Managing a CO_2 Storage Site Portfolio; A Regulator's View

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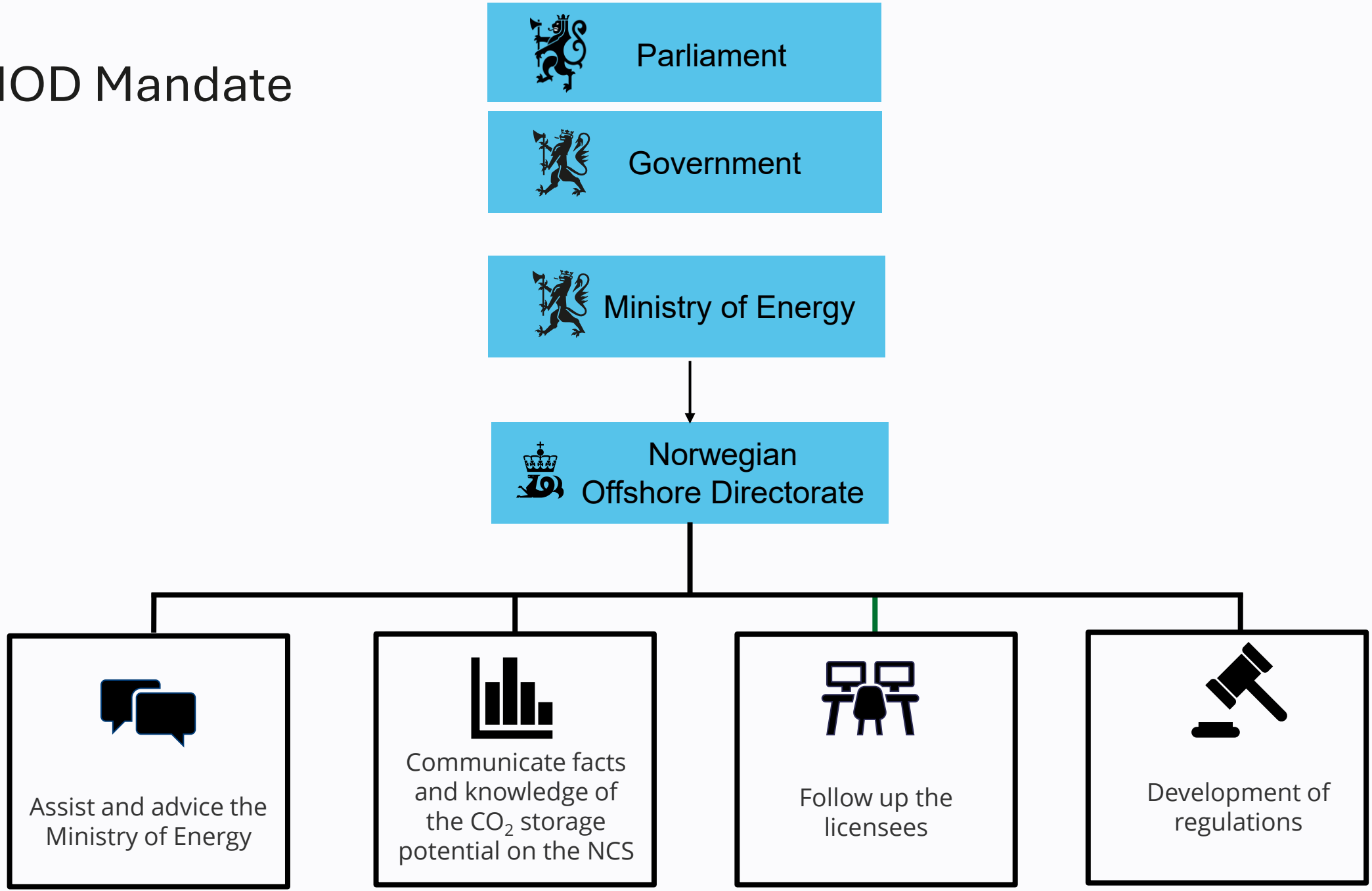
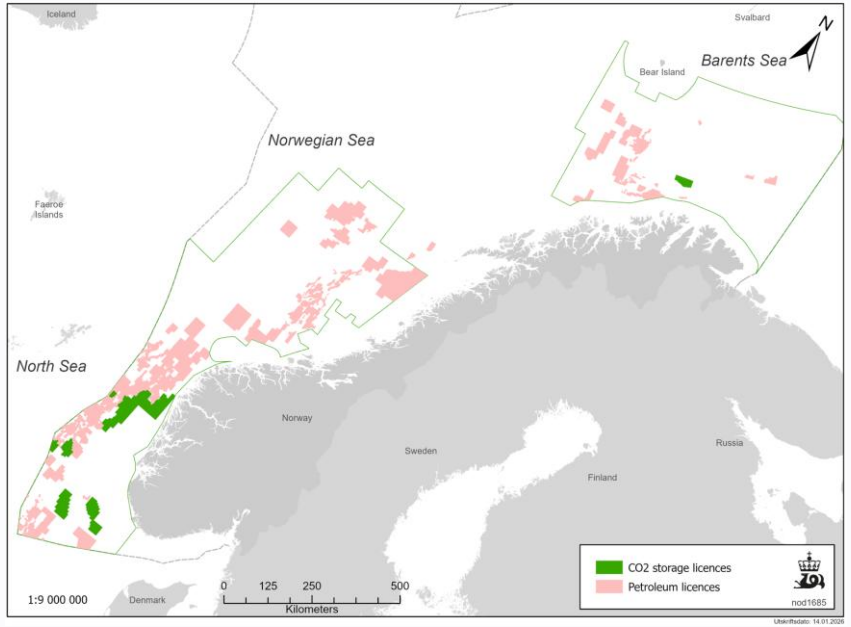
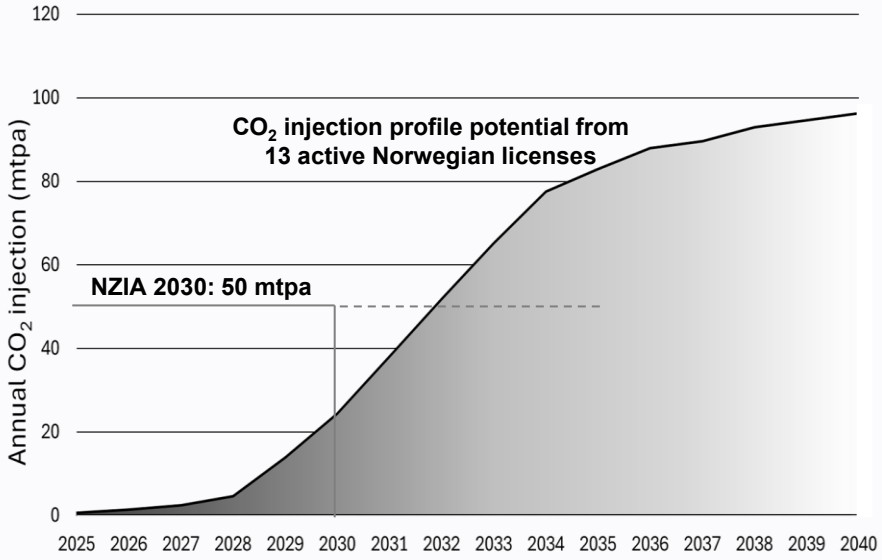
NOD Mandate


