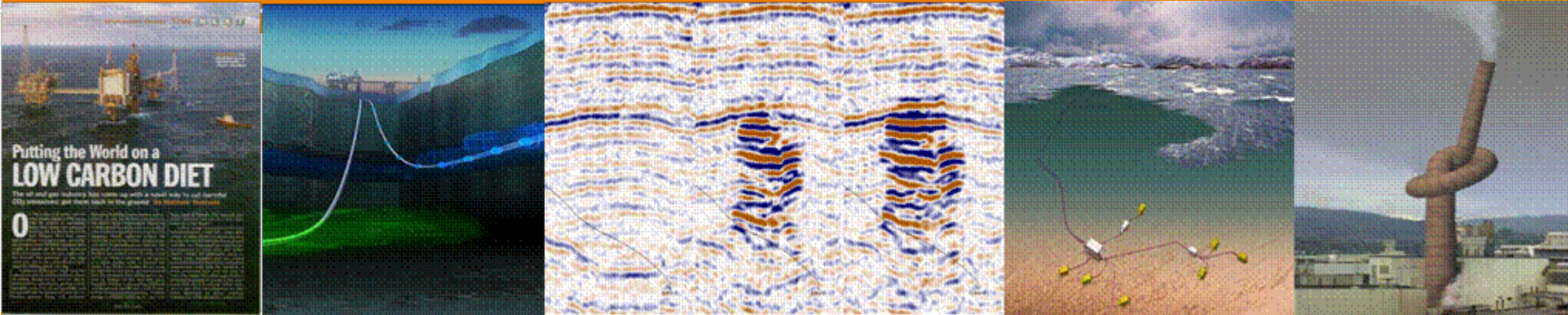


European Perspective on CCS through Norwegian Commercial Projects

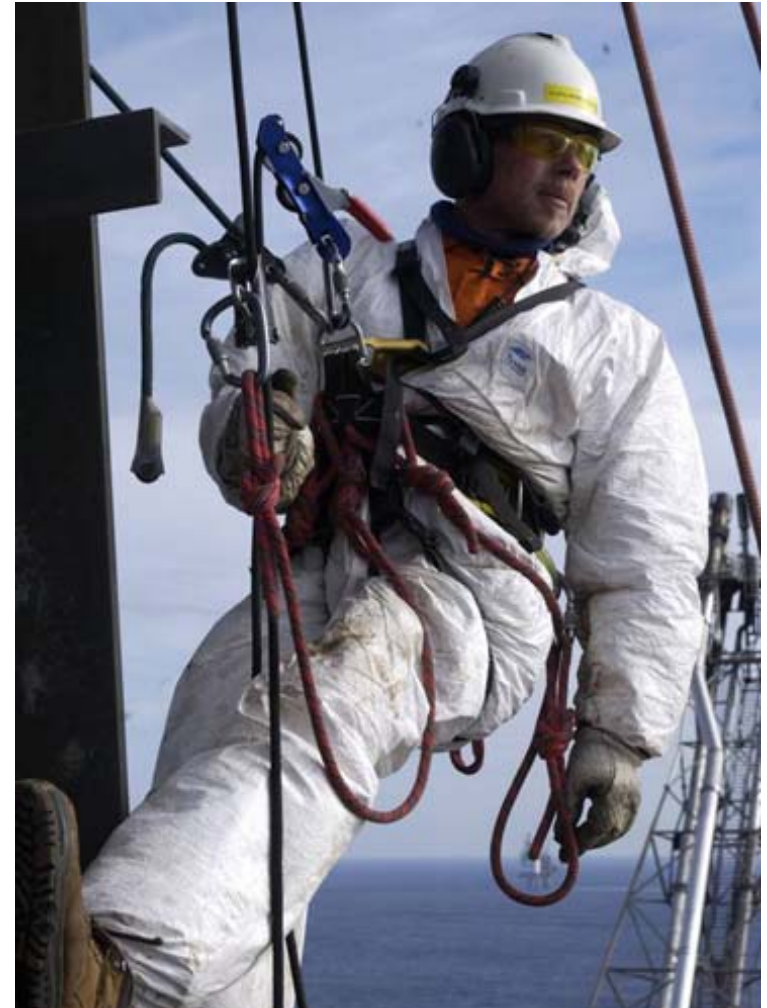


Olav Kaarstad
CO₂-issues Manager, Statoil ASA, Norway

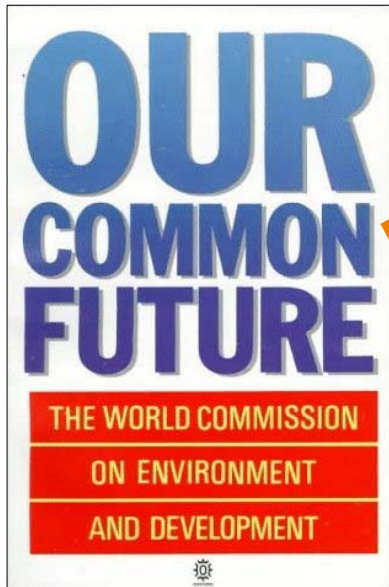
2007 RITE International Symposium:
Technologies for mitigating global warming and the role of Japan

This is Statoil

- World's third largest net seller of crude oil
- Markets two-thirds of all Norwegian gas to European customers
- Largest retailer of oil products in Scandinavia
- A highly competent technology company
- A leader in application of CO₂-technologies



