

Norway's Commercial CCS Projects

CCS Workshop Tokyo November 19, 2007

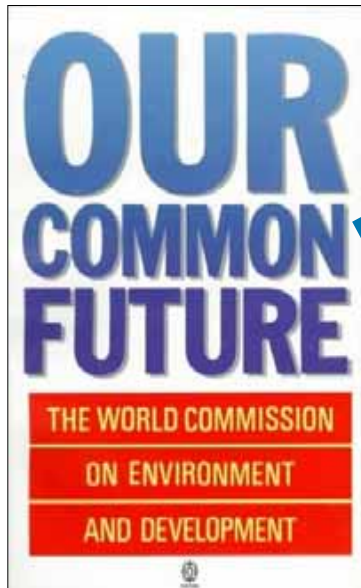


Presentation

by

Dr. Per Christer Lund, Science and Technology Counsellor, Norwegian Embassy in Tokyo
on behalf of StatoilHydro

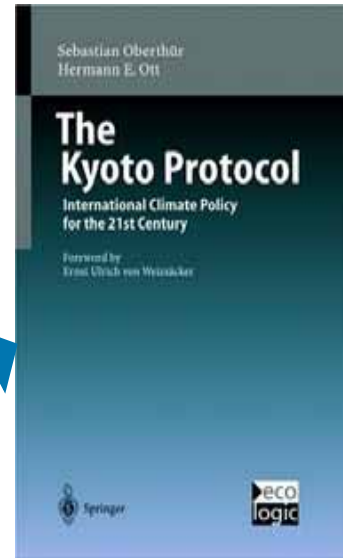
2007: 20 year Anniversary for Our Common Future



