

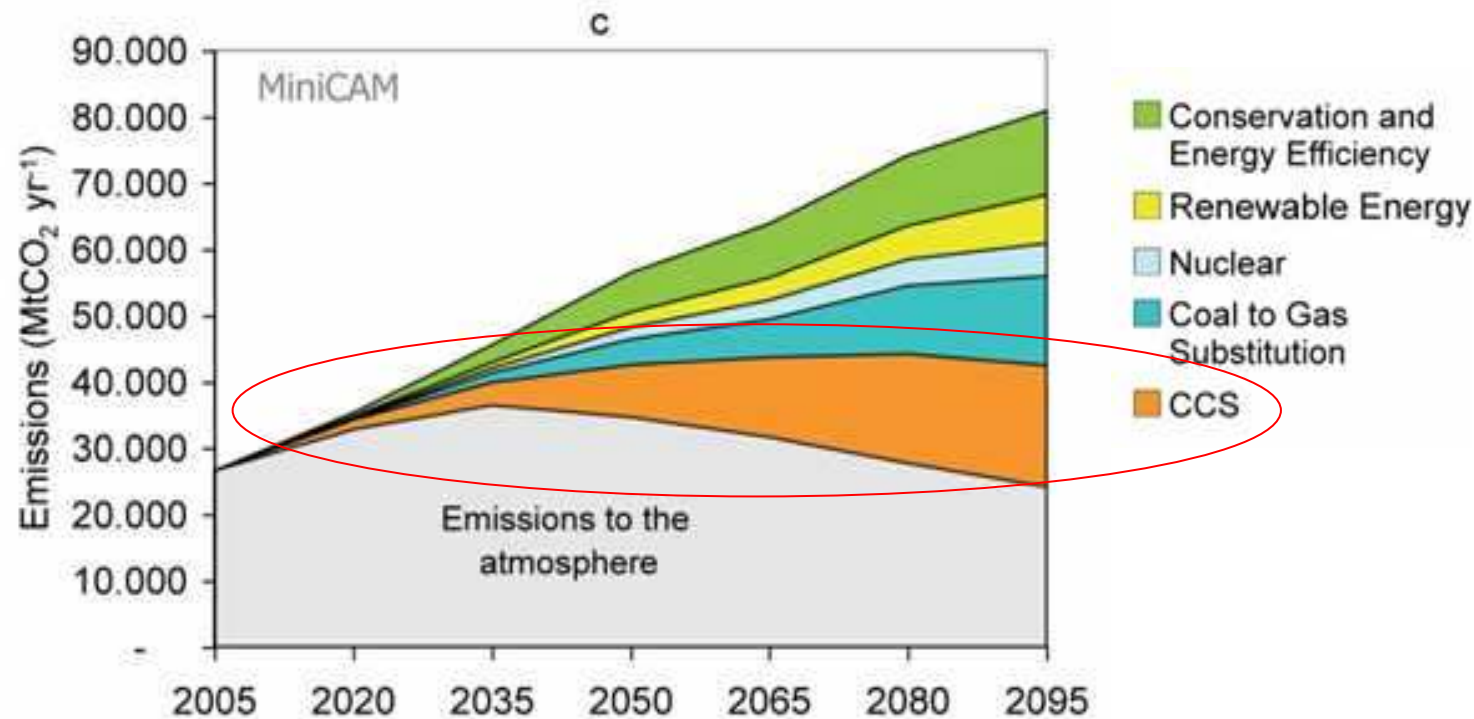


CO₂ Storage – Why is it safe?

Tore A Torp, Dr.ing.

Adviser CO₂ Storage, StatoilHydro, Norway

Market size of CO₂ capture & storage (CCS)



Modelling indicates that CCS will play an important part in climate change mitigation

Worst case scenario
is business as usual!

Need to get started now!



This is StatoilHydro

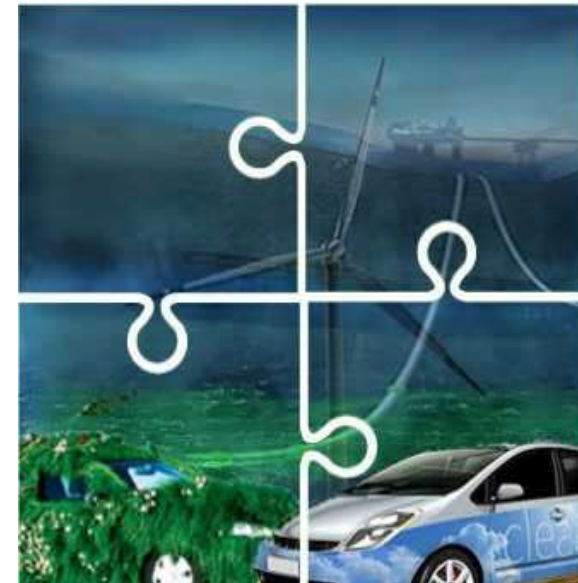
- Present in 40 countries
- 31.000 employees
- Production 1.7 MBBL o.e./day
- Largest deep-water operator
- 3rd largest net seller of oil



