
# Norway as a $CO_2$ Laboratory

Tore A Torp, Dr.ing.

Adviser $CO_2$ Storage, StatoilHydro, Norway

StatoilHydro

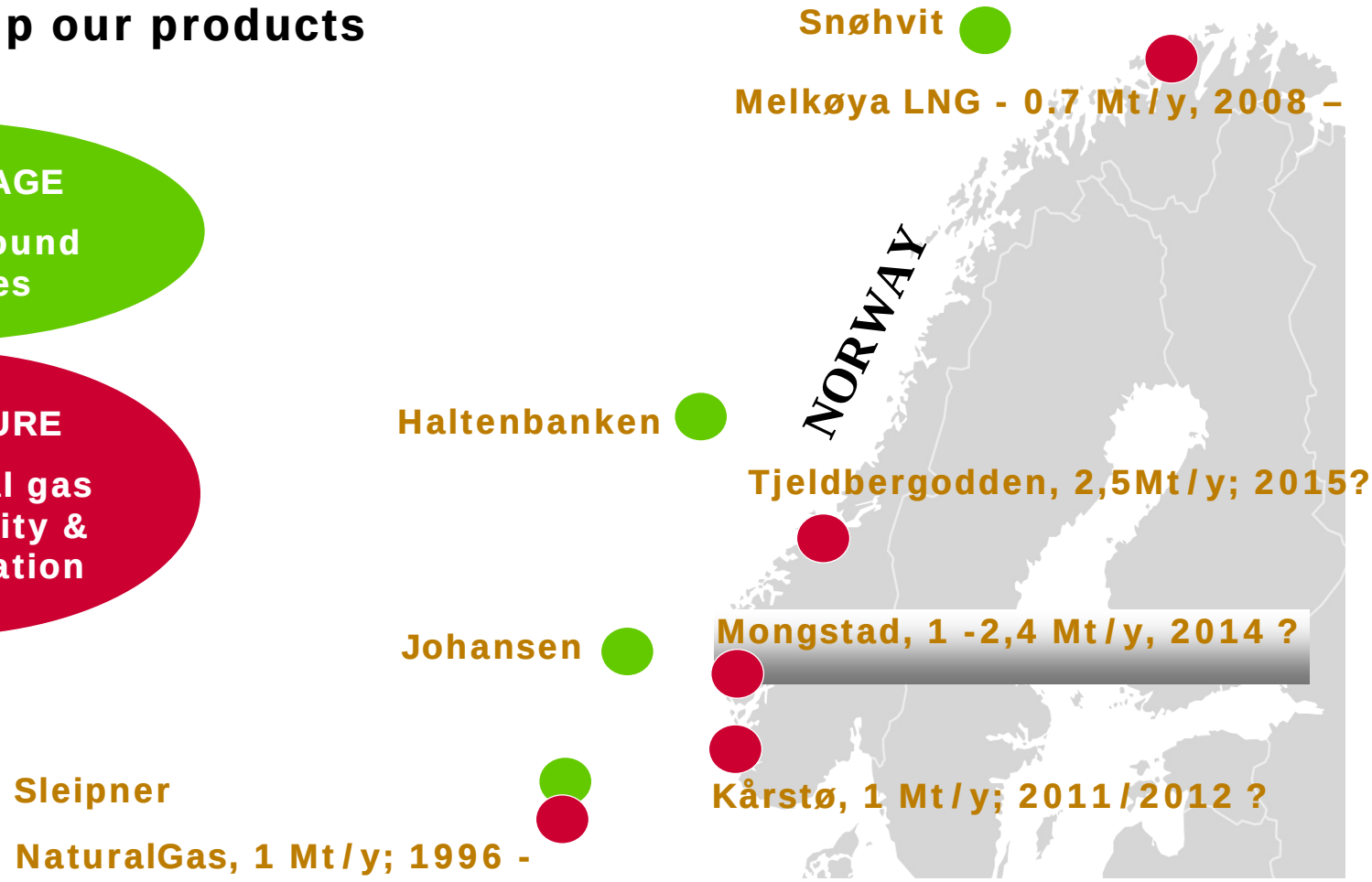

Worst case scenario
is business as usual!
Need to get started now!

