

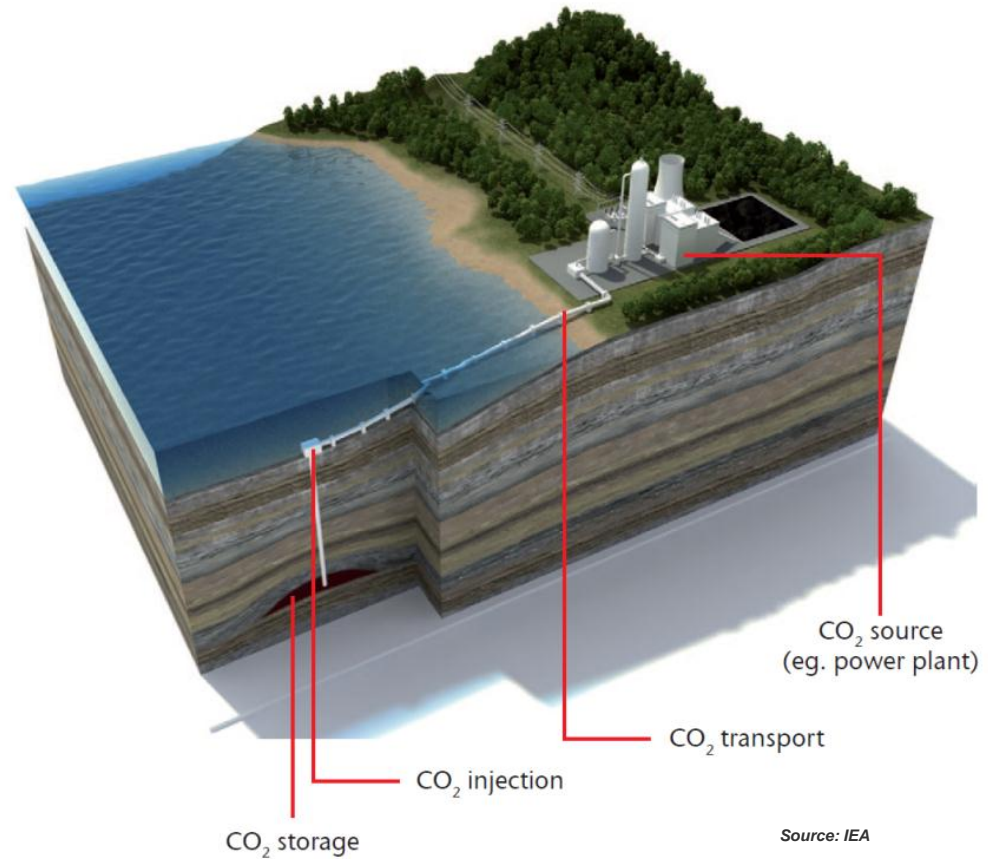
Mapping of Geological CO₂ Storage Sites – an overview

Tor Fjæran – President Director Statoil Indonesia

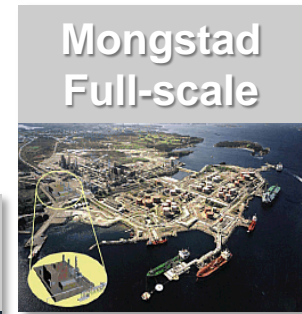
CCOP EPPM Seminar, Bali - September 12-14 2012

Outline

- Review Statoil **activities** within CCS with emphasis on CO₂-storages
- Describe key CO₂ storage **principles**
- Assess the **permanence** aspect
- Statoil **mapping** initiative
- Closing **remarks**