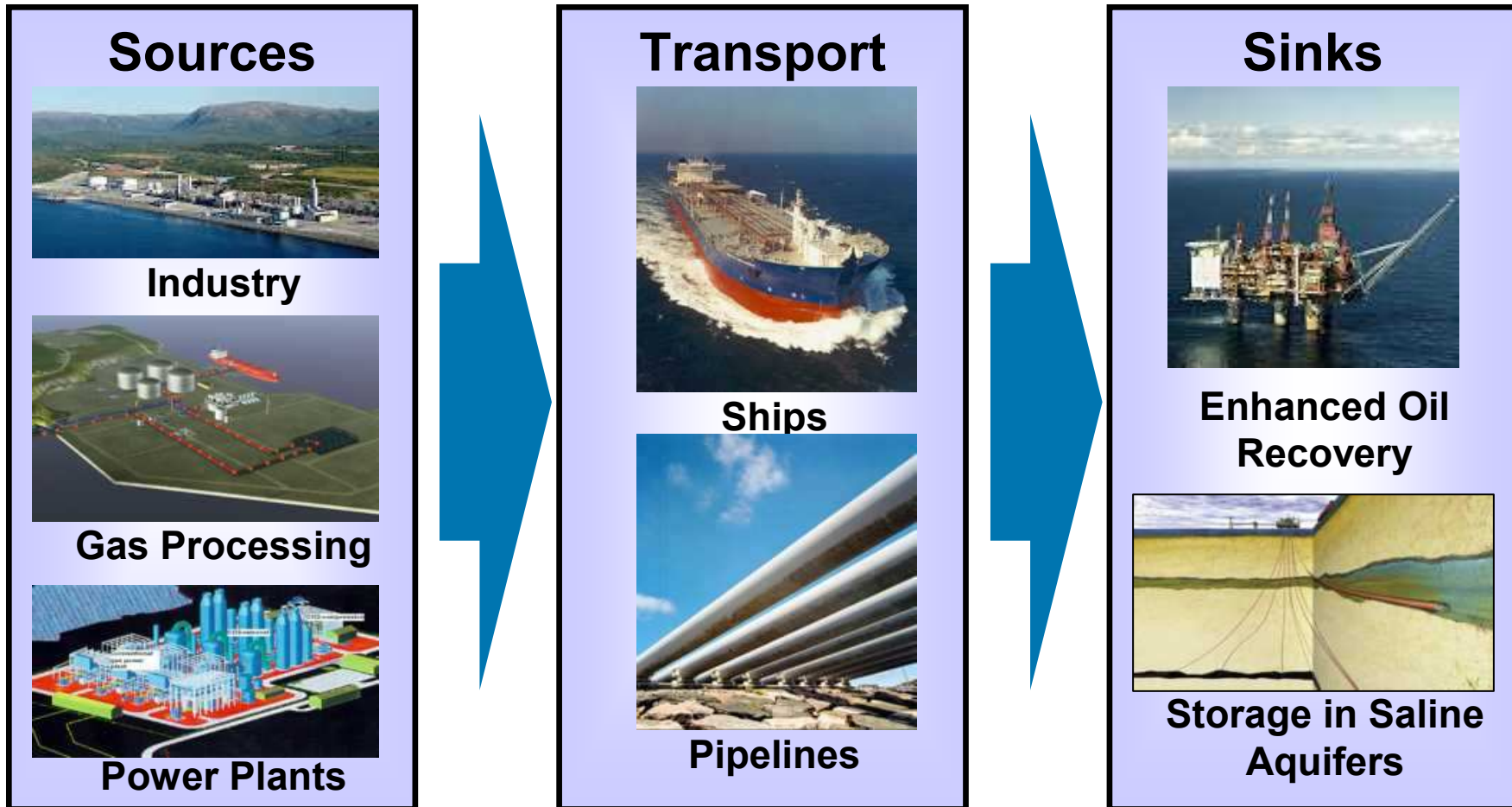
StatoilHydro's climate policy

StatoilHydro recognize the link between the use of fossil fuels and manmade changes in climate. We work actively to limit the environmental consequences of our activity.

- We will increase energy efficiency
- We welcome global mechanisms for carbon trading
- We will keep our position as a world-leader in CO₂ capture and storage
- The cornerstones in our new energy portfolio will be offshore wind and biofuel