# Norway as a "$CO_2$-laboratory"

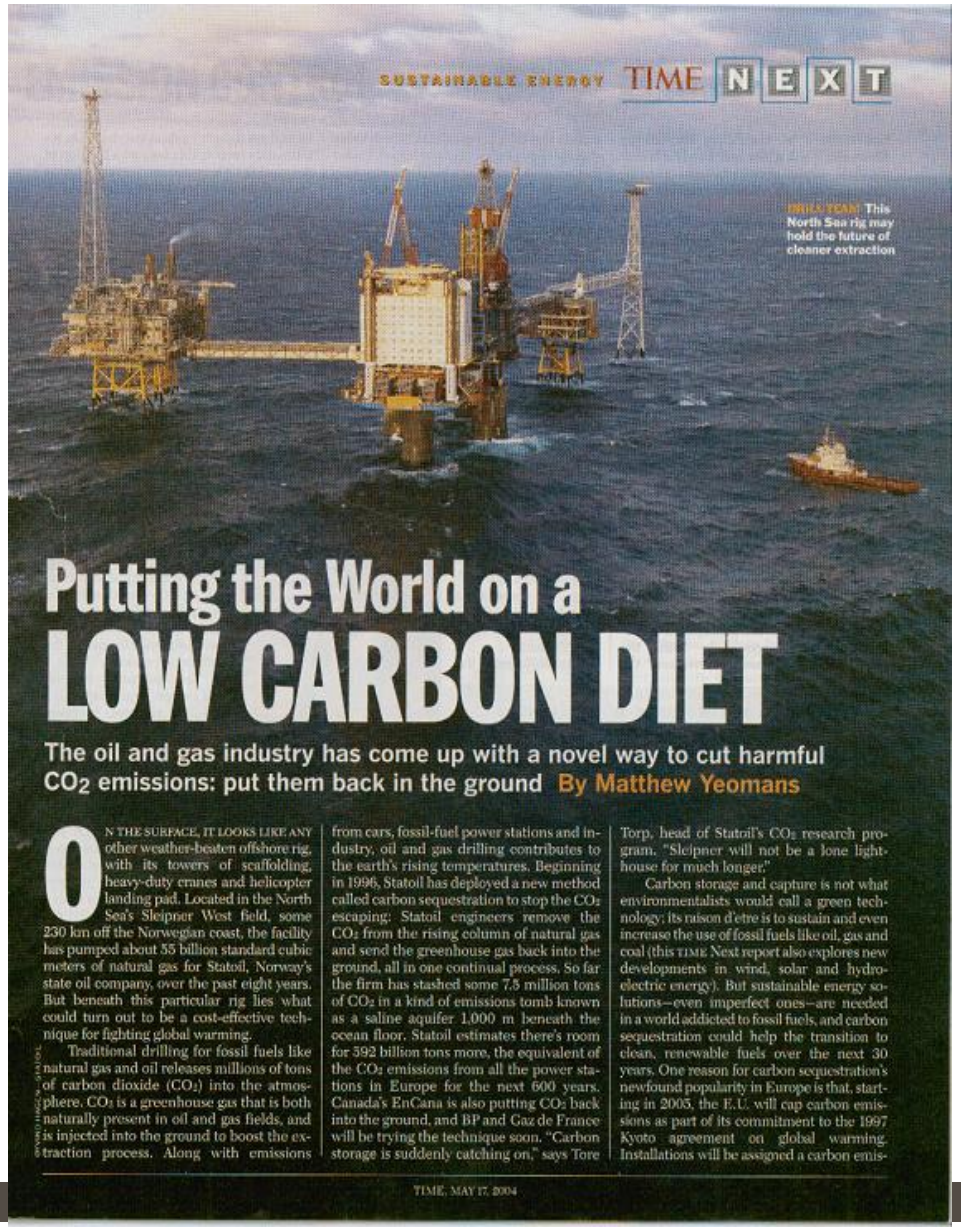
- Cleaning up our operations
- Cleaning up our products

**$CO_2$ STORAGE**
in underground structures

**$CO_2$ CAPTURE**
from natural gas and electricity & heat generation




StatoilHydro



SUSTAINABLE ENERGY TIME NEXT

DRILL TEAM: This North Sea rig may hold the future of cleaner extraction

# Putting the World on a LOW CARBON DIET

**The oil and gas industry has come up with a novel way to cut harmful $CO_2$ emissions: put them back in the ground** By Matthew Yeomans

ON THE SURFACE, IT LOOKS LIKE ANY other weather-beaten offshore rig, with its towers of scaffolding, heavy-duty cranes and helicopter landing pad. Located in the North Sea's Sleipner West field, some 230 km off the Norwegian coast, the facility has pumped about 35 billion standard cubic meters of natural gas for Statoil, Norway's state oil company, over the past eight years. But beneath this particular rig lies what could turn out to be a cost-effective technique for fighting global warming.

Traditional drilling for fossil fuels like natural gas and oil releases millions of tons of carbon dioxide ($CO_2$) into the atmosphere. $CO_2$ is a greenhouse gas that is both naturally present in oil and gas fields, and is injected into the ground to boost the extraction process. Along with emissions from cars, fossil-fuel power stations and industry, oil and gas drilling contributes to the earth's rising temperatures. Beginning in 1996, Statoil has deployed a new method called carbon sequestration to stop the $CO_2$ escaping: Statoil engineers remove the $CO_2$ from the rising column of natural gas and send the greenhouse gas back into the ground, all in one continual process. So far the firm has stashed some 7.5 million tons of $CO_2$ in a kind of emissions tomb known as a saline aquifer 1,000 m beneath the ocean floor. Statoil estimates there's room for 592 billion tons more, the equivalent of the $CO_2$ emissions from all the power stations in Europe for the next 600 years. Canada's EnCana is also putting $CO_2$ back into the ground, and BP and Gaz de France will be trying the technique soon. "Carbon storage is suddenly catching on," says Tore Torp, head of Statoil's $CO_2$ research program. "Sleipner will not be a lone lighthouse for much longer."

Carbon storage and capture is not what environmentalists would call a green technology; its raison d'etre is to sustain and even increase the use of fossil fuels like oil, gas and coal (this TIME Next report also explores new developments in wind, solar and hydroelectric energy). But sustainable energy solutions—even imperfect ones—are needed in a world addicted to fossil fuels, and carbon sequestration could help the transition to clean, renewable fuels over the next 30 years. One reason for carbon sequestration's newfound popularity in Europe is that, starting in 2005, the E.U. will cap carbon emissions as part of its commitment to the 1997 Kyoto agreement on global warming. Installations will be assigned a carbon emis-