Statoil – a CCS front runner



Statoil's CCS projects
An Industrial Approach to the Climate Change Challenge

1996-

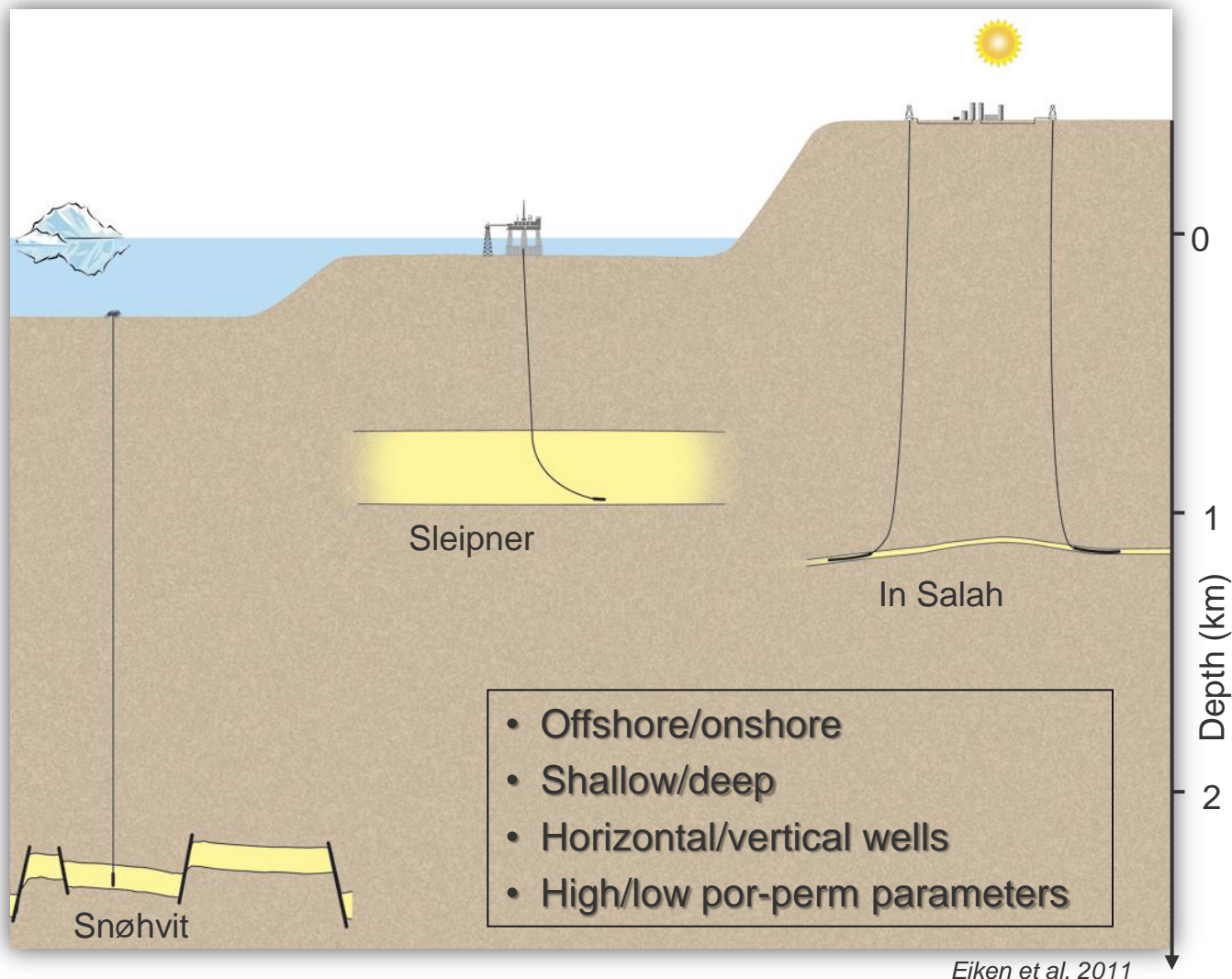
2004-

2008-

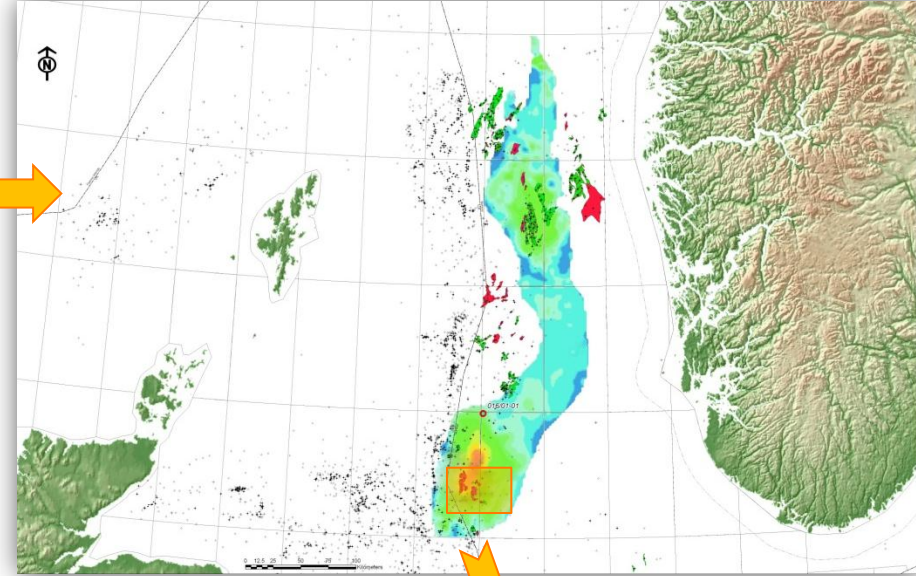
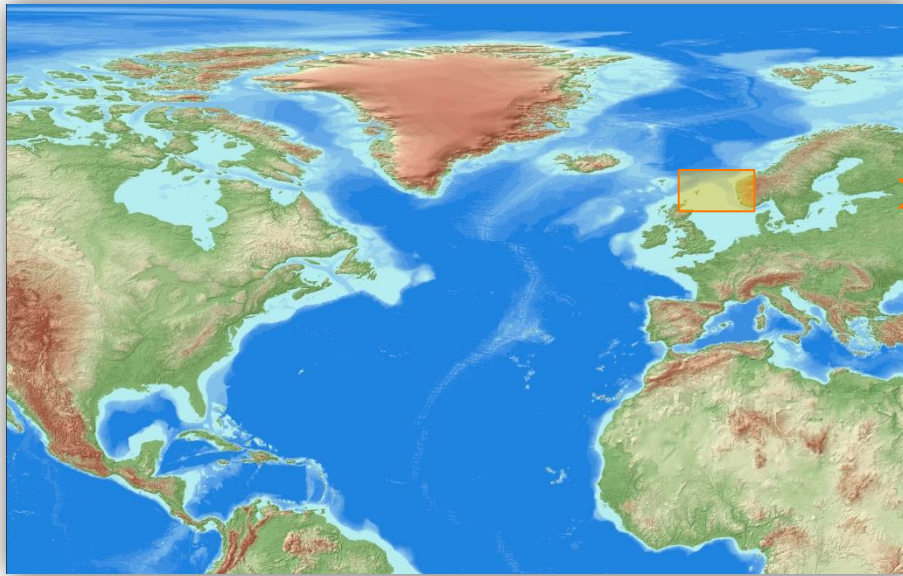
2012-

?