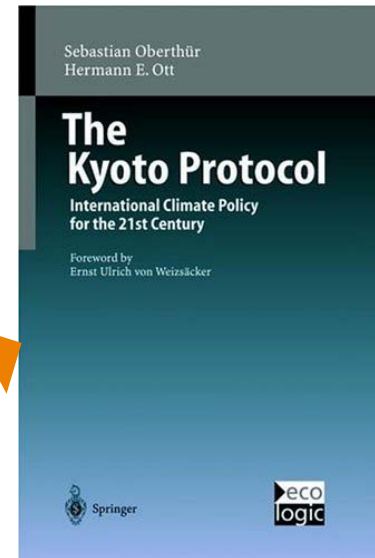
The Norway - Japan climate heritage



"The Brundtland Report", 1987



Norway's Prime Minister Gro Harlem Brundtland in Rio in 1992*



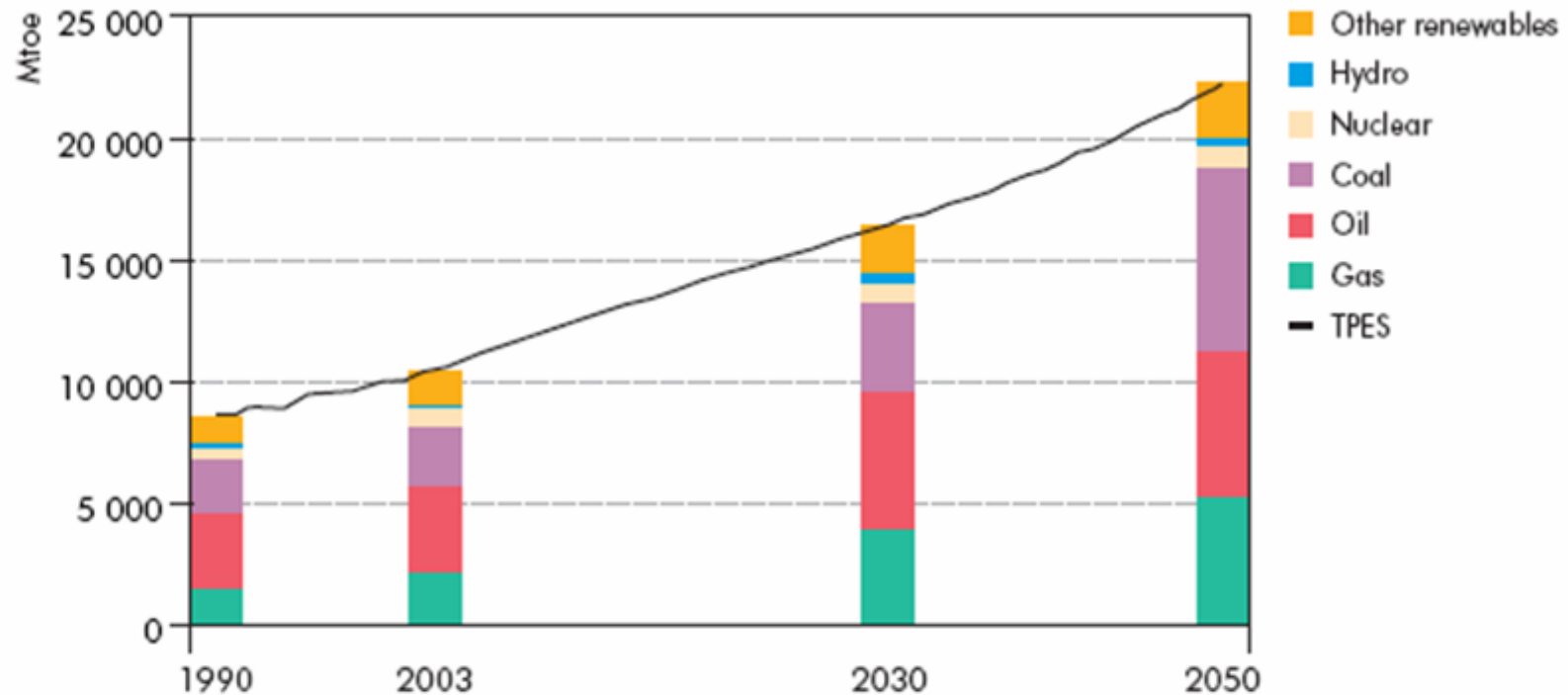
The Kyoto Protocol, 1997



The Kyoto Protocol ratified, 2005

* Gro Harlem Brundtland introduced a CO2-tax of about 45 US\$/ton in Norway in 1992

The background → IEA Baseline scenario: Primary energy use will more than double to 2050



Key point

Primary energy use more than doubles between 2003 and 2050, with a very high reliance on coal.

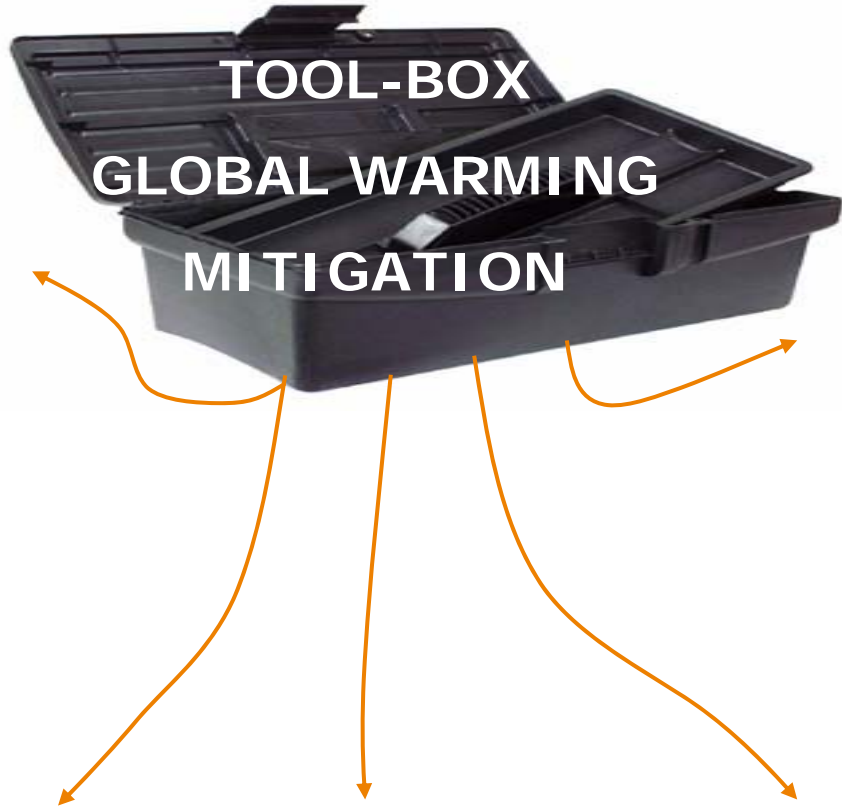
**We are not
running out of
fossil fuels...**