TIME, MAY 17, 2004

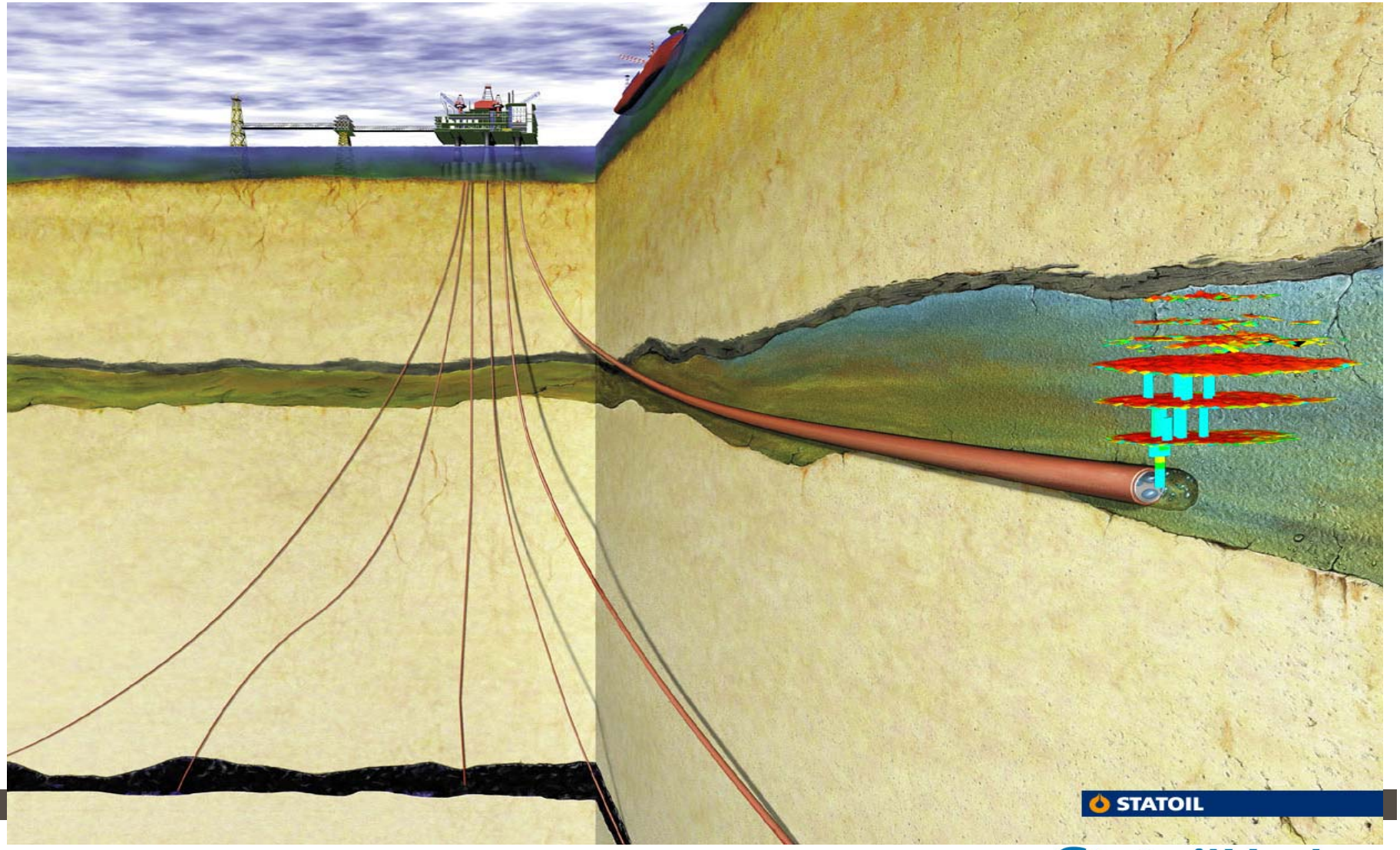
Sleipner $CO_2$ injection:

- Decided in 1992
- In operation since 1996
- 1 million tonne $CO_2$/år

Time Magazine,
17. May 2004

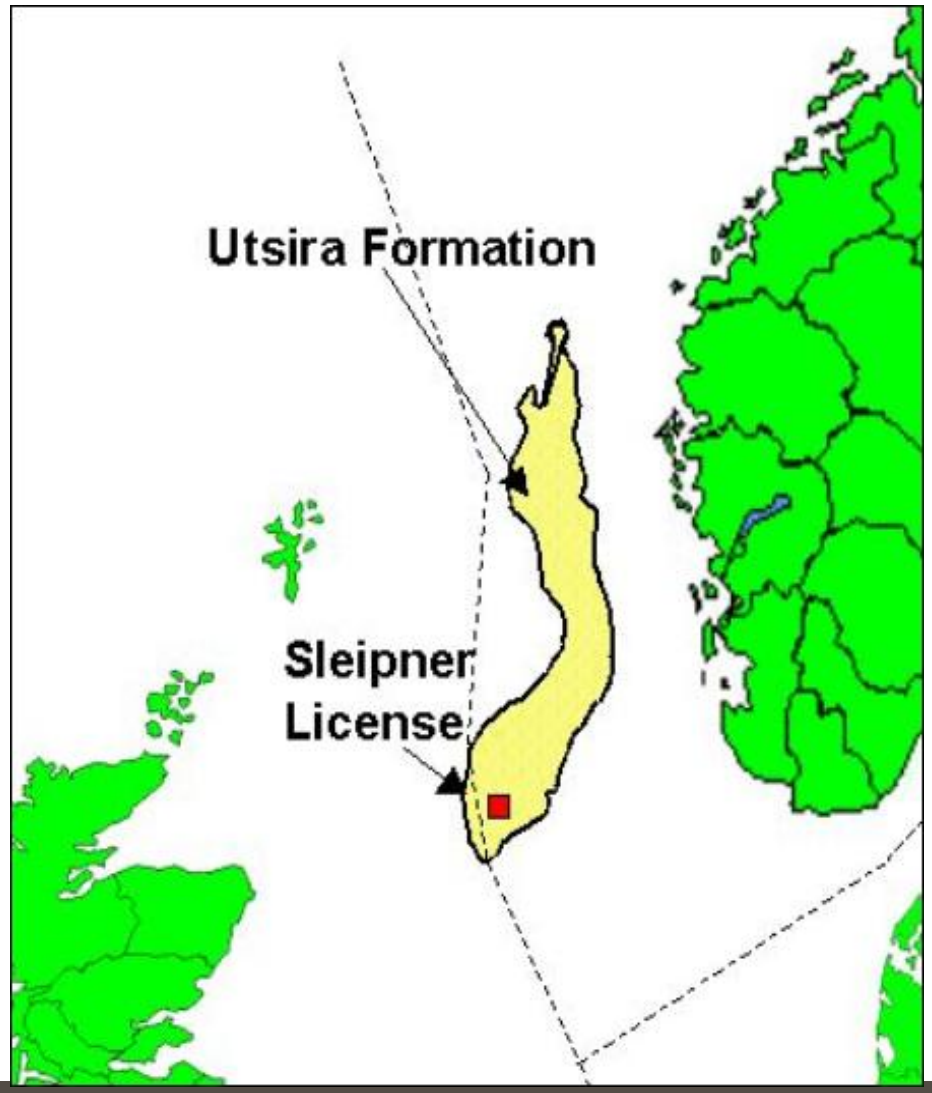
StatoilHydro

# Sleipner CO2 Injection

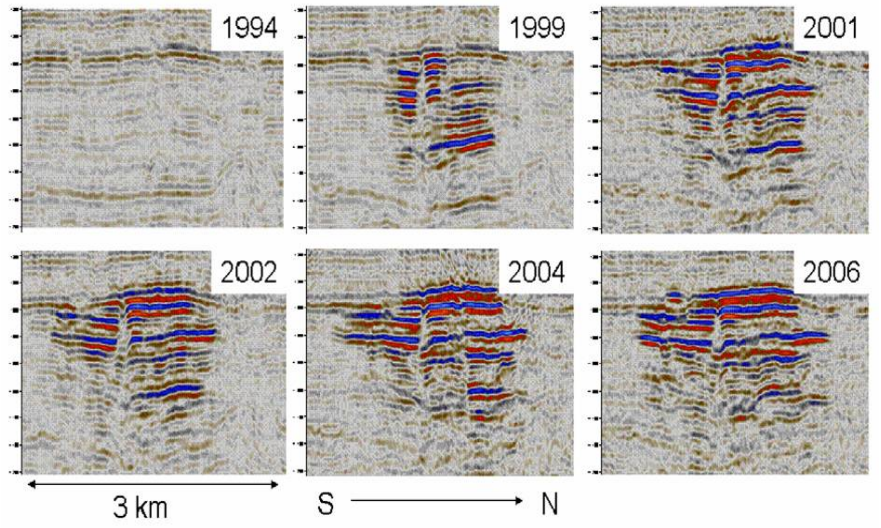


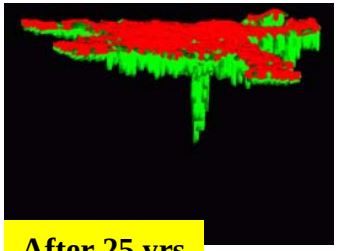

StatoilHydro

# The Utsira Formation

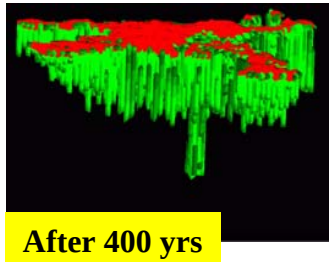


# Proof of concept through extensive monitoring and R&D programmes

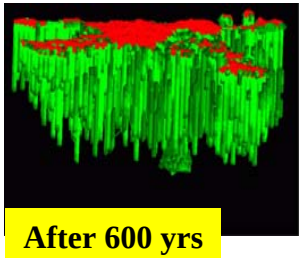


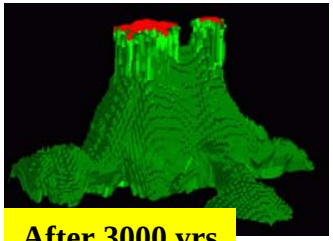
After 25 yrs



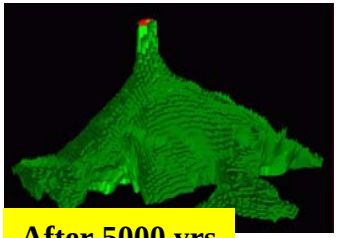
After 400 yrs



After 600 yrs



After 3000 yrs



After 5000 yrs

# In Salah, Algeria and Snohvit, Norwegian Sea

- Started in August 2004
- $CO_2$ from natural gas
- Injecting 1,2 mill. tons $CO_2$ annually
- Injection into gas reservoir aquifer
- **Driver:** BP internal quota system

- Started in April 2008
- $CO_2$ from natural gas
- Injecting 0,7 mill. tons $CO_2$ annually
- Injection below gas reservoir
- **Driver:** $CO_2$ tax

# StatoilHydro's CCS projects
## An industrial approach to climate change

($CO_2$ injection capacity MT/yr)