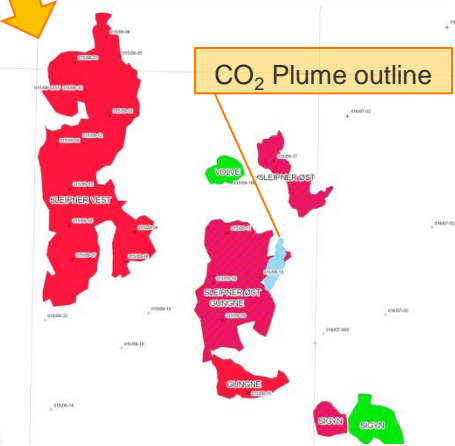
Statoil's diverse storage experience



Sleipner – Setting the scene

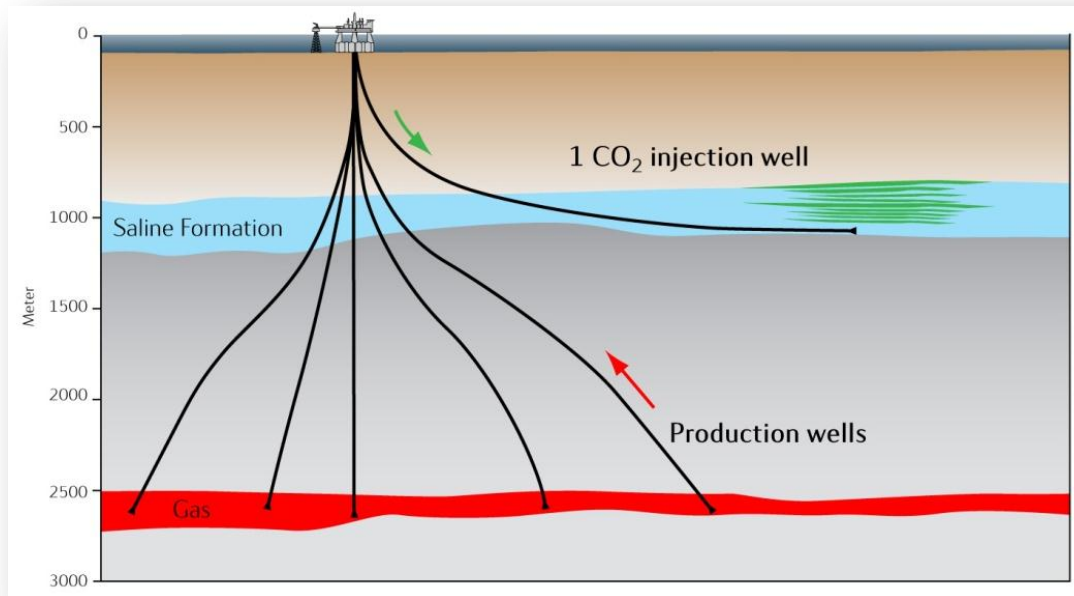


- CO₂ from the Sleipner field is stored in the Utsira Formation, North Sea
- Reservoir unit at 800-1100 m depth
- One CO₂ injector - 36 meter perforation at ~1012 meter (TVD)
- Injected gas is ~98% CO₂
- >13,5Mt CO₂ have been injected (as of Sept. 2012, ~0,9M per annum)



Sleipner - Key characteristics

- Higher CO₂ content (4-9%) than the gas export quality specification allows (2,5%)
- Capture absorption at 100 bar, 60-80°C, Amine 45wt% MDEA
- Decision to store the captured CO₂ was based on environmental consciousness, willingness to try out new technology and the CO₂ tax incentive



Sleipner - Experience operating a CO₂ storage

Operational Performance

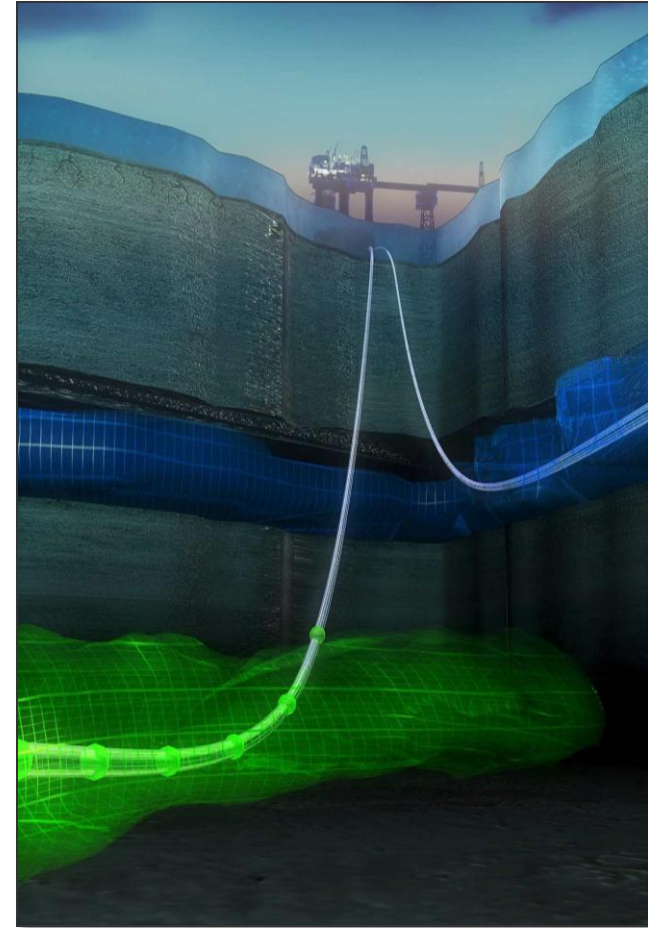
- Stable wellhead pressure ~65bar
- Wellhead temperature held at 25°C