Parliament
Government
Ministry of Energy
Norwegian Offshore Directorate
Assist and advice the Ministry of Energy
Communicate facts and knowledge of the CO_2 storage potential on the NCS
Follow up the licensees
Development of regulations

CCS Status Norwegian Continental Shelf (NCS)

Award	License	FID (PDO)
2019	EL001 Aurora	2020/2025
2022	EXL002 Smeaheia	2028
2022	EXL003 Polaris	2029
2022	EXL004 Luna	2029
2023	EXL005 Poseidon	2030
2023	EXL006 Havstjerne	2028
2023	EXL007 Trudvang	2027
2024	~~EXL008 Albondigas~~	2028
2024	EXL009 Iroko	2030
2024	EXL010 Kinno	2028
2024	EXL011 Atlas	2028
2025	EXL012 Kaupang	2029
2025	EXL013 Forsete	2029
2025	EXL014 Fritos	2031





1969 First NCS discovery (Ekofisk)

1991 CO_2 Tax

1996 Sleipner CO_2 storage

2008 Snøhvit CO_2 storage

2011 CO_2 Atlas North Sea

2012 TCM Mongstad

2014 CO_2 Atlas NCS

2019 EL001 awarded (Northern Lights)

2022 3x EXL awarded

2023 3x EXL awarded

2024 4x EXL awarded

2025 3x EXL awarded

Northern Lights operational

2030 — 2040

Nearly 100 mtpa currently undergoing maturation in awarded CO_2 exploration licenses

Maturation timeline from submitting CO_2 exploration licenses application to first CO_2 injection is currently 8-10 years for projects where data is available.

CONTINOUS EXPERIENCE → **60 years** of subsurface data and knowledge

CONTINOUS EXPERIENCE → **30 years** of CO_2 storage experience in saline aquifers

Sharing The Pressure Resource

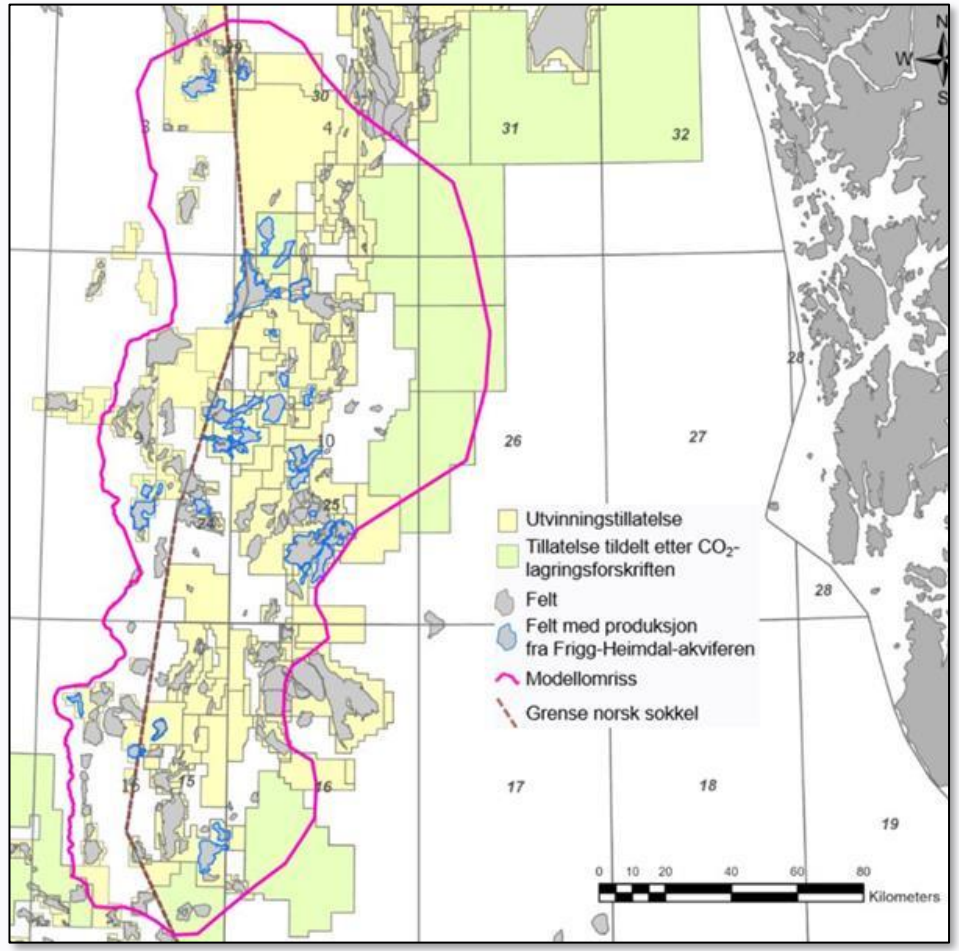
Injecting CO2 increases reservoir pressure