**1**

Sleipner

First CCS in the world

**1**

In Salah

Onshore, stored in an active production reservoir

**0,7**

Snøhvit LNG

Sub sea, stored below gas reservoir

**2,5**

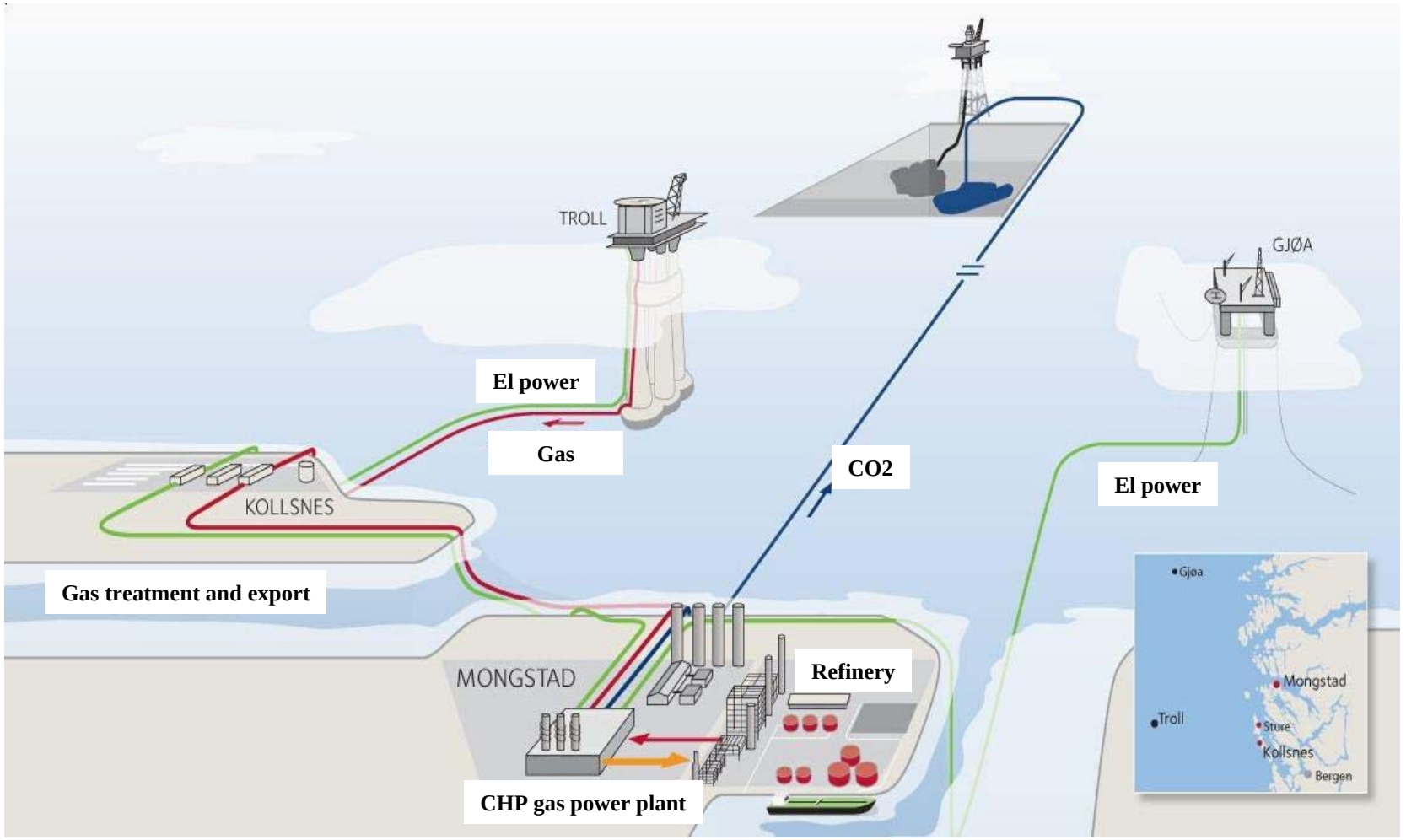
Mongstad

Agreement with Norwegian authorities

**1996-** **2004-** **2007-**

StatoilHydro

# The Mongstad Concept



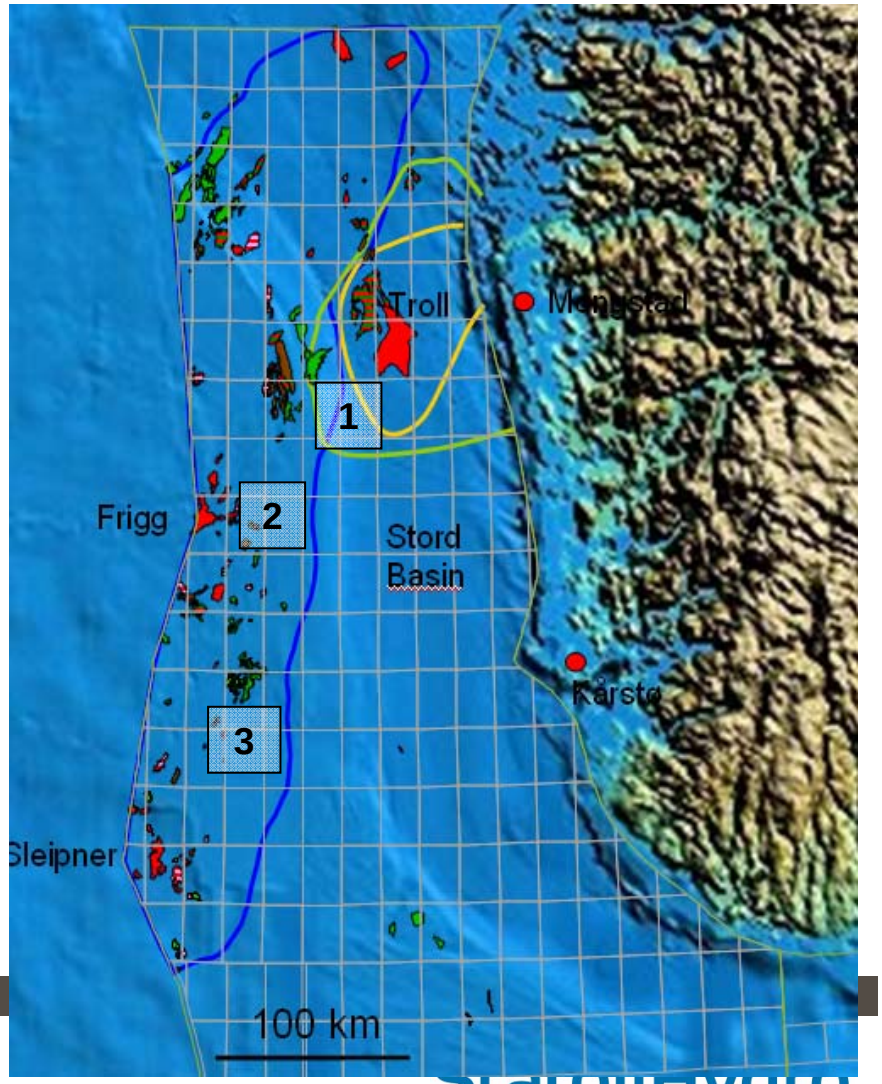

StatoilHydro

# Power stations with CCS 2012-14

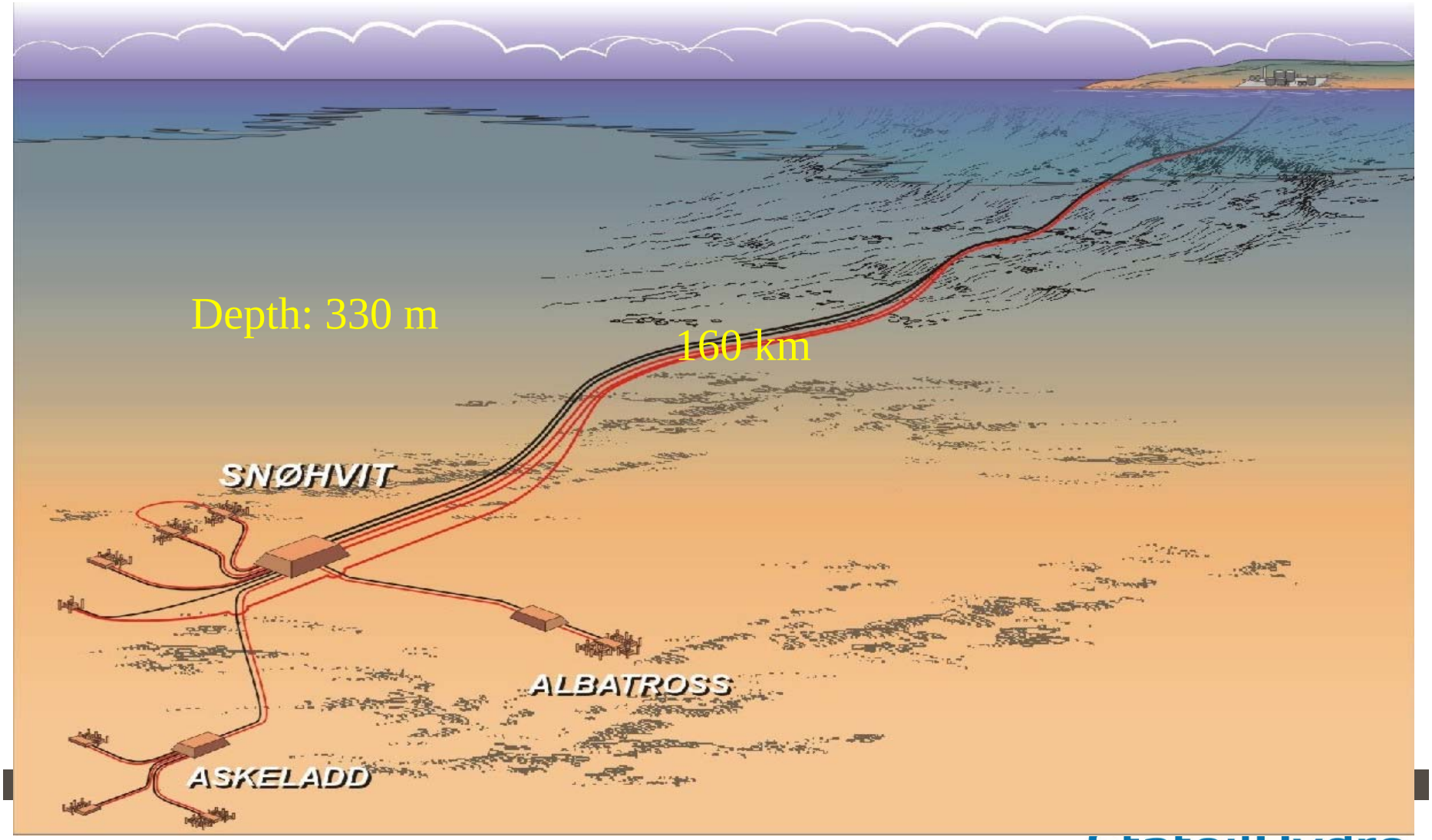
Site characterisation:

- 3 new sites
  - formation west of Mongstad
  - Extend mapping of Utsira fm.
  - Transport med pipe and/or ship

- $CO_2$ from
  - Kårstø : 1.1 Mt/year