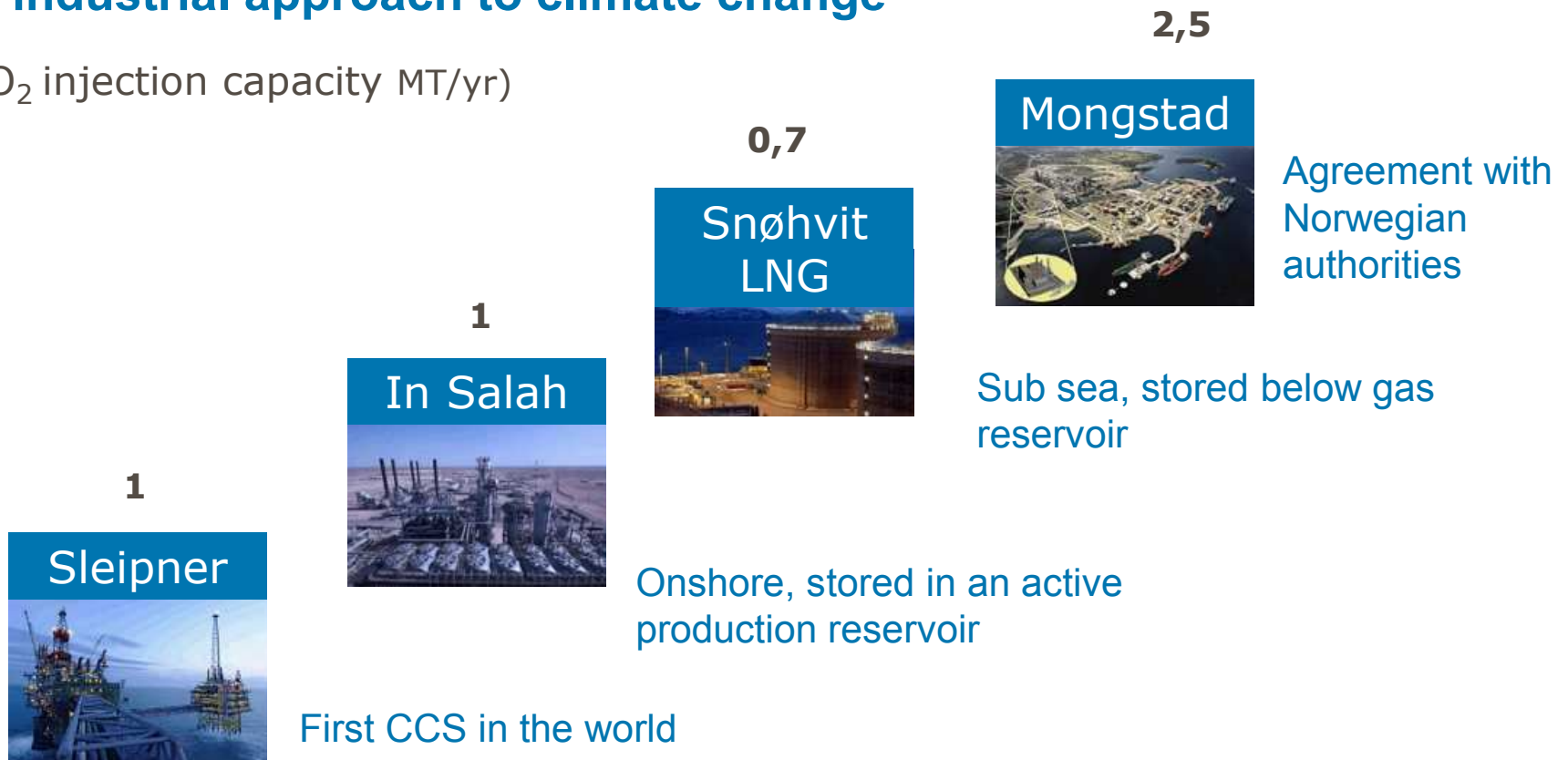
CO₂ Value chain



StatoilHydro's CCS projects

An industrial approach to climate change

(CO₂ injection capacity MT/yr)



1996-

2004-

2007-

CO₂ Capture and Storage (CCS) needs two legs to walk!

Leg 1: **TRUST** in Storage

- Methods from oil and gas industry
 - Geology varies from place to place
- **More demonstrations**

Leg 2: **COST** of Capture

- Energy use
 - Costs
- **Better technologies**

Pace: CO₂ Transport

- Pipeline
 - Ship
- **Large projects**

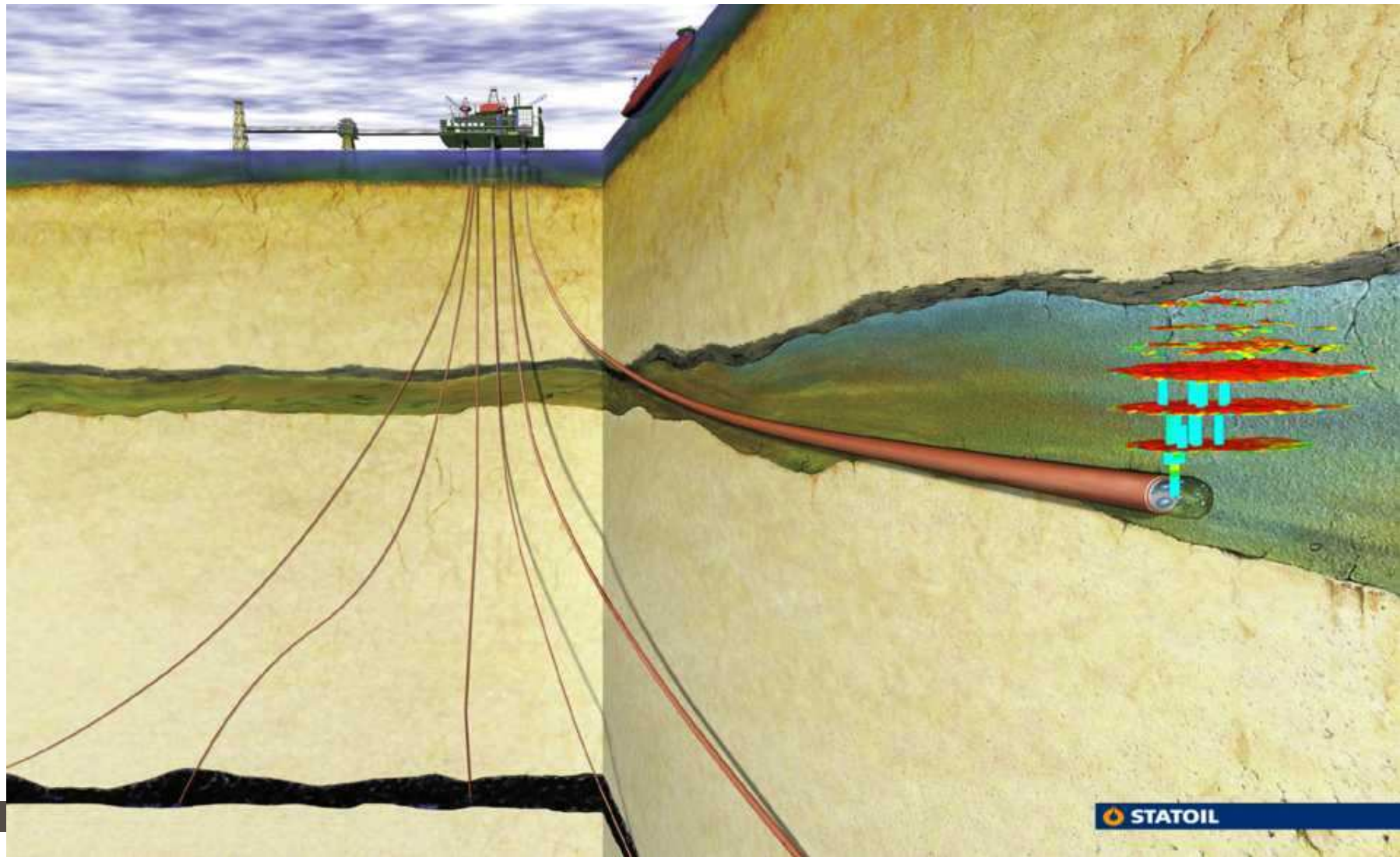


Sleipner CO₂ injection:

- Decided in 1992
- In operation since 1996
- 1 million tonne CO₂/år

Time Magazine,
17. May 2004

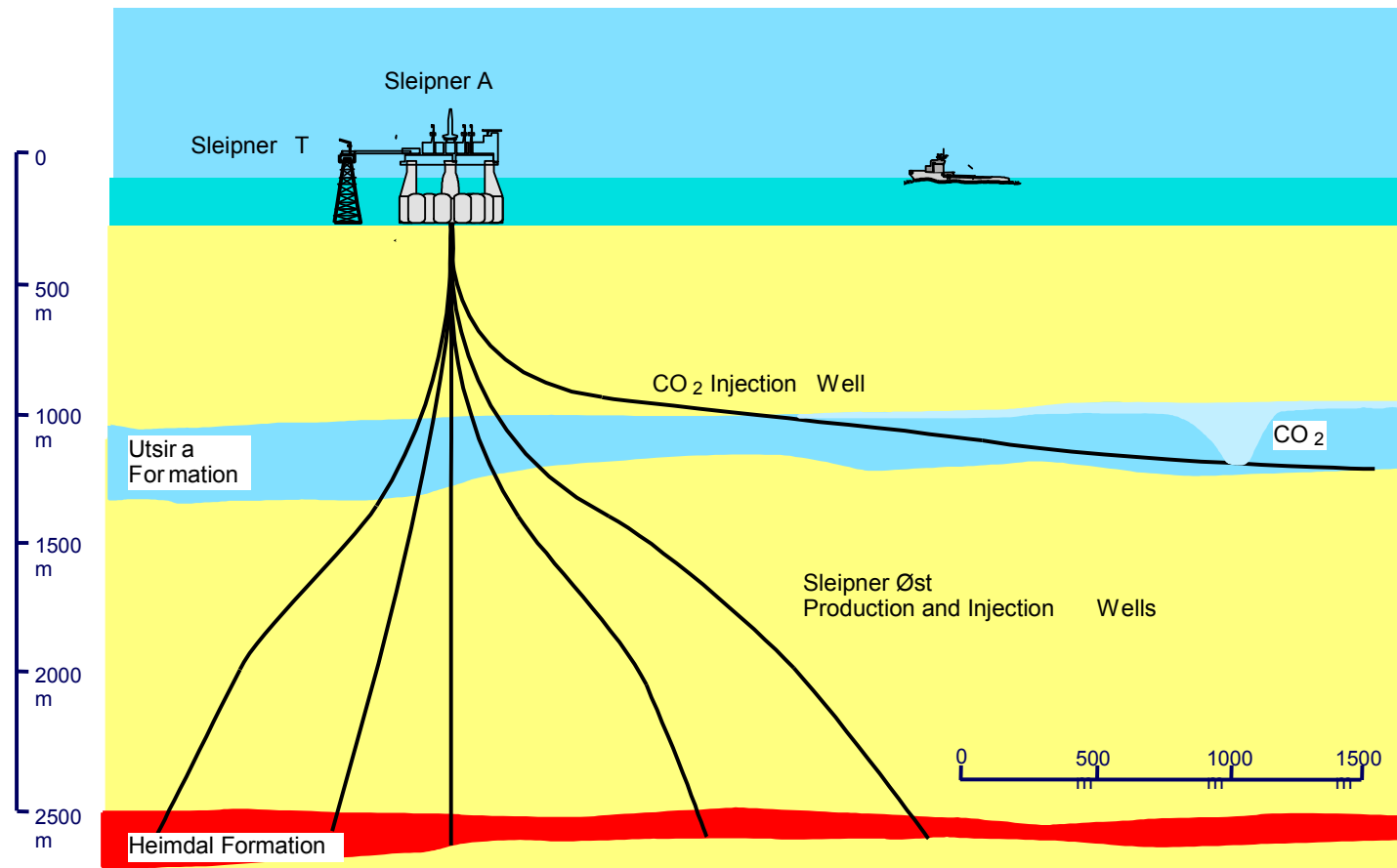
Sleipner CO2 Injection



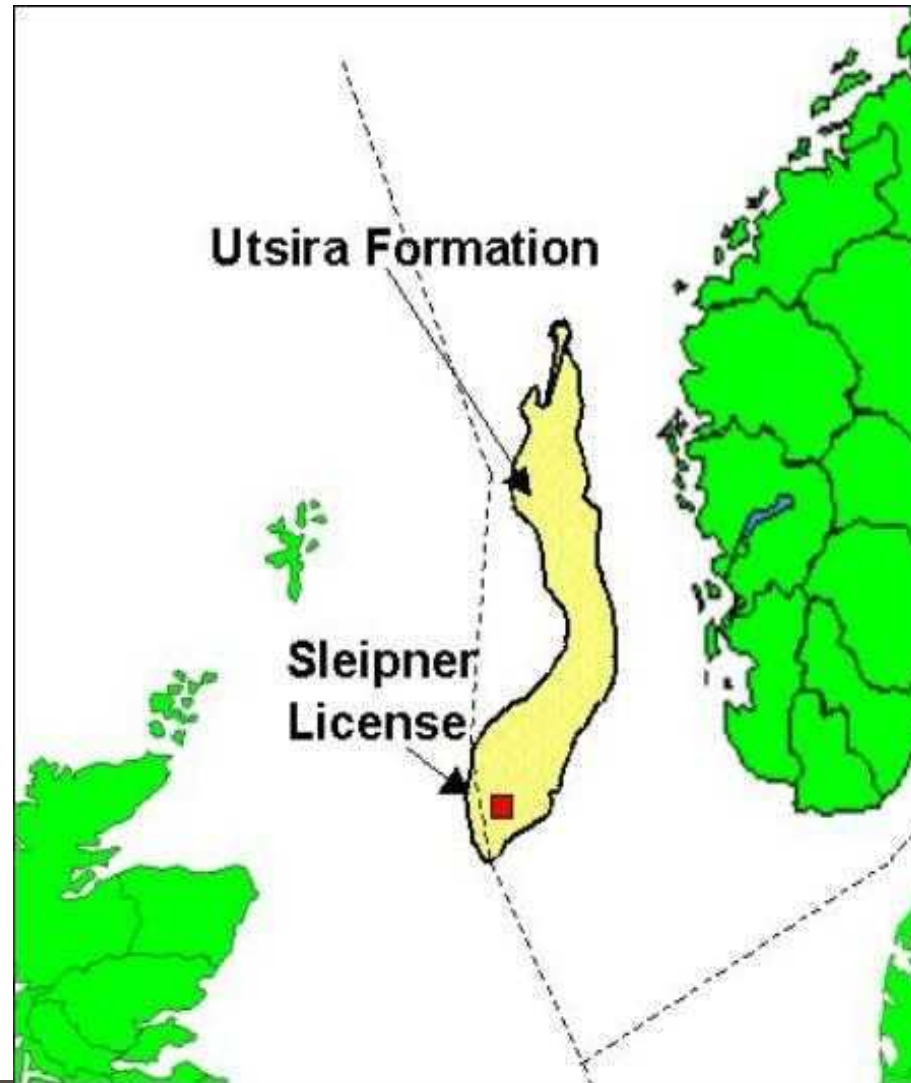
STATOIL

StatoilHydro

CO₂ Injection Well in "Utsira"