"The Brundtland Report", 1987



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



The Kyoto Protocol, 1997

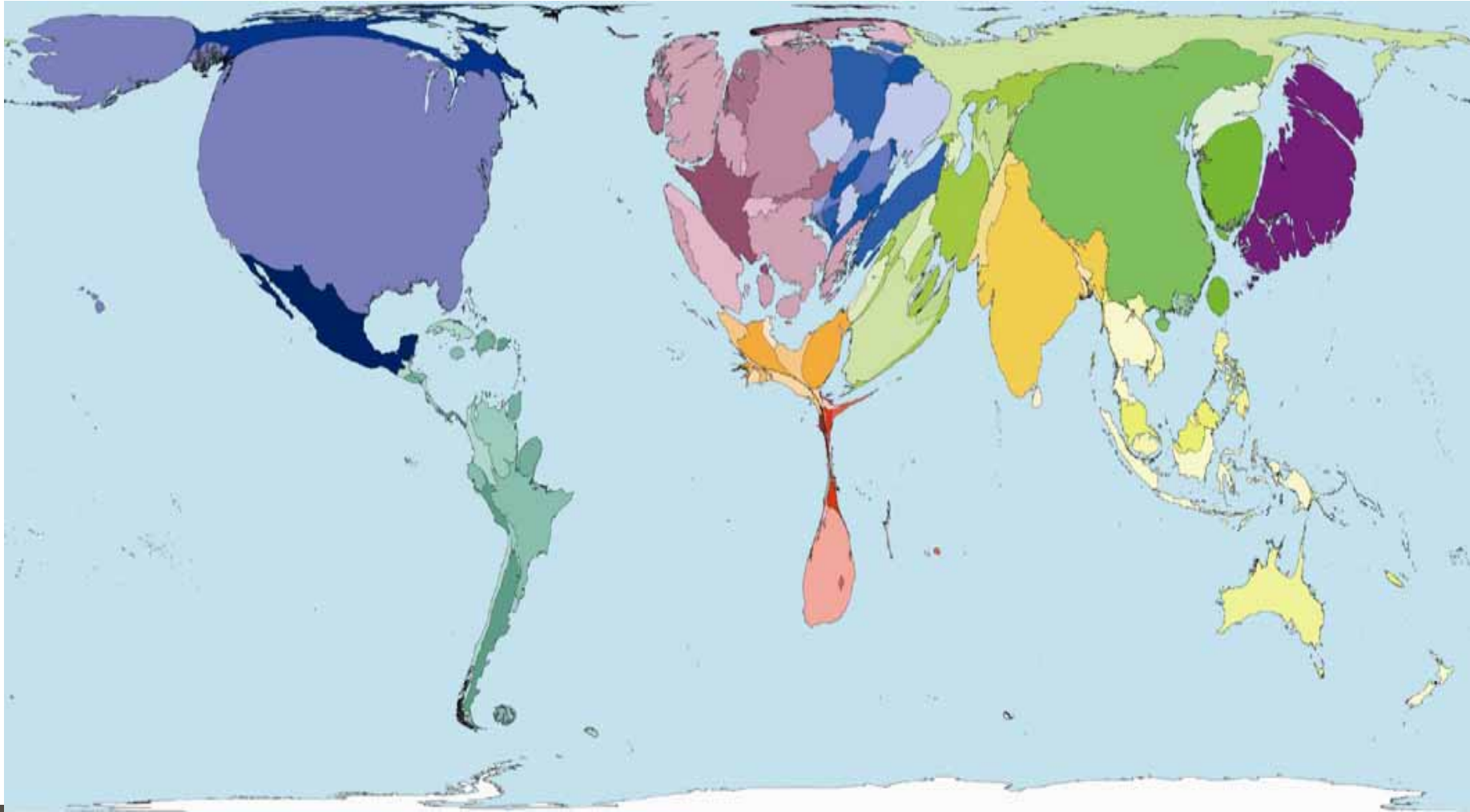


The Kyoto Protocol ratified, 2005

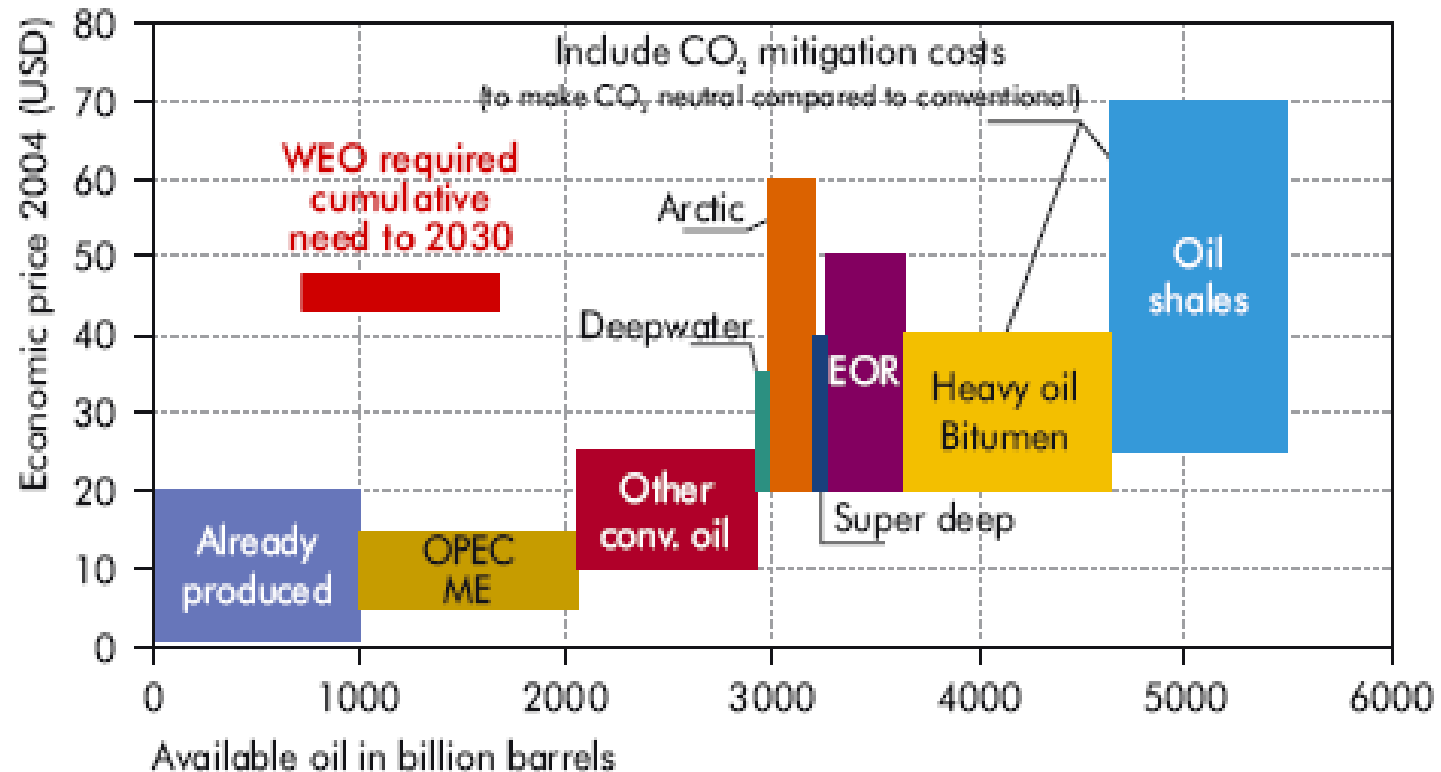
* Gro Harlem Brundtland introduced a CO₂-tax of about 45 US\$/ton in Norway in 1992