  - Mongstad 2,2 Mt/year
  - + extra volumes?



# Snøhvit – All subsea




StatoilHydro

# SAFETY STRATEGY

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

# 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!**

# LEGAL & REGULATORY STATUS

- OSPAR – Storage sub-sea allowed since 2007 – Limitations
- London Protocol - - - - ” - - -
- UNFCCC (Rio Convention) – National reporting: “SLP not emitted”: OK!
- - - - ” - - - - CCS in CDM under debate
- EU CCS Directive - under debate in 27 capitals and European Parliament

  CONTRA:

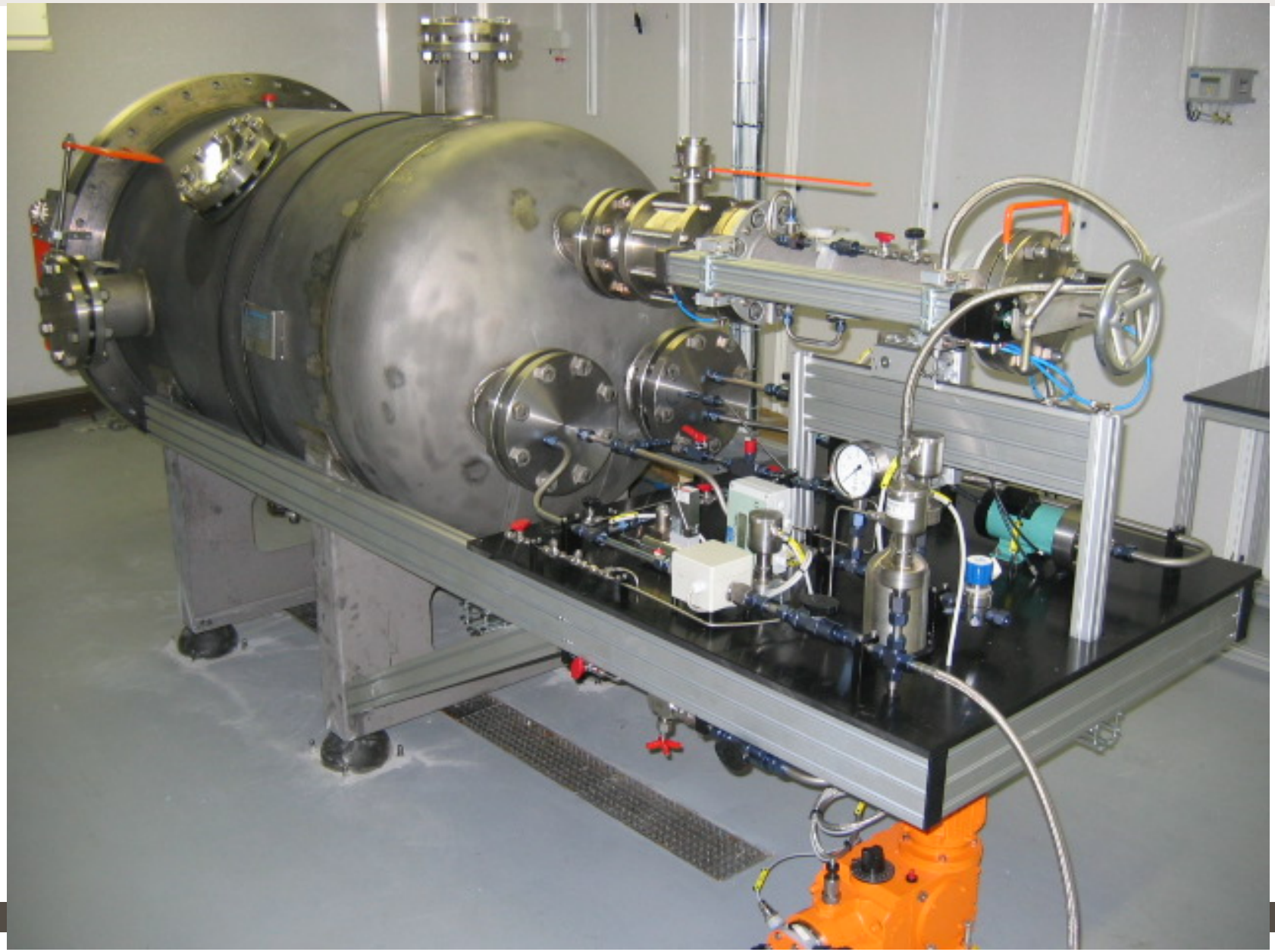
  – “Divert funds from Efficiency and Renewables”