The Utsira Formation



SALINE AQUIFER CO₂ STORAGE PROJECT

Statoil
BP
ExxonMobil
Total
Norsk Hydro
Vattenfall

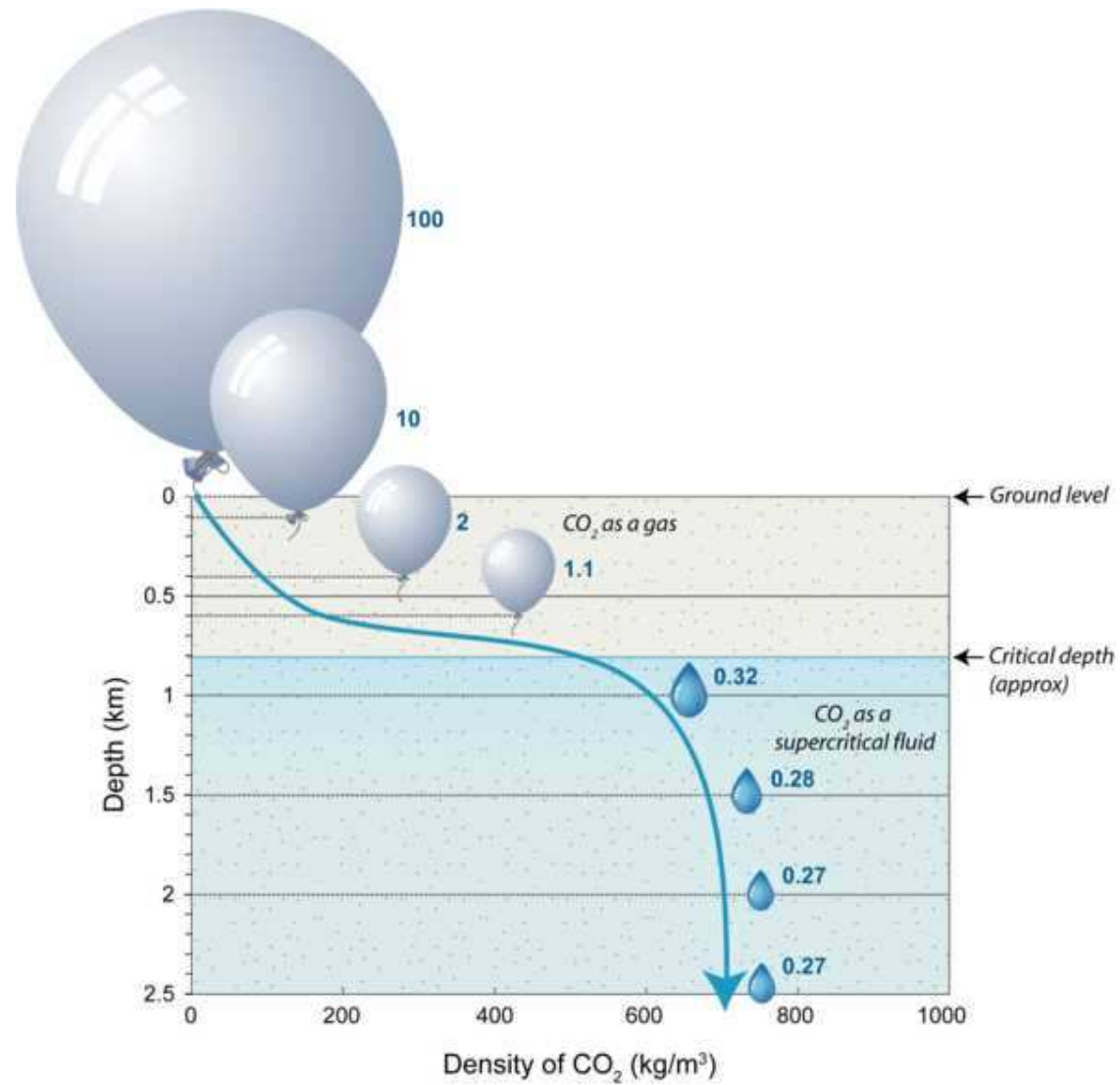


BGS
BRGM
GEUS
IFP
NITG-TNO
SINTEF

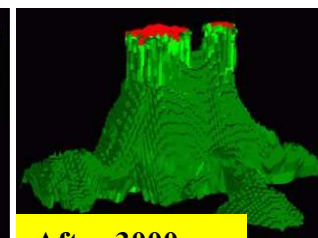
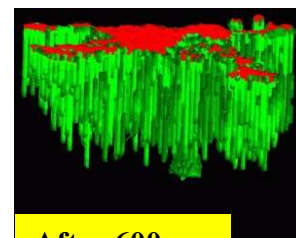
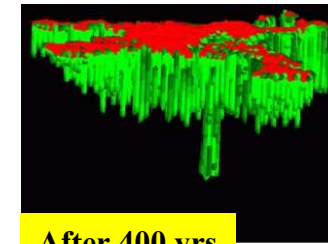
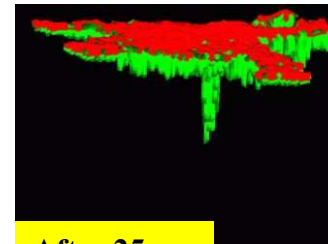
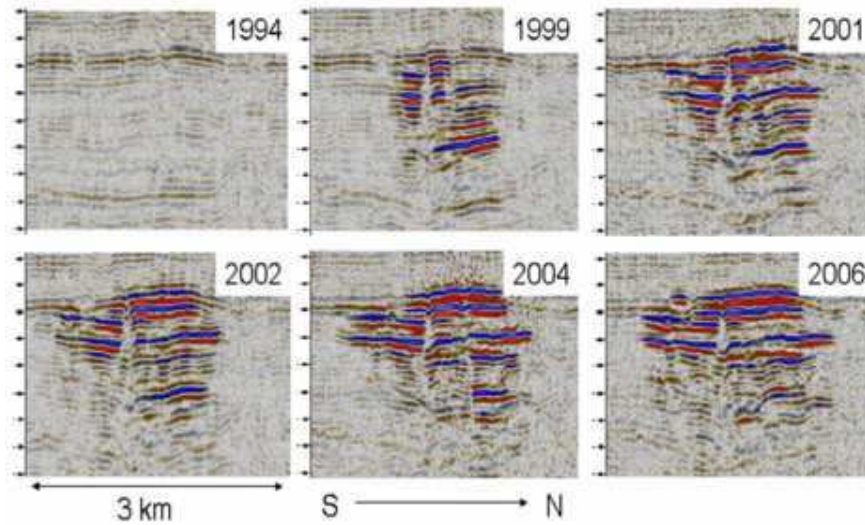


IEA Greenhouse Gas R&D Programme
Schlumberger Research
NO, DK, NL, FR & UK Authorities





Proof of concept through extensive monitoring and R&D programmes



StatoilHydro has developed gravimetric monitoring as a complimentary monitoring technique

- 4D and 3D seismic monitoring are expensive
- A supplementary monitoring technique would provide independent analysis and valuable research input



- **StatoilHydro in cooperation with leading research institutes have developed offshore gravimetric monitoring as a new technical solution**
 - Measure changes in density by monitoring of the seabed
