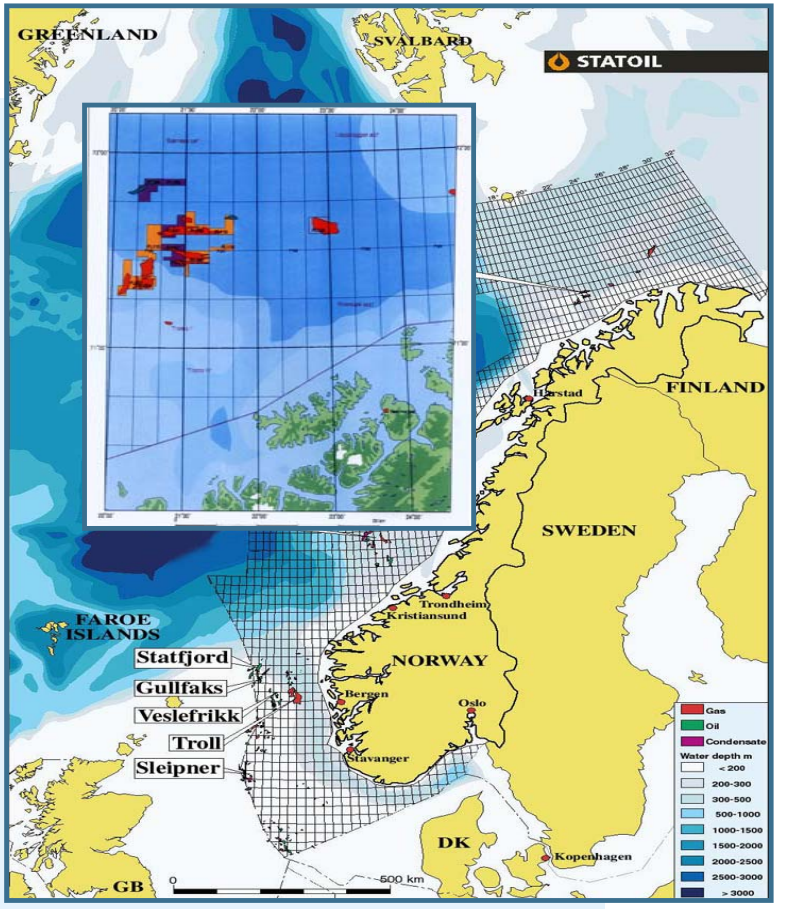
Snøhvit reservoirs





Start-up April 2008

Water depth: 250– 340 m

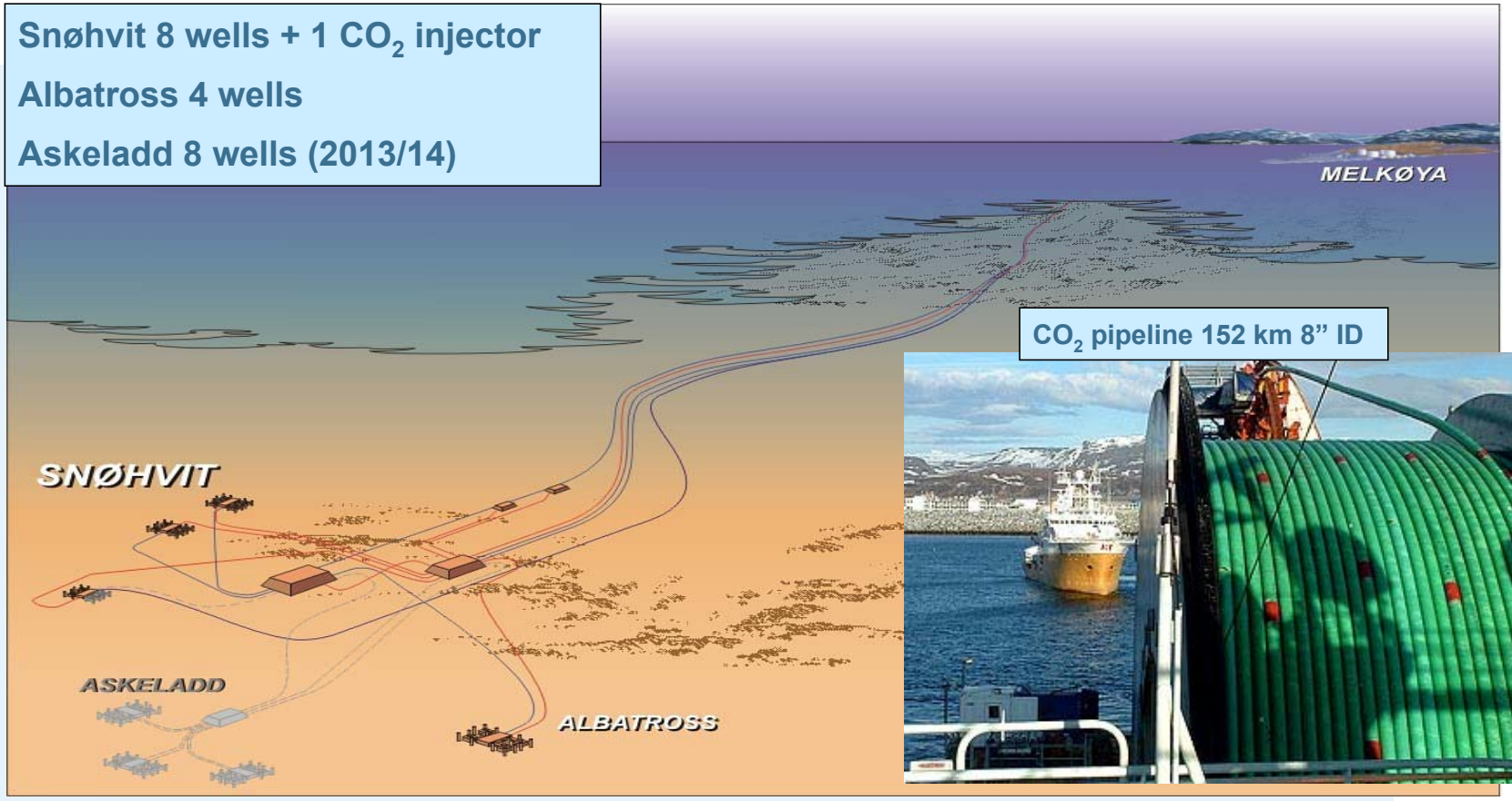
Distance to shore: 140 km

→ Re-injecting 700,000 tons CO_2/year

Snøhvit 8 wells + 1 CO_2 injector

Albatross 4 wells

Askeladd 8 wells (2013/14)



CO_2 pipeline 152 km 8" ID

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Capture readiness and implementation of CCS

- possible to require capture-readiness as well as implementation of CCS according to the Pollution Control Act
- Norway has required capture-readiness for specific facilities
- in the emission permits for gas power stations such as Kårstø it is required that they should be designed to make later retrofitting of CCS equipment possible (2000 government)
- present government policy:
  - existing Kårstø power plant should be facilitated to implement CCS
  - new gas-fired power plants should only be given a permit if they are fitted with CCS

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Capture readiness and implementation of CCS continued

Mongstad energy plant - implementation of CCS developed stepwise in parallel with the energy plant:

- 2008 the operator to present a master plan for CO_2 -capture incl. an assessment of separation of one part of the CO_2 -emissions from the Mongstad petroleum refinery (the cracker).
- 2011 a test plant for CO_2 -capture
- 2014 full scale CCS from the energy plant - 1.3 mill tonnes CO_2