  – “Continue fossil era”,

  PRO:

  – Efficiency and Renewables first priority, BUT takes time, so

  – CCS NOW!



StatoilHydro

# $CO_2$ 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: $CO_2$ Transport

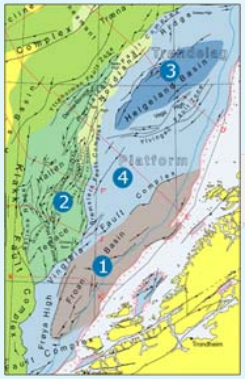
- Pipeline
- Ship

➔ Large projects

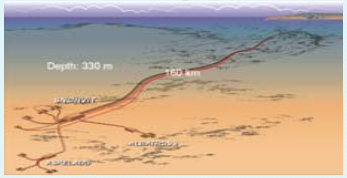
StatoilHydro

# Norway as a $CO_2$ laboratory

Halten $CO_2$ in aquifer storage - 2015?



Snøhvit - all subsea



Snøhvit, 2007

Melkøya LNG - 0,7 million tonn/y from 2007

Melkøya LNG plant with $CO_2$ capture

Halten

Tjeldbergodden - 2,5 million tonn/y, 2012?

Methanol plant at Tjeldberg-odden - future capture site?

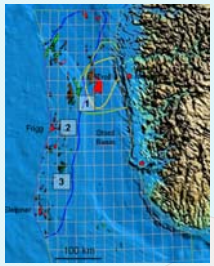
Johansen

Sleipner – 1 million tonn/y from 1996

Mongstad 1,3 to 2,1 million tonn/y, 2014

Kårstø – 1 million tonn/y, 2011/2012?

North Sea $CO_2$ storage in aquifer - 2014?



Mongstad combined heat and power (CHP) station with $CO_2$ capture plant -European Test Center Mongstad & Full scale capture

Sleipner - $CO_2$ capture and storage - 1996

$CO_2$ Transport

Yara $CO_2$ tankers, 1500 m3 capacity

Laying a new pipe-line in the ocean

Kårstø gas power station – with $CO_2$ capture

StatoilHydro

THANKS for your attention!

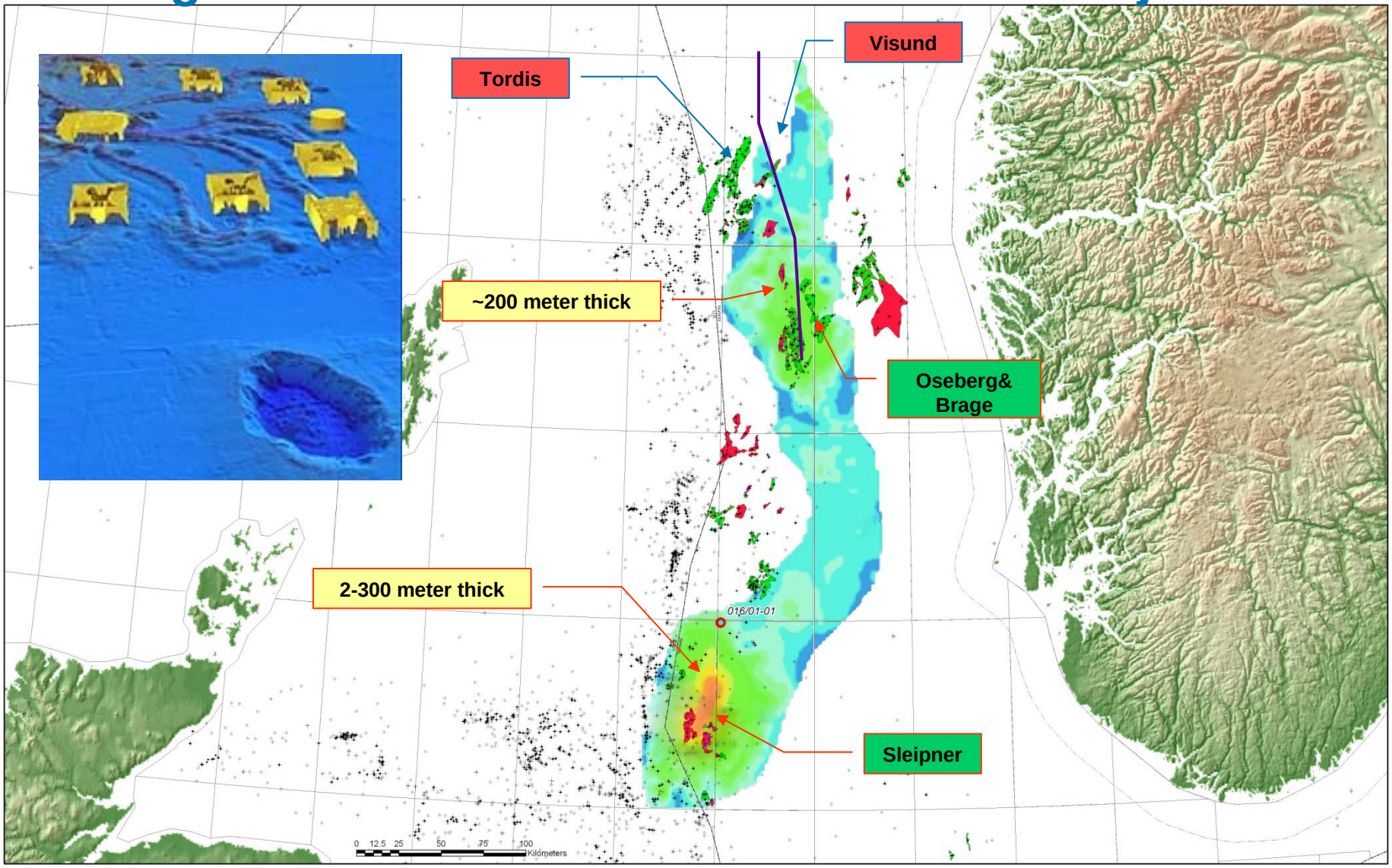
QUESTIONS?