 - Predict the distribution and amount of CO₂
- **The technology has been applied to Troll East, Midgard and Snøhvit**



SACS Project 1998-2002

WHAT WE DID ACHIEVE:

- **3D Seismic proven, Gravimetry tested**
- **Reservoir simulation tools partly proven**
- **Geology and Geochemistry of “Utsira” mapped**
- **Reason to expect the CO₂ to stay for thousands of years**

DOCUMENTATION

- **“SACS Best Practice Manual, 1.version.”**
- **Download from www.co2store.org, see page “SACS”.**

SAFETY STRATEGY

- **Prepare**
- **Detect**
- **Remediate**

What is keeping the CO₂ down?

Trapping Mechanisms

- Closure - from day one – faults?
- Micro-pore trapping - during injection - lasting
- Dissolution in water - sinking to the bottom – centuries
- Mineral binding - precipitating solids – centuries/millennia

Possible Leakage?

Leakage ways?

- **WELLS** - Corrosion of cement & steel
- Faults/Cracks – Overpressure critical
- Underground fluid mobility – Site specific

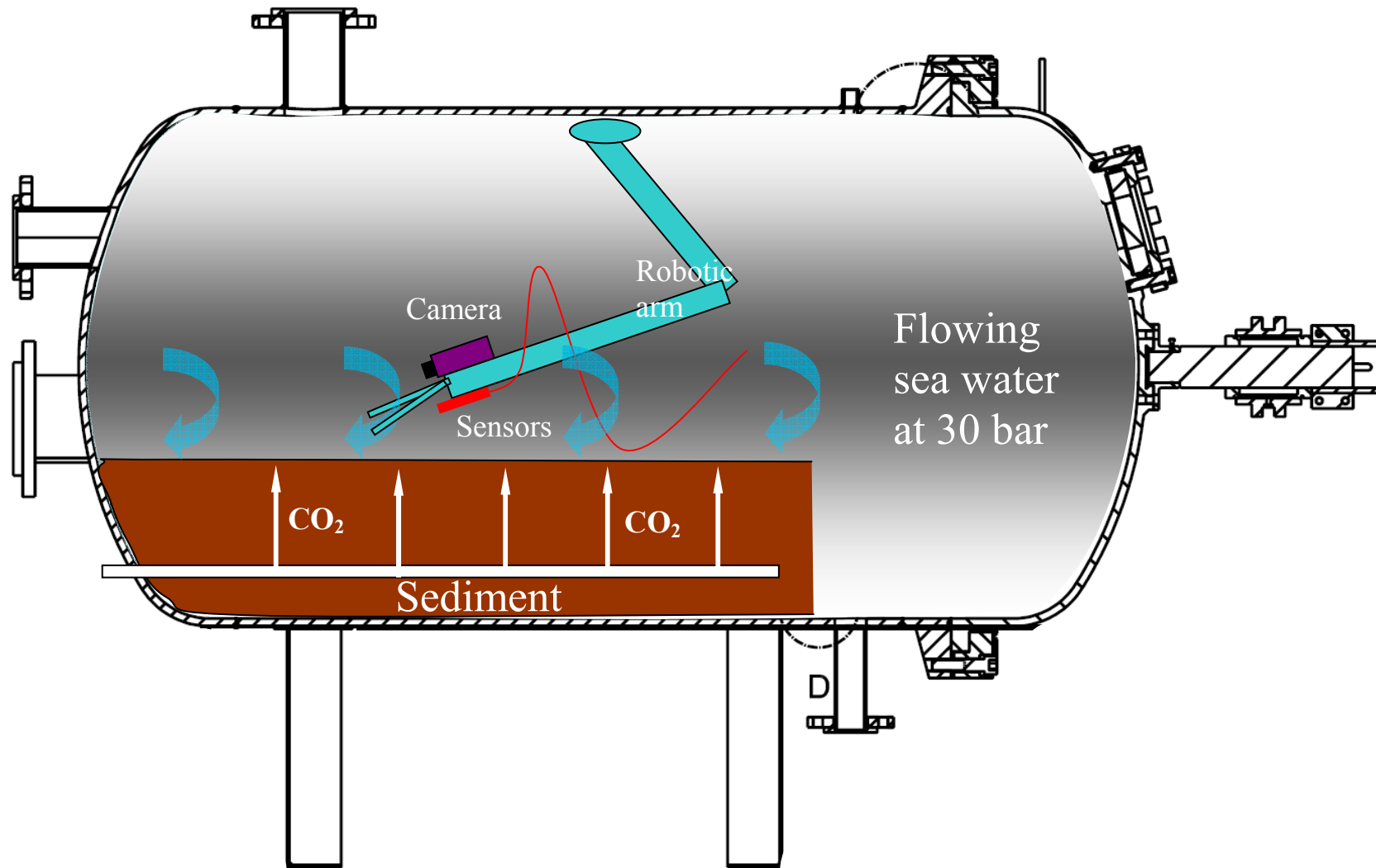
WHAT IF - COSEQUENCES?