Monitoring Data

- Wellhead pressure and flow rate is monitored continuously
- Gas composition samples are taken intermittently
- Seven time-lapse (4D) seismic surveys
- Two repeat gravimetric surveys
- Electromagnetic survey
- Seabed surveys (2006 & 2011)

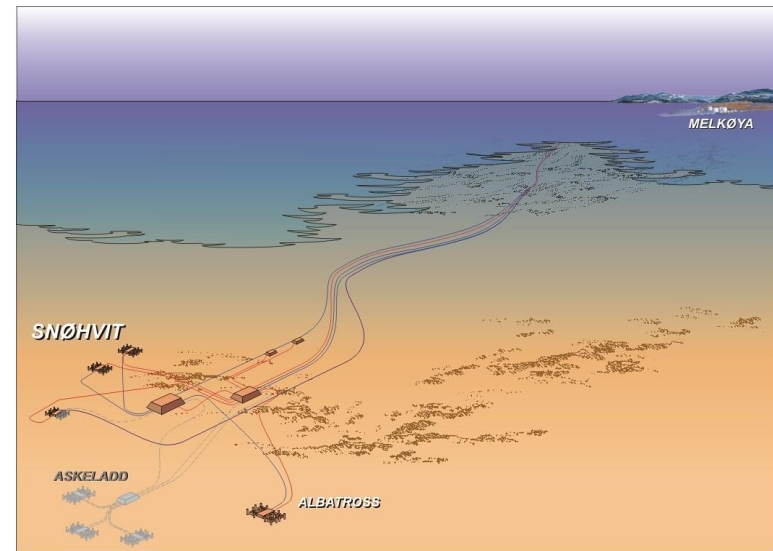
Key subsurface uncertainties

- Role of internal Utsira shale layers, plume propagation
- Reservoir and wellbore processes
- Maximum injection capacity (rate)



Snøhvit - Overview

- Snøhvit LNG project, in the Barents Sea offshore Norway
- CO₂ is captured onshore and transported in a ~140 km subsea pipeline to a subsea template
- The CO₂ is injected at a depth of 2600m into the Tubåen/ Stø Formations (below the gas reservoir)
- Injection of CO₂ started in 2008, at a rate of ~ 80 t/hr
- Gradual rise in reservoir pressure indicated limited injection rate/capacity
- Well intervention operation successfully completed May 2011