**we are running
out of
atmosphere**



ENERGY EFFICIENCY

- REDUCE CONSUMPTION
- MORE EFFICIENT ENERGY USE
- MORE EFFICIENT ENERGY CONVERSION



ENERGY SWITCHING

COAL
OIL
NATURAL GAS
HYDROGEN

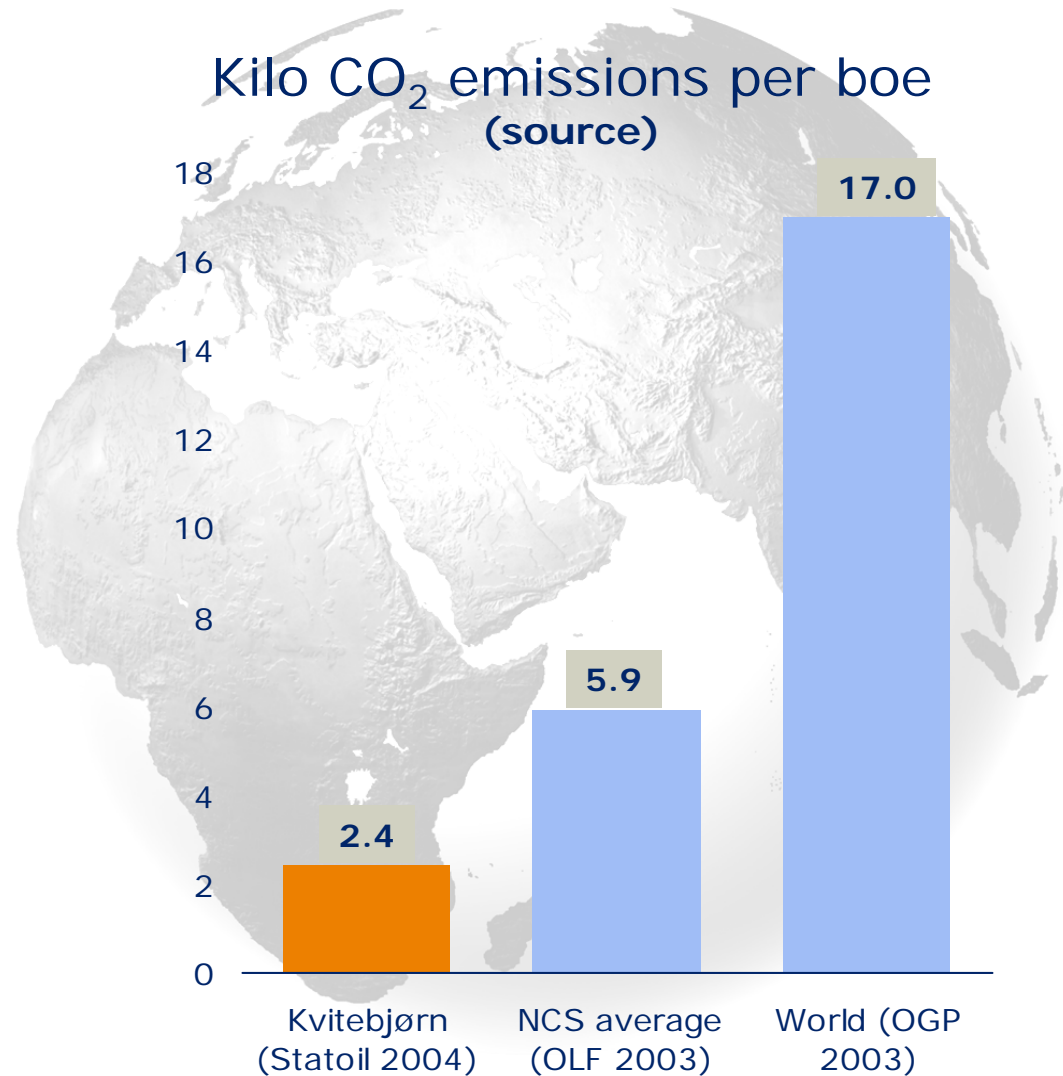


CCS= CO₂-Capture and -Storage

Statoil's climate policy – cleaning up our operations

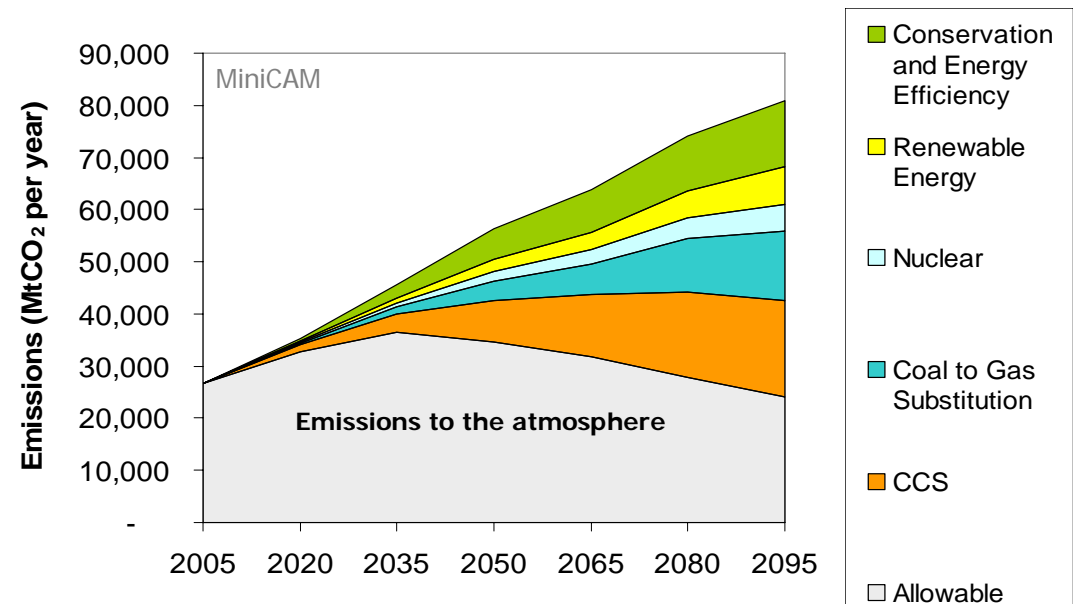
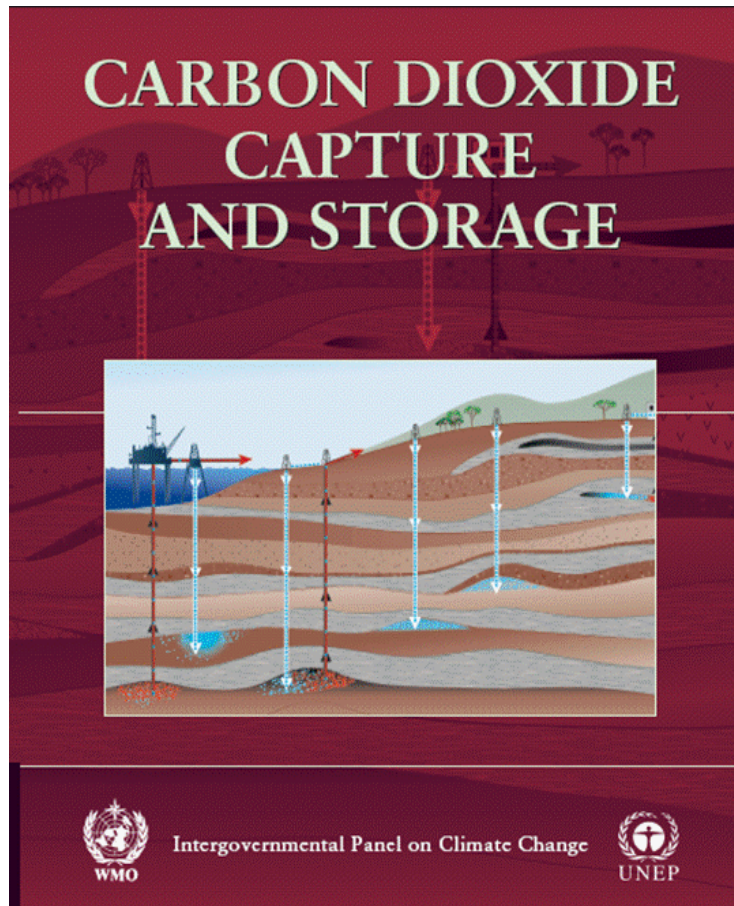
Statoil's strategy to reduce greenhouse gas emissions:

- Energy efficiency in own operations
- Emissions trading
- Carbon capture and storage
- Renewables



Economic potential of CCS:

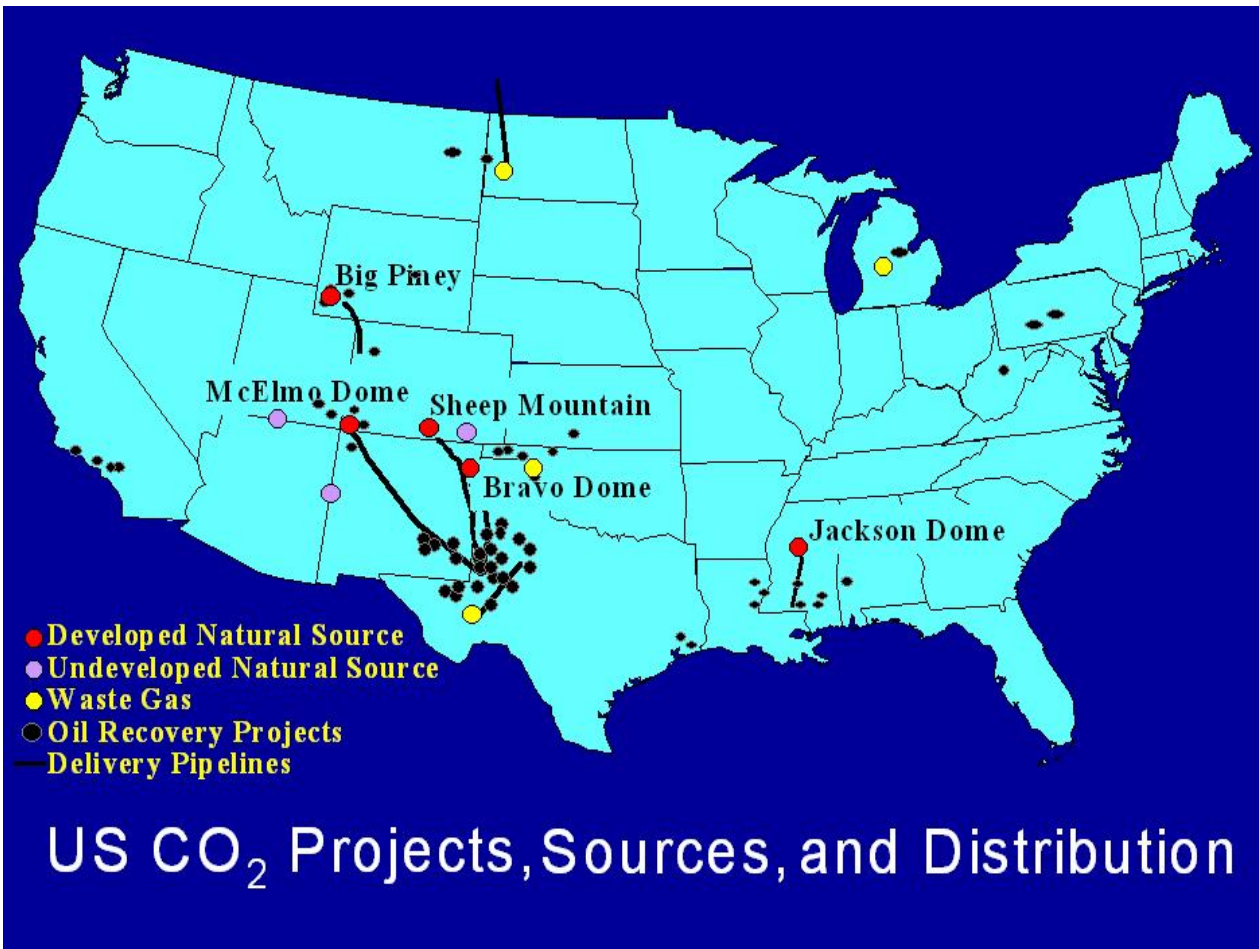
Typical modelling result (orange = CCS)



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

Background:

CO₂ for enhanced oil recovery well known on land



- 70 fields on going
- For more than 30 years
- About 30 Mt injected pr year, mostly from naturally occurring CO₂-fields
- Large long CO₂-pipelines
- But not focus on climate
- Very profitable at to-days oil prices

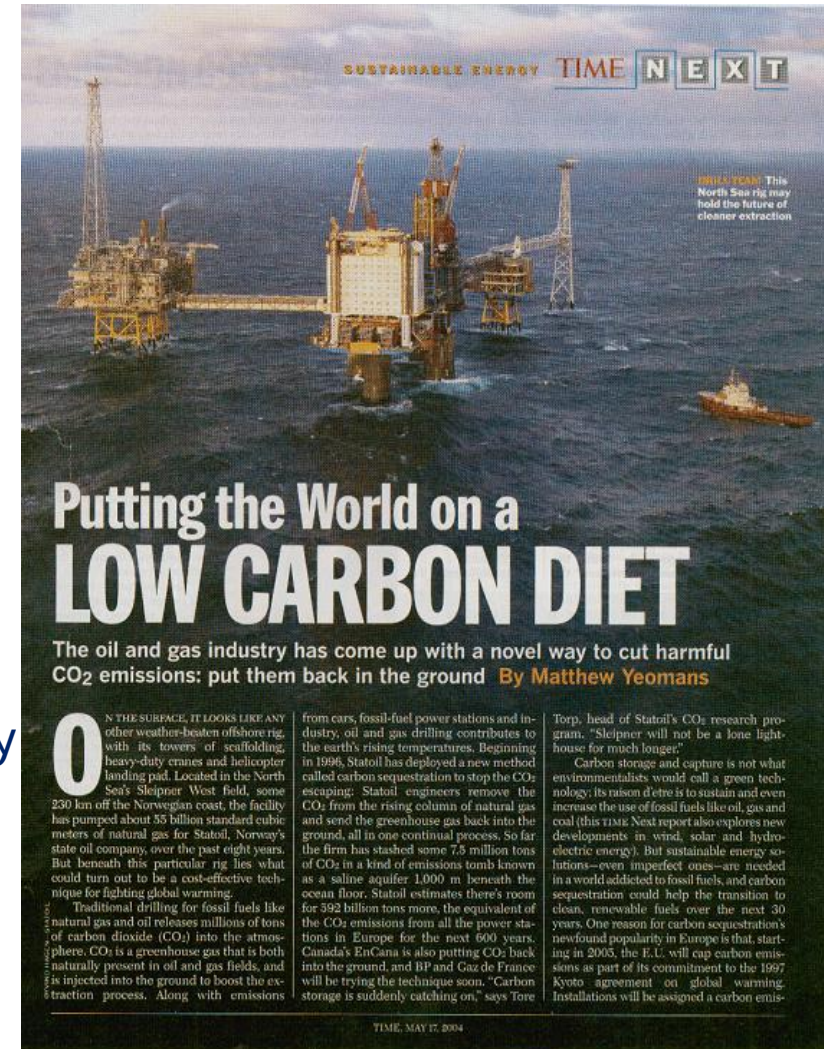
Is there enough underground CO₂ storage capacity?