- Land – on site - Known from previous experience
- Land – landscape – Analogues from volcanic areas
- Sea – free water – Known from previous R&D
- Sea – bottom – **We need to know more...**

Monitoring and safety over TIME?

- **Before start:** Site selection, Planning and Risk assessment => licence
- **During injection:** Monitoring – “Watch the barn doors” => report
- **Closure:** Monitoring and long-term risk => agreement
- **Post-closure:** Monitoring gradually less => hand-over

→ Safety against leakage will be better over time!



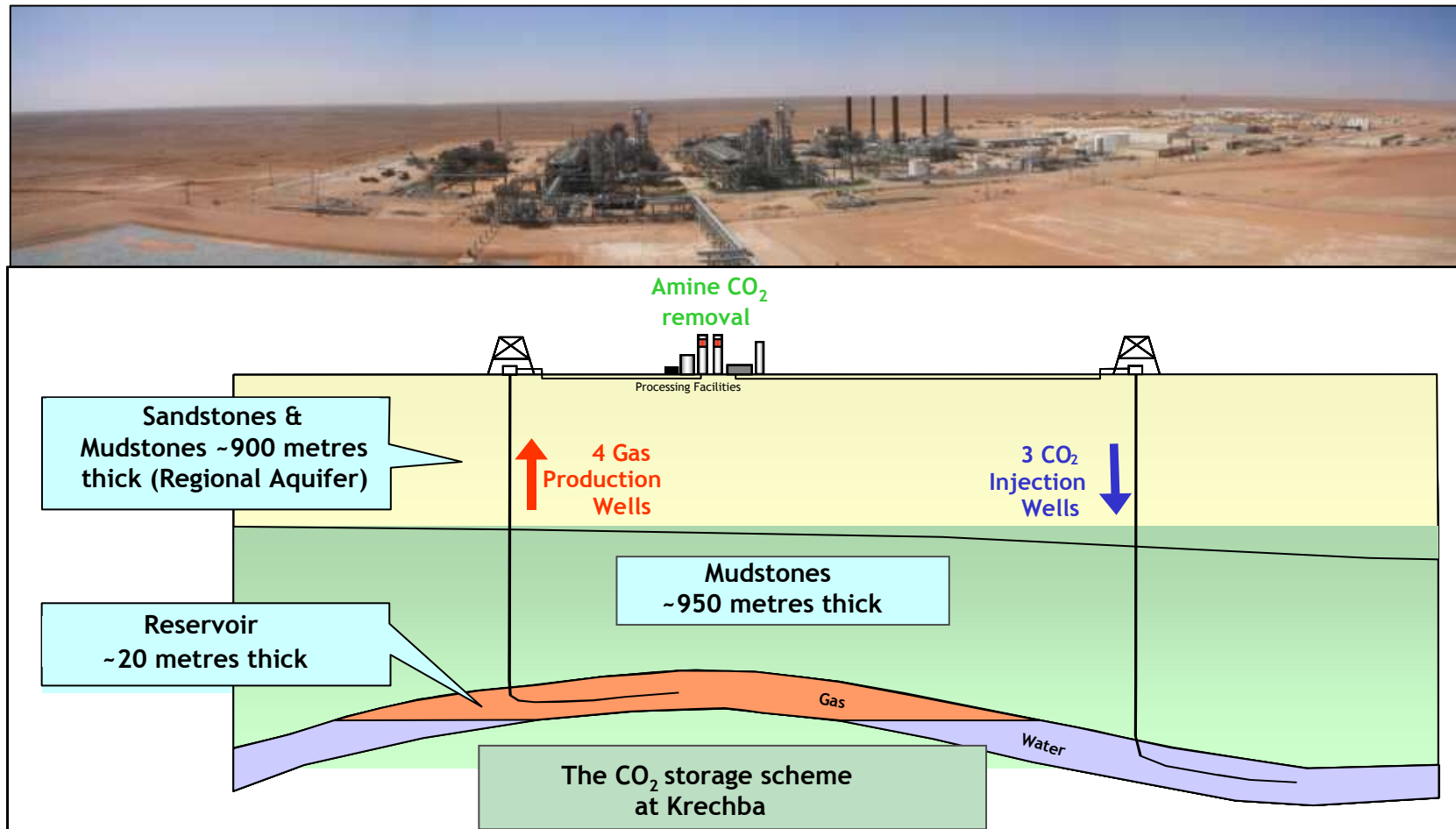


In Salah and Snøhvit LNG – the next CCS steps

- Started in 2004
 - CO₂ from natural gas
 - Separating and injecting 1,2 mill. tons CO₂ annually
 - Injection into reservoir aquifer
 - **Driver:** BP internal quota system
- Started in 2007
 - CO₂ from natural gas
 - Separating, piping and injecting 0,7 mill. tons CO₂ annually
 - Injection below reservoir
 - **Driver:** CO₂ tax