Pressure propagates further than the CO2 plume

Resource optimization

- Effective management of storage resource
- Predictable framework conditions for all players

Pressure interference across license and country boundaries



- 80 billion tonnes theoretical capacity

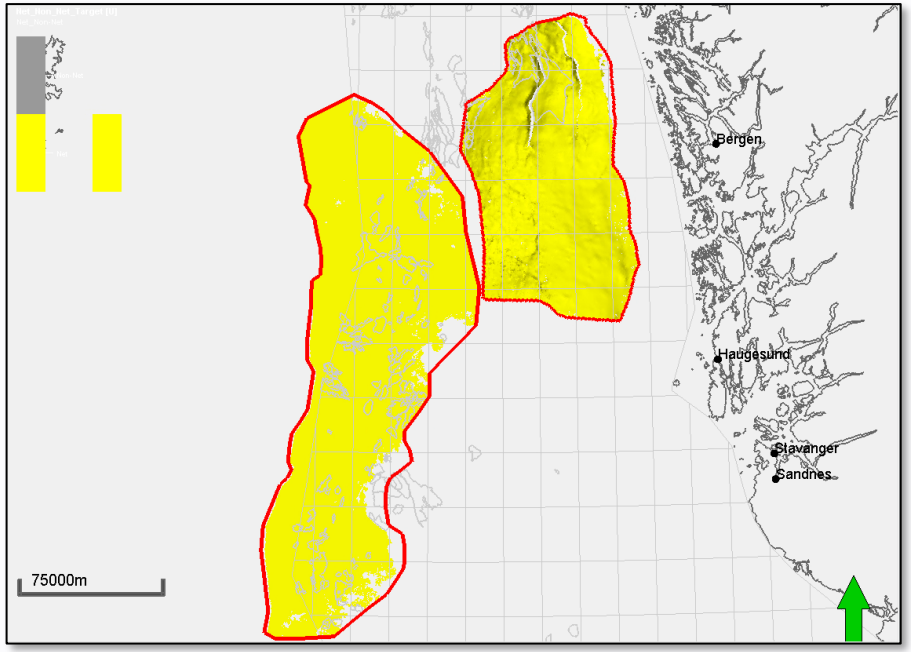
Extensive CO_2 Storage Potential

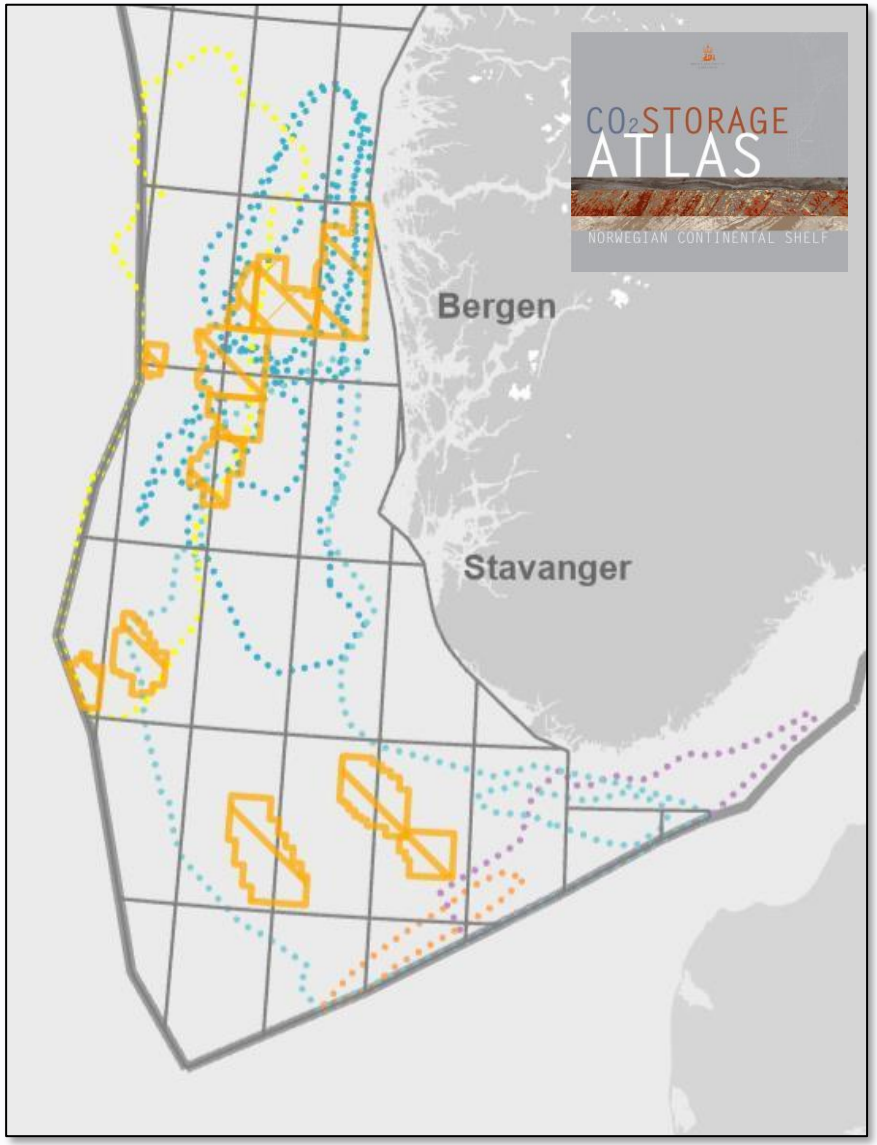
Proven basin-wide reservoir systems carrying substantial CO_2 storage potential

Large-scale reservoir models for dynamic modelling of regional aquifers – available to the public

Regional understanding of pressure development is key to optimize the storage potential

The models can be used to investigate how induced pressure and CO_2 plume is developing within regional hydraulic units





Norwegian Regulations on Pressure Interference

Norwegian CO_2 Storage Regulations:

§ 5-3 C

Pressure interactions between licenses may not compromise each site's ability to meet the requirements of the storage regulations