CO2-emissions by country:

In these maps territories are re-sized on each map according to the size of the emissions in each country.



Oil cost curve, including technological progress: availability of oil resources as a function of economic price



Source: OECD/IEA 2006

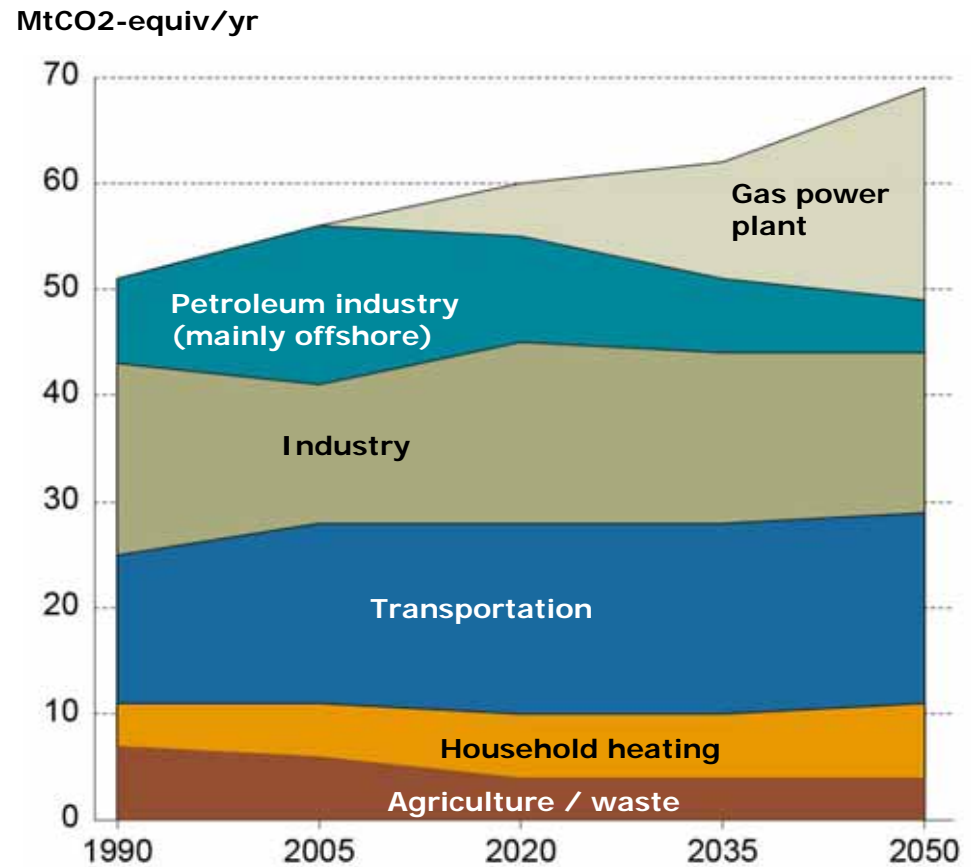
**We are not running
out of fossil fuels
anytime soon...**