**DOCUMENTATION**

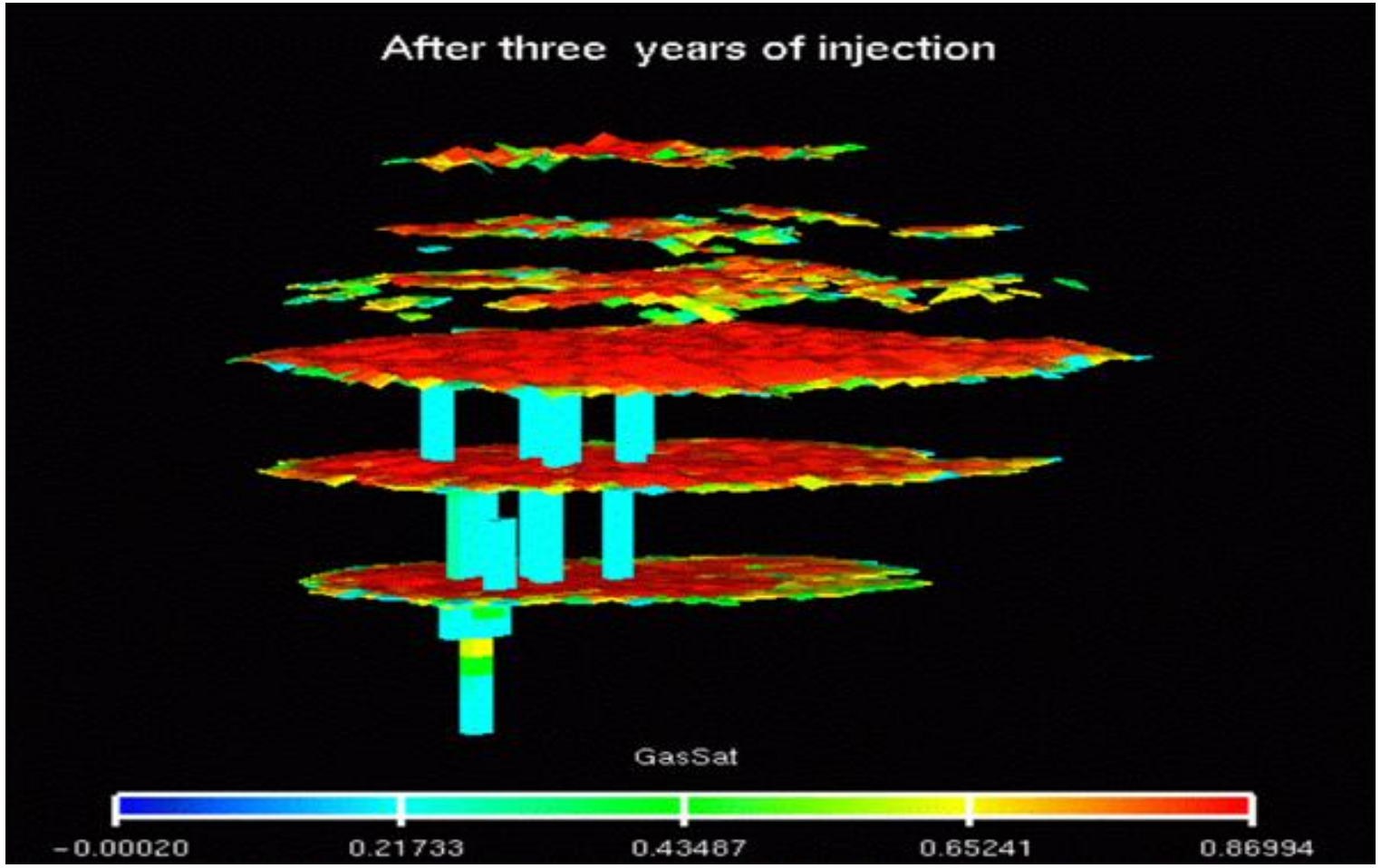
**“SACS Best Practice Manual, 1.version.”**

**Download from www.co2store.org, see page “SACS”.**

# Learning from the Tordis incident – Water reinjection




StatoilHydro




**Simulated picture of the distribution of $CO_2$ after three years. Radius of largest bubble 800 m and the total plume 200 m high.**

**Ref: SINTEF Petroleum 2001**

StatoilHydro