§ 5-4

The operator shall monitor the injection facilities and the storage complex

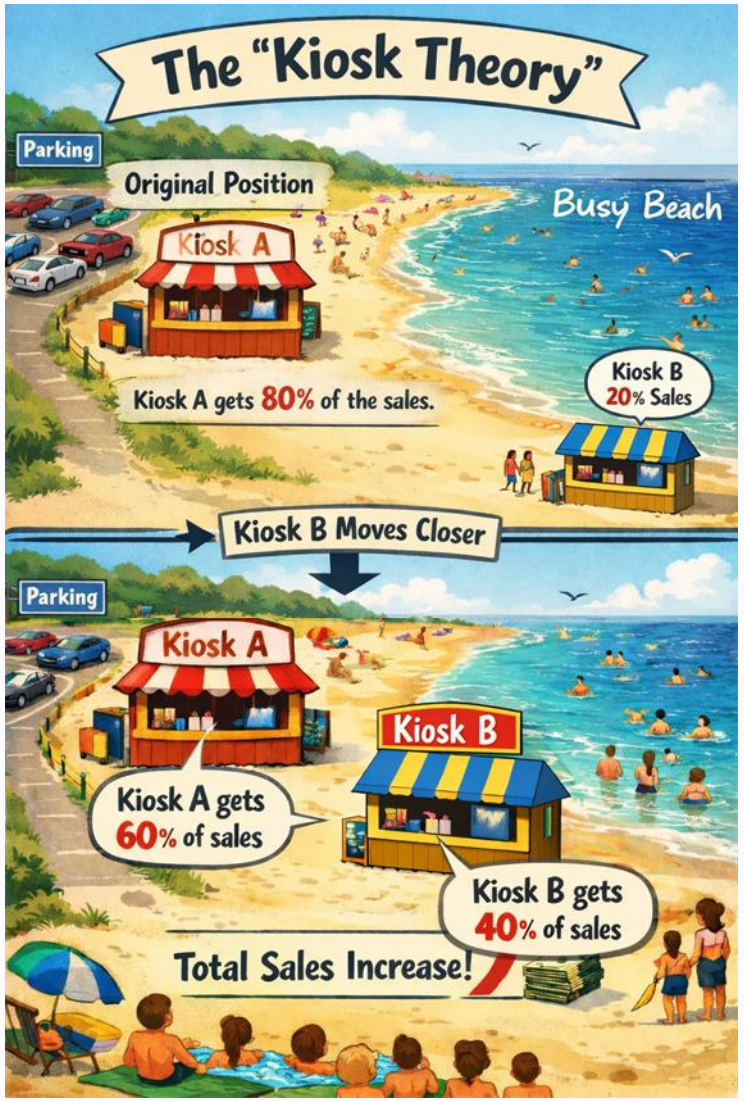
§ 5-11

Coordinated storage of CO_2 when a hydraulic unit extends across multiple licenses/national borders

Authority Perspective

- Authority management solutions
  - Suitable detail level

  - All licenses must comply with storage regulation section 5-3 C and 5-11



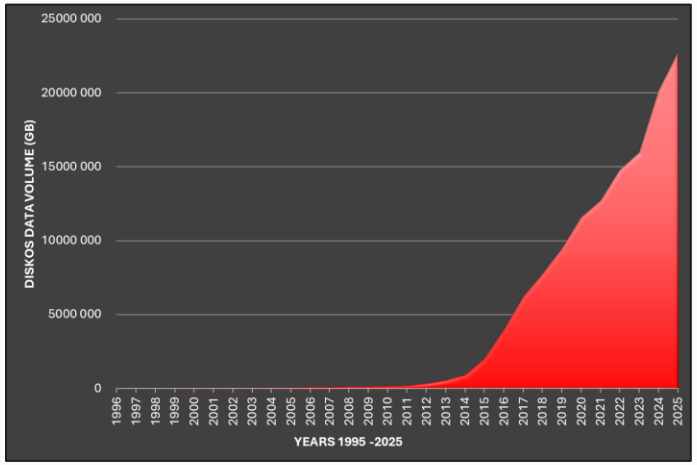
Data at Your Fingertips

- Open door policy – companies can nominate area for CO_2 storage when required
- Most NCS subsurface data eventually become publicly available
  - Seismic and wells
  - CO2 atlas
  - Production data
  - Exploration play models
  - Aquifer models
  - Relinquishment reports
- NCS data repository is hosted by NOD through the Diskos database
- Transparency is a key principle of Norwegian data management
- Data sharing creates strong cross-sector synergies
- Compete on knowledge, not data access

Amount of data stored in the Diskos database, where approx. 90 % is publicly available

Total data stored is more than 22 Petabyte (22.747 TB)

Seismic data		
	5 810	Seismic Surveys
	11 280	Navigation sets
	83 226	Seismic Datasets
	93 589	Seismic Documents
Well data		
	12 032	Wellbores
	5 512 656	Well Files
Production data		
		Monthly production data per field
		Monthly production data per well



Summary

- The Frigg–Heimdal model helps assess coexistence feasibility between petroleum activities and CO_2 injection operations.
- Regulations ensure, resource management with flexibility for project-specific needs.
- CO_2 injection forecast limitations is based on customer supply not storage capacity
- An open-door policy allows companies to nominate CO_2 storage areas, promoting timely development and innovation.