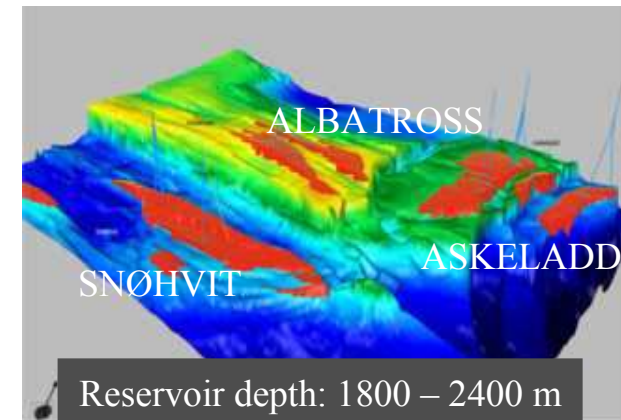
In Salah in Algeria



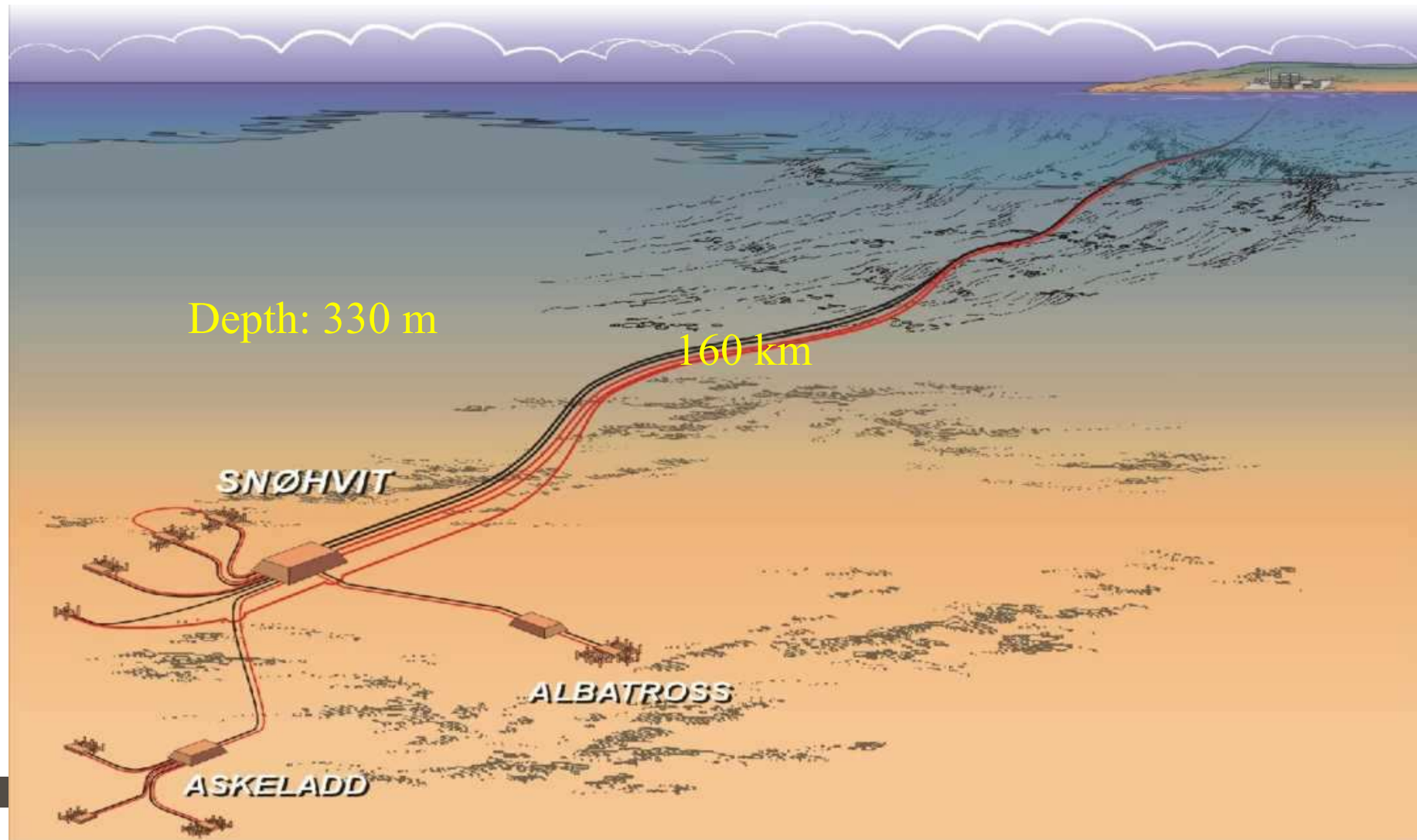
Snohvit

CO₂ capture, transport and storage in an arctic climate

- Snohvit is a full subsea development
- The gas is produced subsea
- Onshore gas processing and LNG facility
- The CO₂ content in the gas is reduced
- The CO₂ is stored in aquifer below gas field



Snøhvit – All subsea



CO₂ transport

Snøhvit pipeline is 153 km with diameter of 0.2 m



Mongstad Combined Heat and Power (CHP) station with CO₂-capture plant indicated



Summary and conclusions



- CCS is a key element in meeting the global climate challenge
- CCS technically is proven
- Enormous potential – public (and authority) acceptance necessary
- Value chain approach useful – upsides by EOR
- Financing and Kyoto mechanisms are keys to initiate projects that will drive technology development

SLEIPNER - 10 years of CO2 Storage

THANKS for your attention!

QUESTIONS?