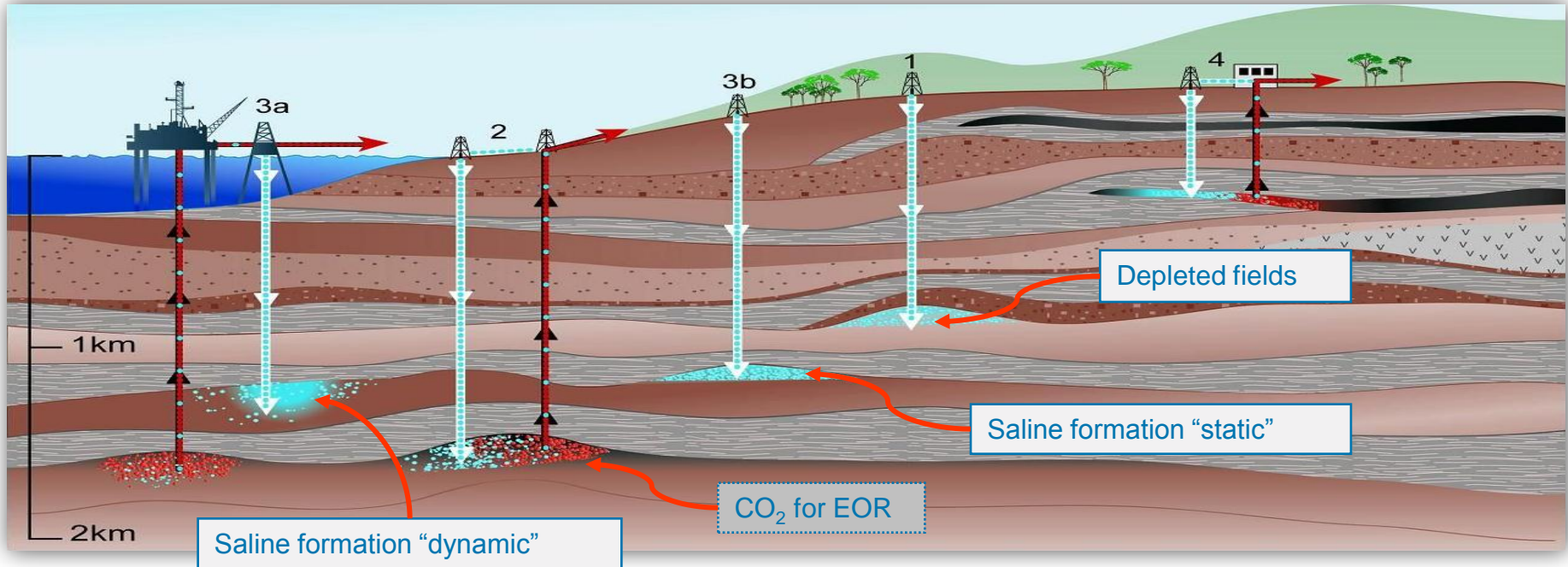


In Salah – Overview

- In Salah is multiple gas field development project in central Algeria (JV with Sonatrach and BP)
- CO₂ contents in the gas fields ranges between 1% and 9%
- CO₂ is separated from the gas and injected into the down-dip aquifer of the Carboniferous sandstone at Krechba (1900m)
- CO₂ Injection started in 2004 and since then over 3.8 million tonnes of CO₂ have been stored
- A comprehensive monitoring programme has been developed - In Salah JIP