THANK YOU FOR YOUR ATTENTION

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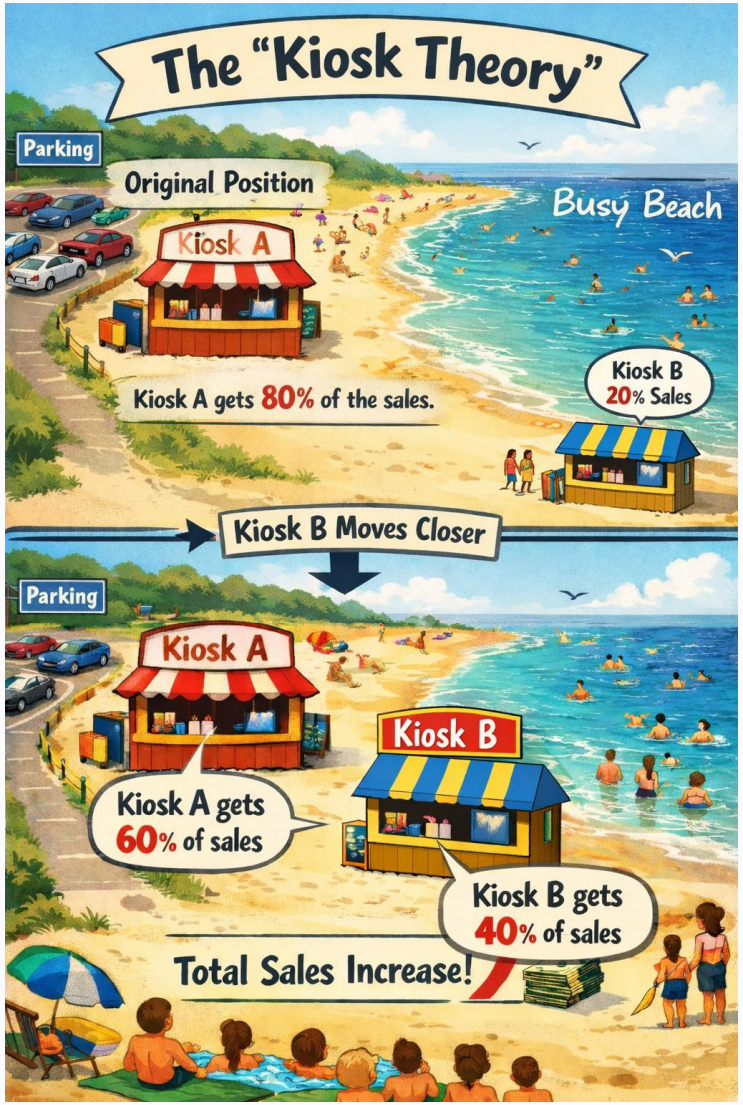
SODIR.NO/EN

- Trykk vil som regel være en begrensende faktor for CO2-lagringsprosjekter
- Flere næringer som påvirker hverandre trykkmessig
- Dialog med næringen og myndigheter i Nordsjøbassenglandene
- NO/UK/DK har veldig likt forvaltningsrammeverk for utnyttelse av trykk på tvers av tillatelser, hvor næringen ønsker mer klarhet og forutsigbarhet.



Resource Optimation

The information during operating phase, like pressure changes from injection breaks could potentially be used to determine pressure interference – although there are challenges with signal/noise and the long delay of pressure propagation at a distance. In theory, the information of connectivity and pressure interference from other injecting activities could be determined by analysing the pressure behaviours of the pressure responses during injection periods.

- Resource optimization may also imply CO2 migration control in addition to pressure limitations

As for the current regulation of resource optimisation principles, these should be further clarified. The CO_2 Storage Regulations do not refer to resource optimisation as such, but states that the objective is to provide "*environmentally secure storage of CO_2 as a measure to counteract climate change*"[1]. However, one may argue that this objective implies that the storage capacity for CO_2 should be optimized by authorities for society at large. Although "*optimisation*" is not a term used in the CO_2 Storage Regulations, the authorities clearly consider the capacity in the subsurface to sequester CO_2 to indeed be a "*natural resource*"[2].