.....the answer is yes for all practical purposes

.....but it is not equally divided between regions and countries

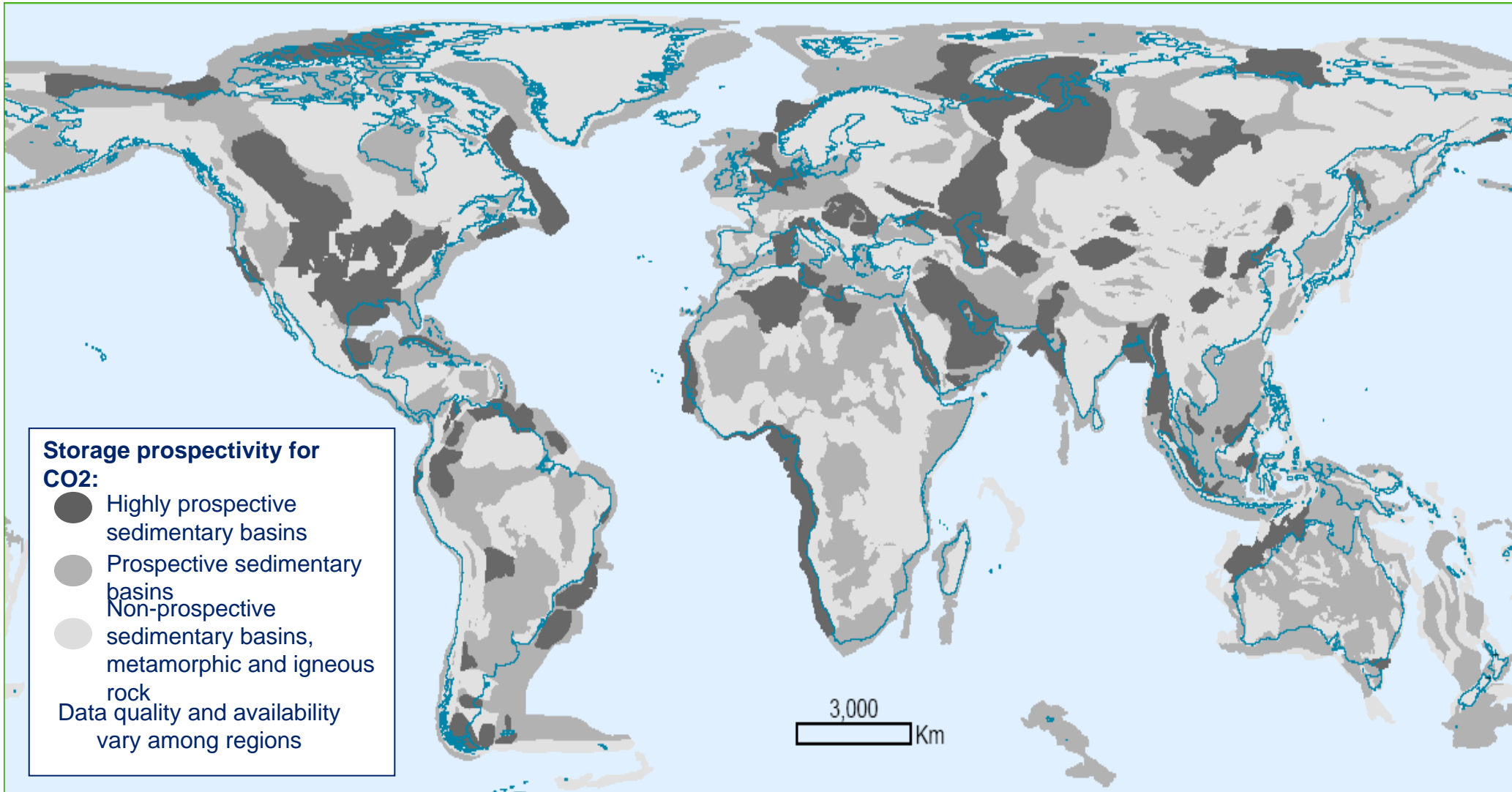
.....but acceptance and regulatory regimes are needed

- Legal
 - London Convention & OSPAR
- Scientific
 - IPCC-report on CCS
 - Large scale demonstration plants needed
- Political support
 - EU Research Framework Programme
 - Carbon Sequestration Leadership Forum
 - Norwegian experience – government very active
- Public
 - NGO support



Source: TIME Magazine, May 2004

Sedimentary basins and CO₂-storage prospectivity



Some current CO₂-projects

Norway as a "CO₂-laboratory"

Cleaning up
our operations

CO₂ from
natural gas

Cleaning up
our products

CO₂ from electricity
generation

Sleipner, 1 million
tonnes/yr from 1996

Snøhvit LNG train 1, 2007

Snøhvit LNG train 2, 2016?