CO₂ Storage options and principles



Capacity

Injectivity

Containment

Monitorability

Volume estimation

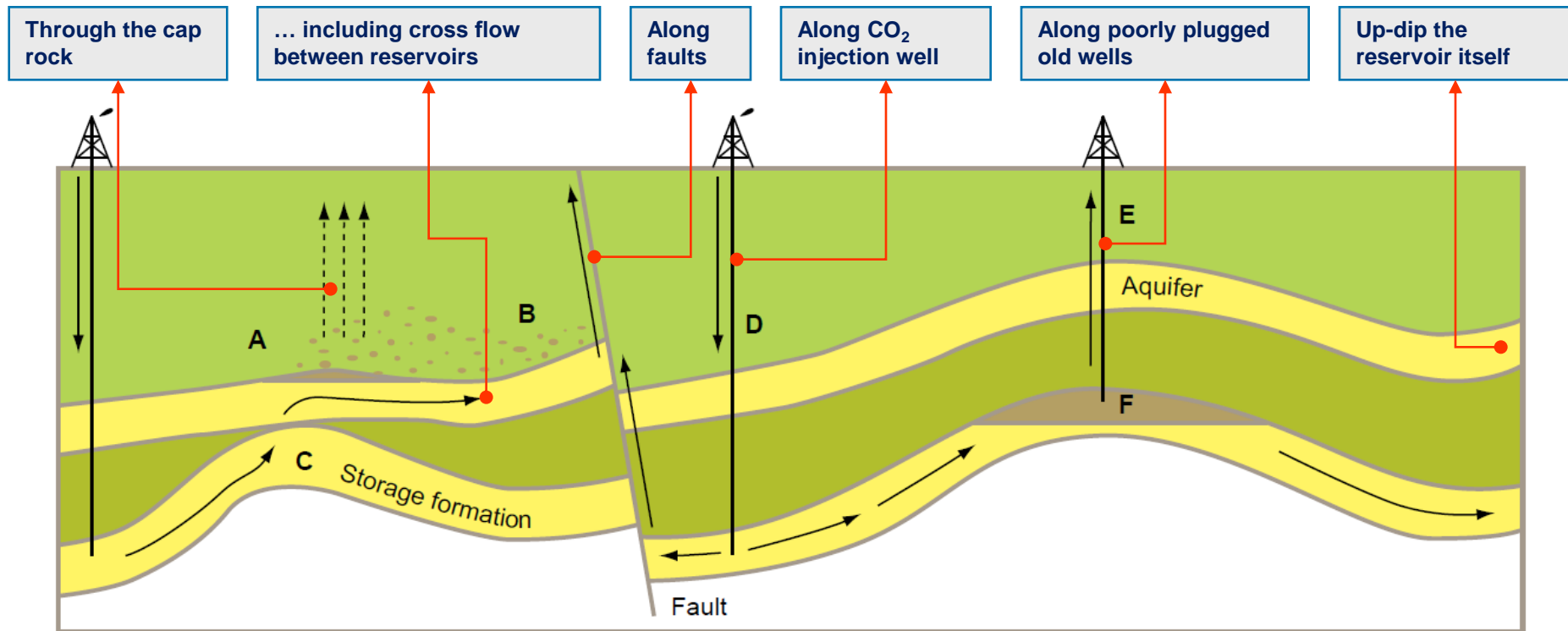
Quality evaluation

Capability assessment

Storage performance

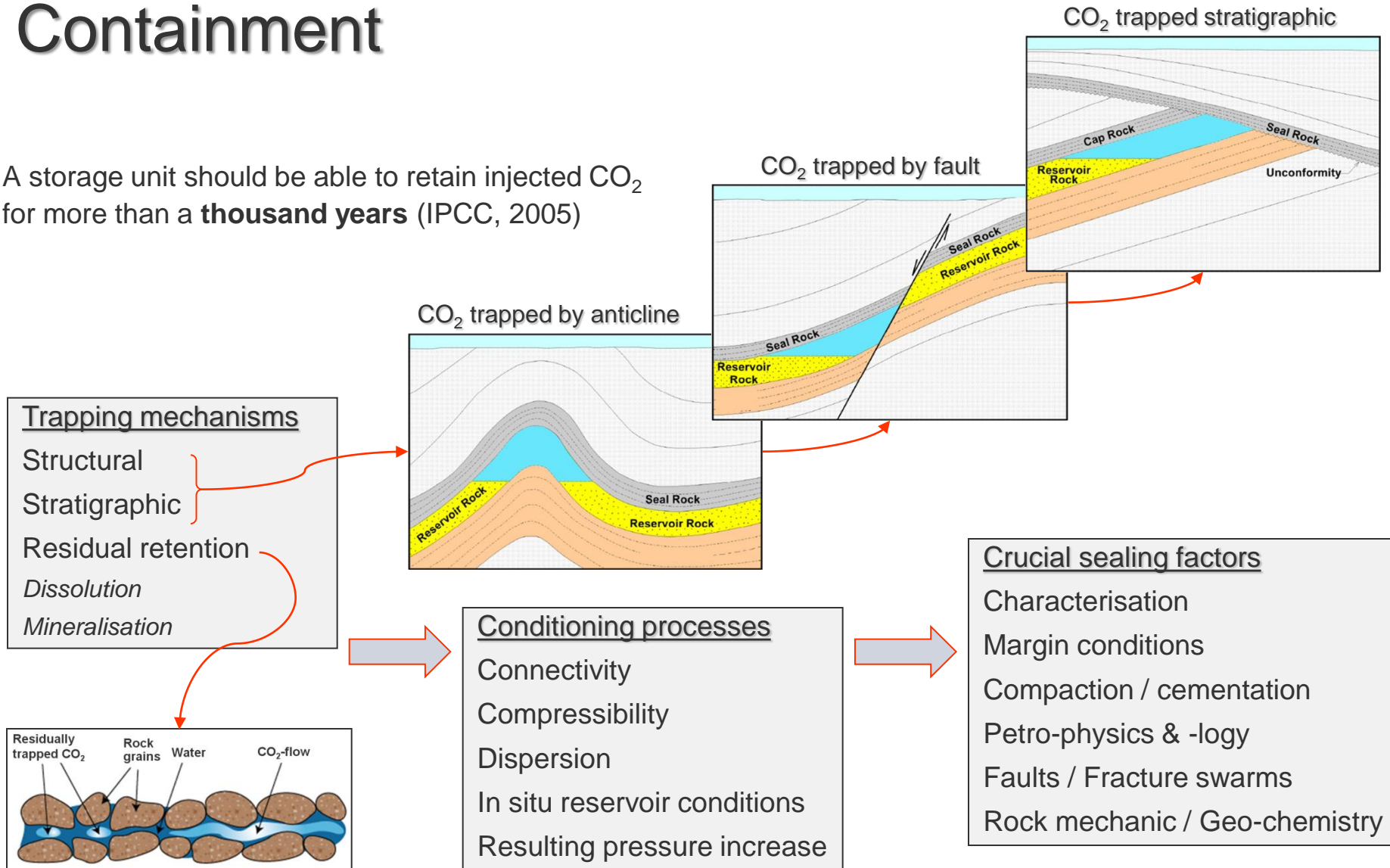
Permanence – Assure credibility

- We need to understand expected CO₂ movement (**migration**) and trapping (**retention**) to ...
- ...assure credible safe storage of the CO₂ injected
- Need to ensure an acceptable risk (probability and consequence)



Containment

- A storage unit should be able to retain injected CO₂ for more than a **thousand years** (IPCC, 2005)

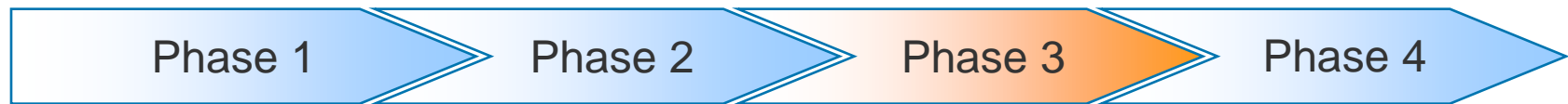


MOST – Mongstad Storage

Ambition

Map and mature suitable reservoirs for storage of CO₂ (own or others) for development and operation by Statoil where this creates a *business opportunity*

Become Mongstad storage operator



- Planning/ manning
- Methodology review
- Risk management
- Database construction

