The Sleipner CCS experience

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18 years of successful CCS operations at Sleipner

- CO$_2$ storage is feasible and safe
**Sleipner CCS project overview**

- Sleipner gas/condensate field
- Amine capture from natural gas
- 0.9 Mtpa CO$_2$ stored
- 15Mt stored by end 2014
- Injection started in Sept. 1996
- CO$_2$ is injected in the Utsira Fm at ~ 900 m depth (above the condensate reservoir)
- From April 2014 CO$_2$ from Gudrun field gas (north of Sleipner) is also injected

*15 Mt CO$_2$ injected since 1996*

*9% CO$_2$ in the gas from Sleipner Vest*
Main achievements

• Significant contribution to Norway’s emissions reductions

• Important learnings for science and technology of CO₂ capture, transport and storage

• Used to pioneer and demonstrate a range of monitoring technologies:
  – Time-lapse seismic
  – Gravity monitoring
  – Seabed mapping
Injection and monitoring history

- Accumulated CO$_2$ [Mt]
- Year
- Seismic surveys
- Gravity surveys
- Seafloor mapping
- CSEM survey

Year:
- 1994
- 1996
- 1998
- 2000
- 2002
- 2004
- 2006
- 2008
- 2010
- 2012
- 2014
Seismic time-lapse monitoring shows that CO$_2$ stays in place in the Utsira Fm at Sleipner and gives a detailed description of where the CO$_2$ is
Regulatory framework and knowledge building

• Project permitted under Norwegian Petroleum law
• Other relevant conventions
  – OSPAR
  – EU CCS Directive
• External interest – data sharing and technical clarifications
• Geophysical monitoring – improved understanding of CO$_2$ flow behaviour and storage capacity
• Experience on how much and what monitoring data is needed for CO$_2$ storage sites in general
EU CCS Directive

• Implementation may impose some additional requirements
  
  − Increased requirements on future monitoring plan

  − Liabilities
    
    • Long term liabilities after injection stop
    • Financial security for leakage risk
Key learnings

• Operational and monitoring experiences
  – Geophysical monitoring has proven essential for site management
  – Monitoring of pressures is as important as saturation
  – Practical learnings about capacity and injectivity from well operations experience
  – Monitoring the overburden is as important as the reservoir
  – Time-lapse seismic imaging of CO₂ plume development gives much improved understanding of flow processes

• Well defined governmental framework and regulations have contributed to the stable and predictable operation
There’s never been a better time for good ideas

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