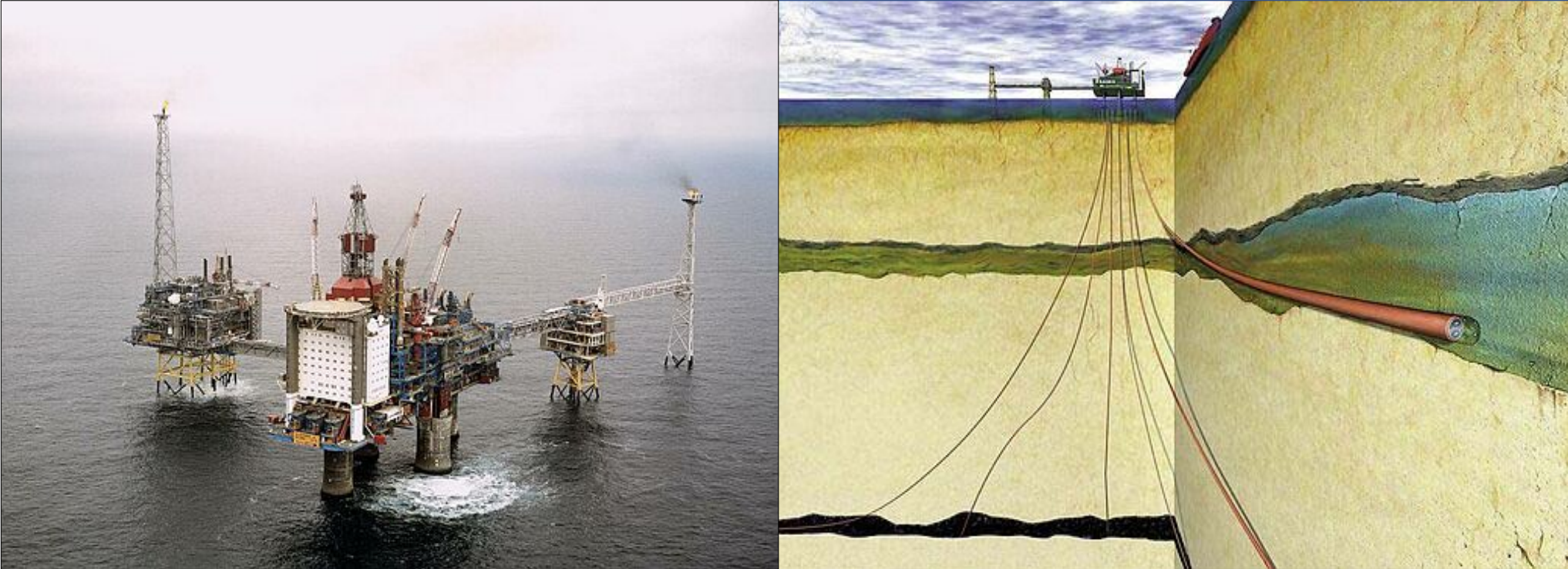
NORWAY

Tjeldbergodden – Halten
CO₂ – 2,5 mill tonnes/yr.
2012?

Mongstad – 1,3 to 2,1 mill
tonnes/yr, 2014

Kårstø – Naturkraft – 1 mill
tonnes/yr, 2011/2012

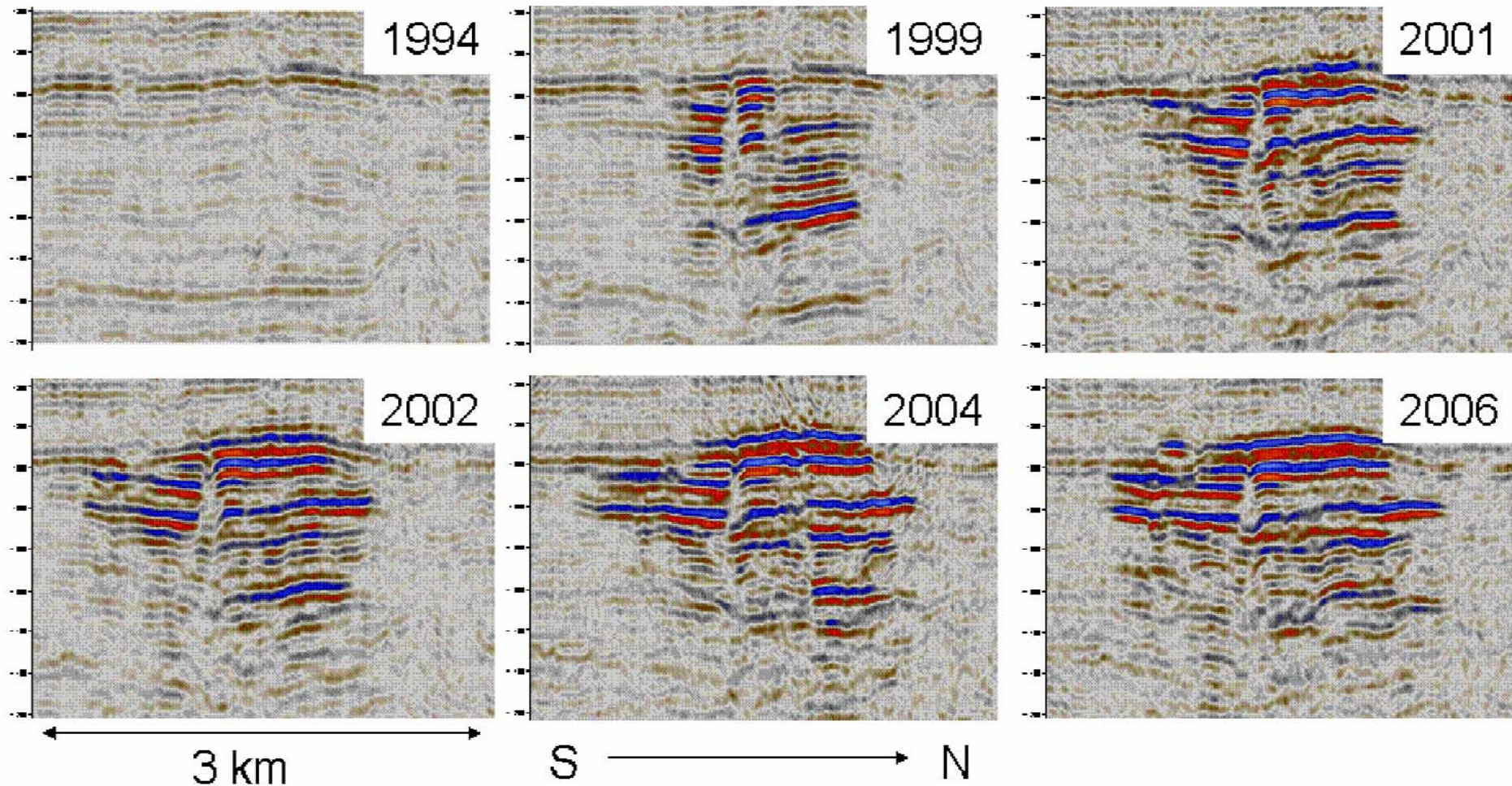
The Sleipner experience – Statoil's starting point



- Started in 1996 – 10 year of CO₂-injection in October 2006
- Separating and injecting nearly 1 mill. tons CO₂ annually
- Storing in saline aquifer above natural gas reservoir
- Driver: Since 1992 a CO₂-tax of approximately 40€/tonne