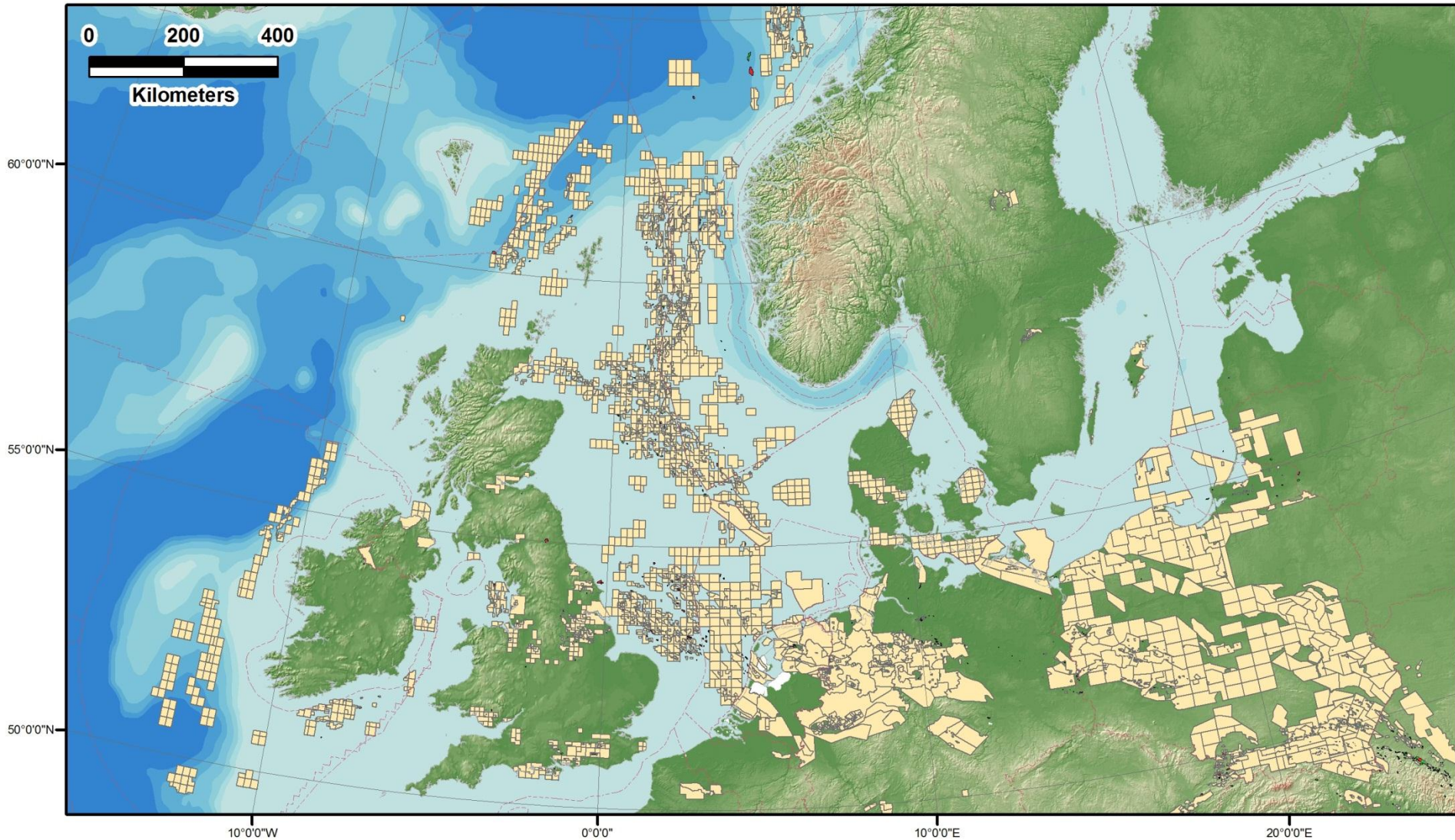
- Screening
- Desktop studies
- Prioritisation
- Establish a portfolio

- Characterisation
- Uncertainty study
- License application
- Exploration drilling

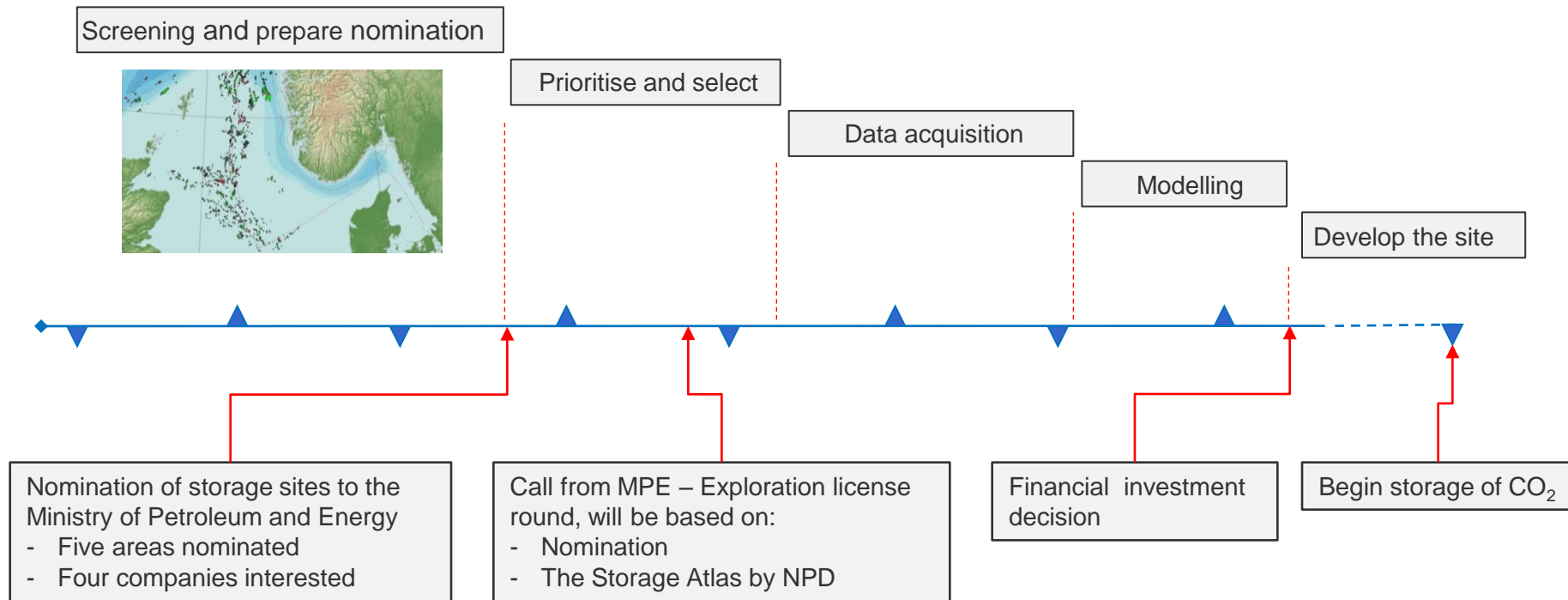
- Feasibility
- Development solution
- Expected value
- Customer review