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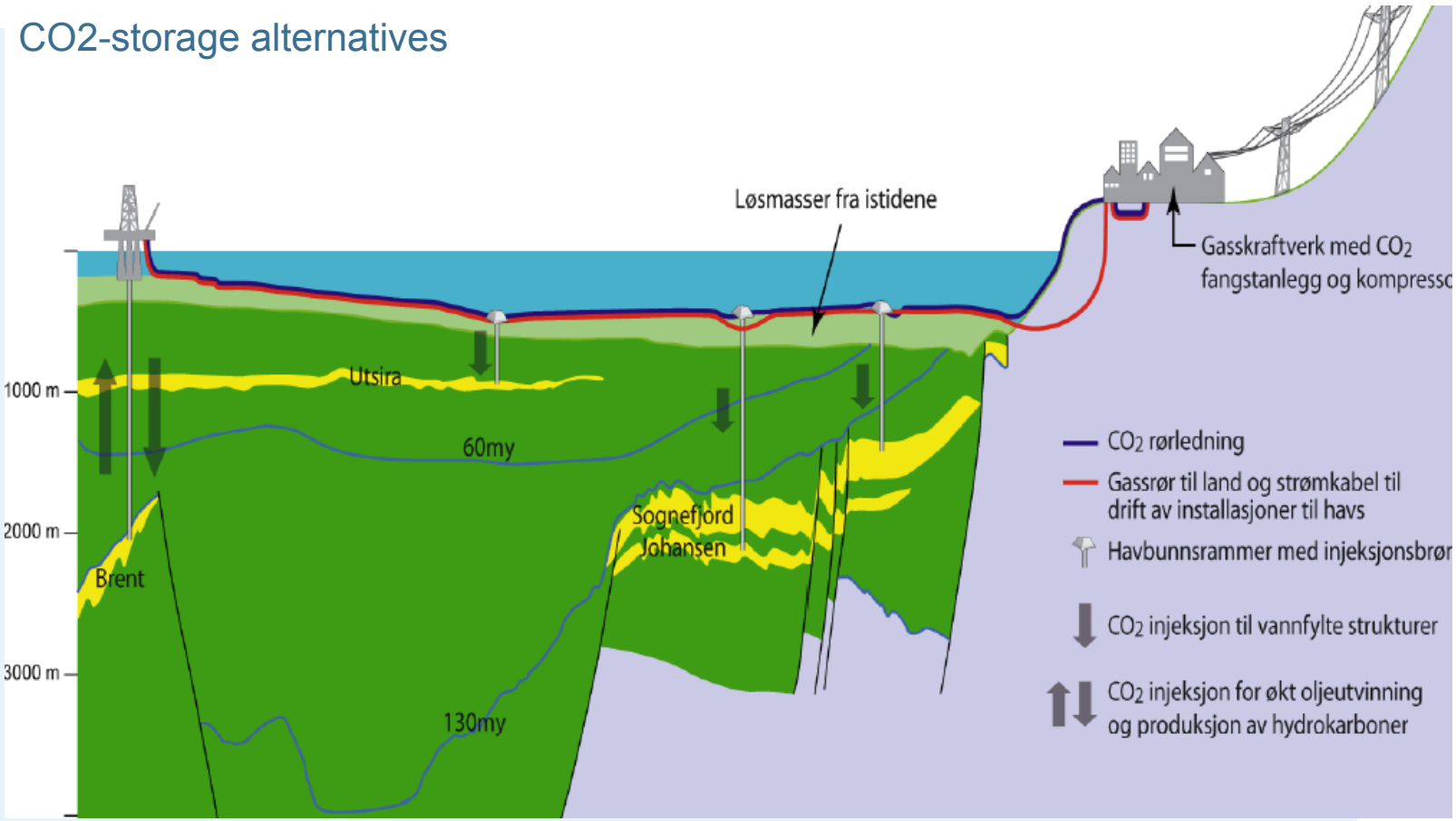
CO2-storage alternatives



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Transport and storage alternatives Kårstsø and Mongstad