**but we are running
out of atmosphere**



Norway's current CO2 situation

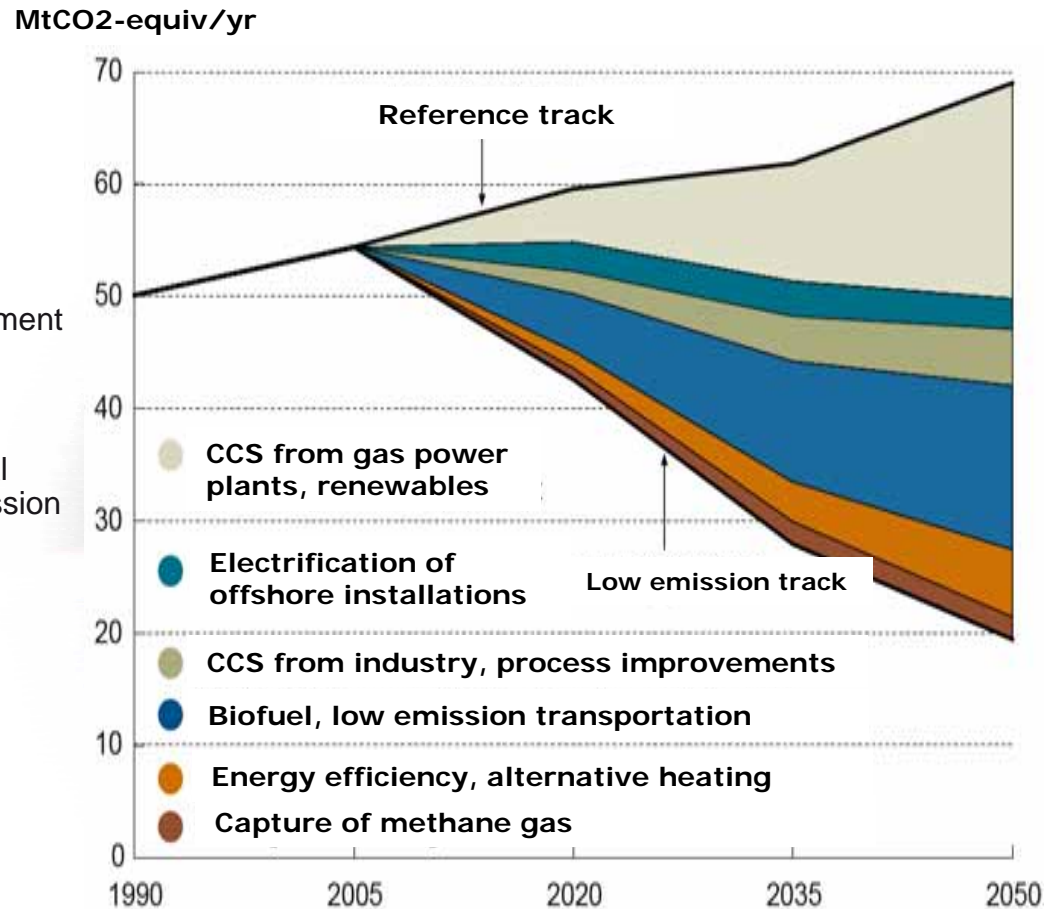
- Contribute 0.2% of global CO2 emissions (~55 Mt)
- Current "Kyoto commitment" is +1% above 1990 level. Gov. proposal is -9% of 1990 level.
- Norway introduced CO2-tax in 1992 as world's first.
- Norway joins the European quota scheme from 2008, and the EU ETS system.
 - ~70% of emissions subject to quotas/CO2 tax
- Industry:
 - Current emissions ~19 MtCO2, expected to increase to 22 MtCO2 within 2010
 - Quotas from 2008: 15 MtCO2 !