The North Sea Basin – Rationale and data



CCS in Norway – possible way ahead

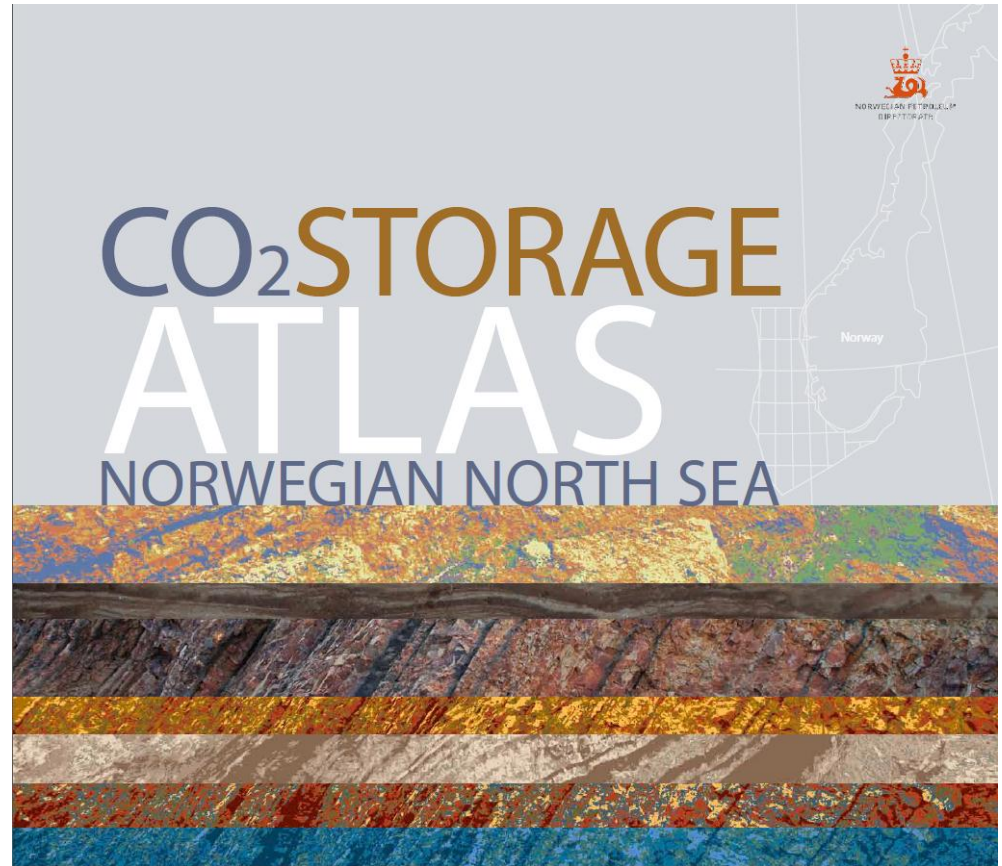


- Nominated areas for CO₂ licensing 3Q 2011 – Statoil nominated 5 areas
- Regulatory framework Norway – to be sent for hearing 3Q 2012
- License round believed to be opened 2012/13

CO₂ Storage Atlas – Norwegian North Sea

CONTENTS

- 1. Introduction**
- 2. Petroleum activity in the North Sea**
- 3. Methodology**
 - 3.1 Geological storage
 - 3.2 Data availability
 - 3.3 Workflow and characterization
 - 3.4 Estimation of storage capacity
- 4. Geological description of the North Sea**
 - 4.1 Geological development of the North Sea
 - 4.2 Geological description
- 5. Storage options**
 - 5.1 Saline aquifers
 - 5.2 Abandoned hydrocarbon fields
 - 5.3 Producing fields (EOR)
 - 5.4 Summary of aquifer evaluation
- 6. Monitoring**



<http://www.npd.no>

Publications, CO₂ Storage Atlas

Carbon Capture and Storage - closing remarks

- We focus on **safe** and **technically, environmentally** and **commercially, sound** storage
- Our aim is to evaluate participation in a **future business** within CO₂-storage
- We envision a future transport **infrastructure** (pipeline) that includes the Norwegian sector of the North Sea Basin – we see however that a **step-wise approach** may be necessary with storage closer to the CO₂ source in an initial phase
- We are assessing both **abandoned fields** and **saline formations (preferable)**
- We welcome a regulatory framework that provides **predictability**
- We appreciate an international agreed **code of conduct**
- We welcome all efforts in **bridging the gap** between **cost and value** as this is a prerequisite for extensive roll out and **commercialisation** of CCS



There's never been a better
time for **good ideas**

CO₂ Storage in Statoil

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