Confidence building: Sleipner CO₂-monitoring

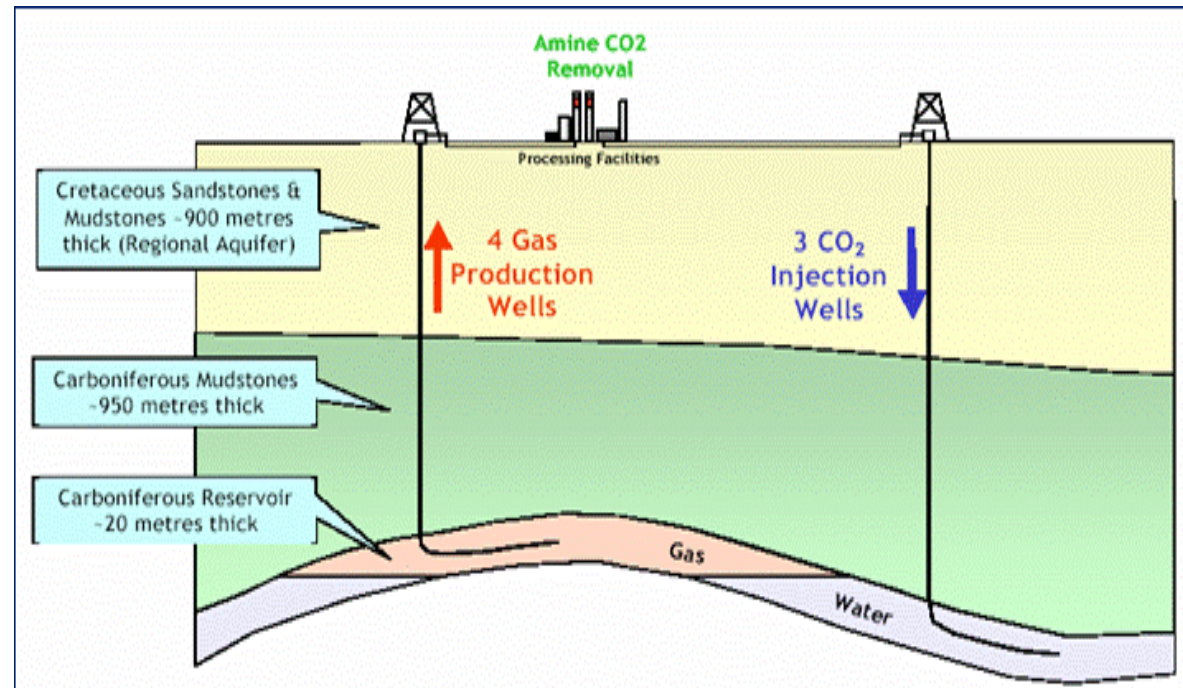
Time-lapse seismic datasets of CO₂ stored in Utsira formation



In Salah Gas

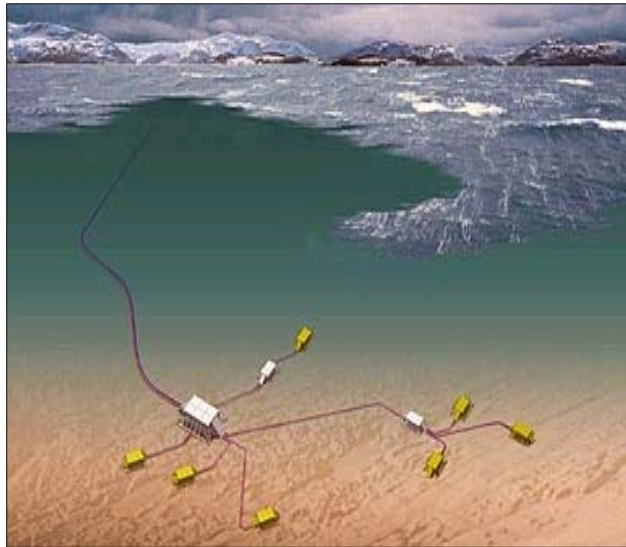
Carbon Dioxide Storage: The In Salah Gas Project Central Algeria

**In Salah
CO₂-injection,
Algeria
(BP, Statoil and
Sonatrach)**



Snøhvit LNG – the next milestone

- Barents Sea
- Piped CO₂ separated from natural gas from onshore LNG plant
- Storing 700.000 tons CO₂ annually from 2007
- Injecting below natural gas reservoir



Need for integrated CCS value chains: Here the Statoil – Shell “Halten CO₂ Project”



The next step: Mongstad CHP* with CO₂-plant



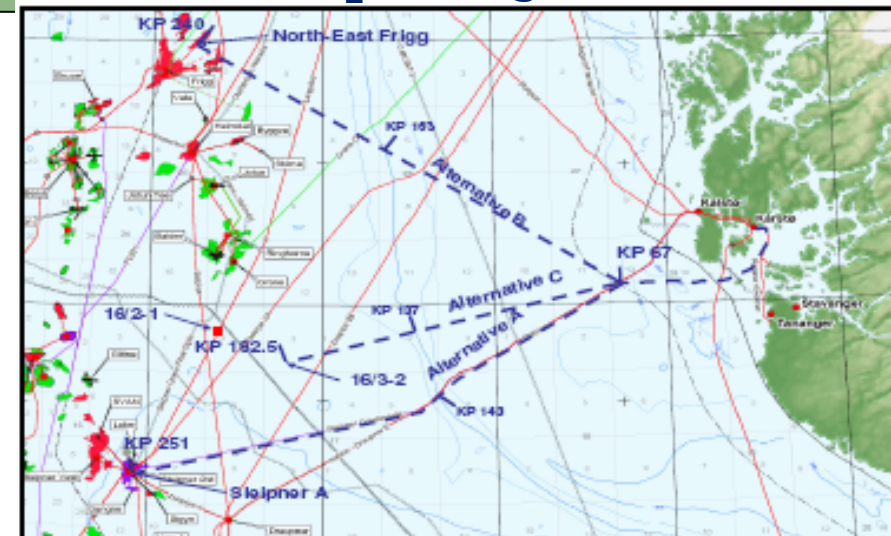
* CHP – Combined Heat and Power

CO₂-capture at Naturkraft's gas fired power plant at Kårstø



CO₂-storage alternatives

- Naturkraft 430 MW
- Electricity 2007
- 1 mill tonnes/year
- CO₂-capture from 2011/2012
- Possibly CO₂ for the Volve field



Can CCS be a profitable investment?



- **The income sources can be:**

- Increased oil recovery (in some cases)
- Emission trading credits from European Union Emission Trading System or perhaps CDM*, JI*

- **Some of the problems:**

- The cost of CO₂-capture is high, but sometimes inexpensive CO₂ is available
- Redeveloping onshore oil fields to use CO₂ for enhanced oil recovery is much better known (and less expensive) than for an offshore platform/reservoir

Other large CCS-projects internationally*

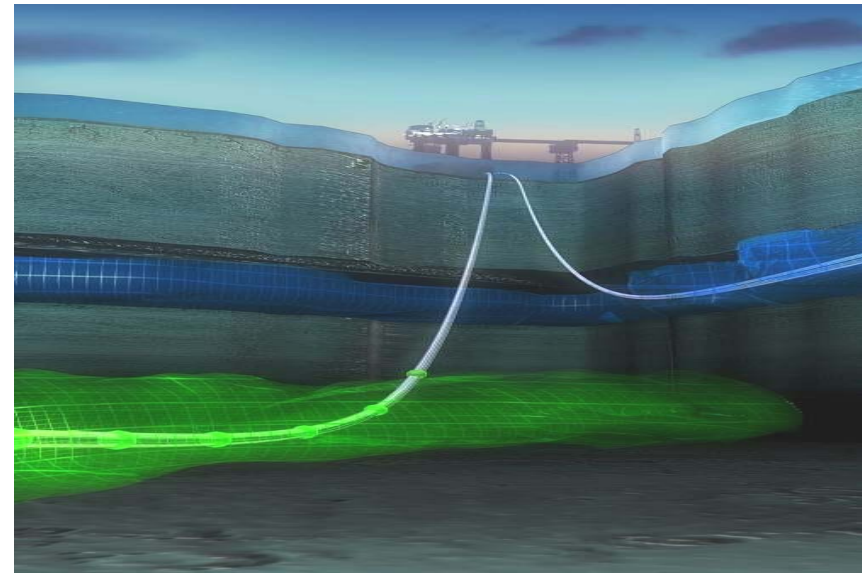
- Projects not mentioned earlier in this presentation

**Power plants with CO₂-capture:
Proposed full-scale projects**



15 projects

**CO₂-storage projects:
Commercial and demonstration**



7 projects

* Based on list compiled by IEA Greenhouse Gas R&D Programme

Research focus for CCS internationally

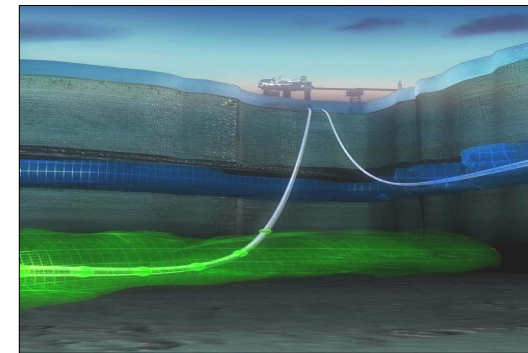
Power plants with CO₂-capture:

- Focus on coal-fired plants
- In Norway → gas fired plants
- Better processes
 - Lower energy consumption
 - Lower cost
 - Environmentally friendly chemicals

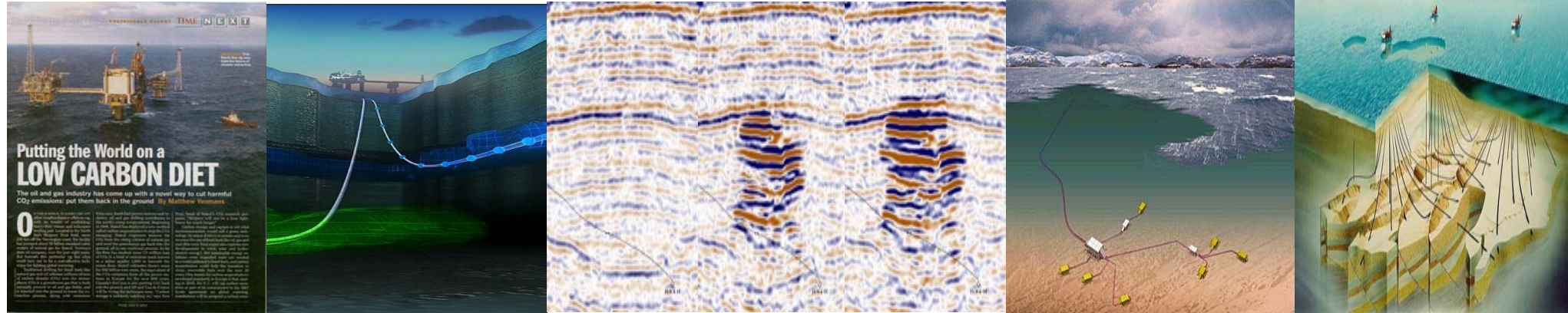


CO₂-storage projects:

- Focus on public acceptability
- How to select good storage sites
- Safety of long term storage
- Monitoring
- Long term liability



Conclusions



- Geological storage technically proven with very large storage capacity worldwide
- Regulations for CCS are slowly coming in place
- CO₂-enhanced oil recovery expected to spread to many oil-regions of the world
- CCS expected to become an important element in meeting the global climate challenge

Thank you for listening!

Back-up material

Other large CCS-projects internationally* (1)

Proposed full-scale (~100 MWe and above) CCS projects in the electricity sector

Company/Project Name	Fuel	Plant output/cost	Technology	Start
BP/SSE DF1, Peterhead/Miller, Scotland	Natural gas	350 MW, (\$600M)	Autothermal reformer + precombustion, storage in the oilfield – EOR	2010
BP DF2, Carson, USA	Petcoke	500 MW, (\$1bn)	IGCC + shift + precombustion, storage in the oilfield – EOR	2011
Nuon, Eemshaven, Netherlands	Coal / natural gas	1200MW	IGCC with option to capture	2011
China Huaneng Group (CHNG), GreenGen, China	Coal	100 MW	IGCC + shift + precombustion	2015
E.ON, Killingholme, Lincolnshire coast, UK	Coal (+petcoke?)	450 MW (£1bn)	IGCC+shift+precombustion? (may be capture read)	2011
Ferrybridge, Scottish & Southern Energy, UK	Coal	500 MW	PC (supercritical retrofit) + post-combustion capture	2011
FutureGen, USA	Coal	275 MW (US\$1 bn)	IGCC + shift + precombustion	2012
GE / Polish utility	Coal	1000 MW	IGCC + shift + precombustion	

* Based on list compiled by IEA GHG

Other large CCS-projects internationally* (2)

Proposed full-scale (~100 MWe and above) CCS projects in the electricity sector

Company/Project Name	Fuel	Plant output/cost	Technology	Start
Powerfuel, Hatfield Colliery, UK	Coal	~900 MW	IGCC + shift + precombustion	2010
Centrica, Progressive Energy, Teeside, UK	Coal (petcoke)	800 MW (+H2 to grid) (\$1.5bn)	IGCC + shift + precombustion	2009
SaskPower, Saskatchewan, Canada	Lignite coal	300 MW	PC+Post-combustion or oxyfuel, storage in the oilfield – EOR	2011
Siemens, Germany	Coal	1000 MW 1.7 bn EUR	IGCC + shift + precombustion	2011
Stanwell, Queensland, Australia	Coal	100 MW	IGCC + shift + precombustion, storage in saline reservoir	2012
RWE, Germany	Coal	450 MW (€1bn)	IGCC + shift + precombustion, storage in saline reservoir	2014
RWE, Tilbury, UK	Coal	1000 MW (£800m)	PC (supercritical retrofit) + post-combustion (may be capture ready)	2016

* Based on list compiled by IEA GHG

Other large CCS-projects internationally* (3)

Major commercial and R&D storage projects

Project name and location	Source of CO ₂	Type of geological formation	CO ₂ stored
K12b (Netherlands)	Stripped from natural gas	Gas field -EGR	Over 0.1 Mt/year since 2004
Gorgon (Australia –offshore)	Stripped from natural gas	Saline reservoir	129 Mt over the life of the project, starting between 2008-2010
Weyburn (Canada/USA)	Coal	Oil field –EOR	1 Mt/year since 2000
Permian Basin, US	Natural reservoirs and industry	EOR	500 Mt stored since 1972
Frio Brine, USA		Saline reservoir	3 Kt injected in 2005-2006
Nagaoka, Japan		Saline reservoir	10.4 Kt in 2004-2005
Ketzin, Germany		Saline reservoir	60Kt total , starting 2006

* Based on list compiled by IEA GHG