The Norwegian Government's Climate Policy - 1

- Oct. 2006: White Paper from the Norwegian Commission on Low Emissions:

- Norway has a responsibility to significantly reduce emissions and contribute to development of technology for combating climate change.
- Proposal of a “low emission track”
- Proposal of a series of political and industrial decisions and actions to reach the “low emission track”



The Norwegian Government's Climate Policy - 2

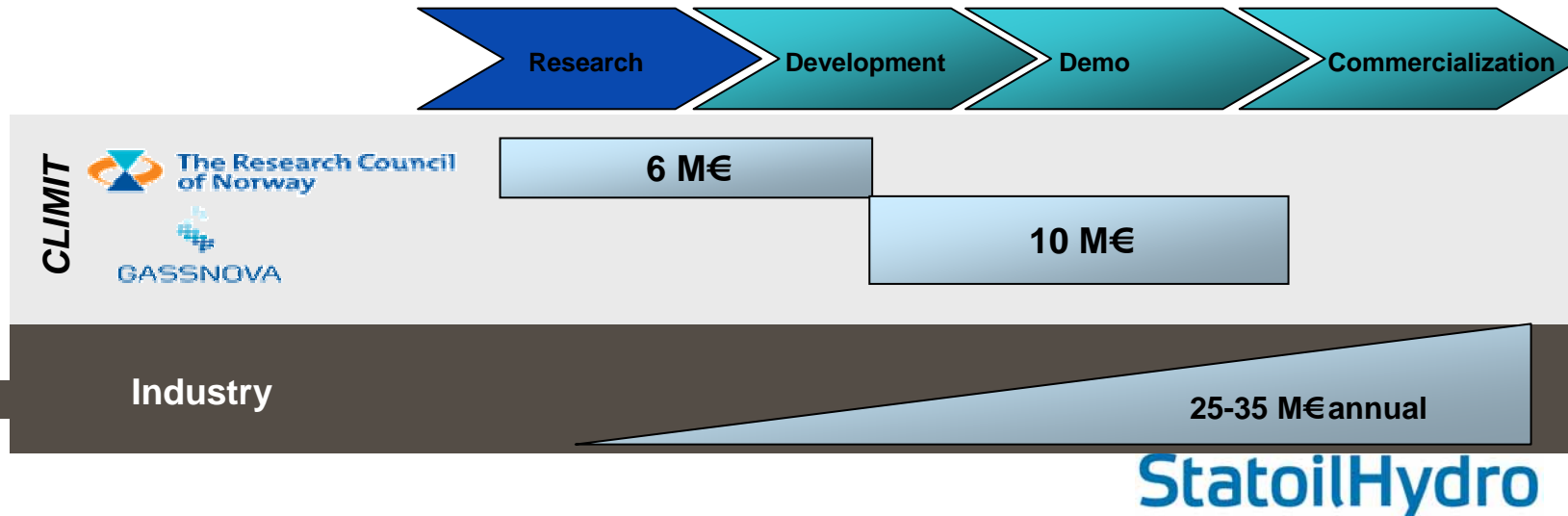


- Prime Minister Jens Stoltenberg's New Year Address 2007:
 - “Norway will take a pioneer role for development of technologies for CO2 capture and storage within 7 years – demonstrated at Mongstad”
 - “This is a large, national project and can be compared to the US Moon Landing project in the 1960's”
- Government's White Paper June 22, 2007:
 - Global target: limit average temperature hike to 2°C above pre-industrial level
 - Strengthen Norway's “Kyoto commitment” from 1% **above** 1990-level to 9% **below** 1990 level
 - Reduce Norway's carbon emission footprint with 30% within 2020
 - Reduction of 13-16 MtonCO2 including forestation
 - Norway shall be “carbon neutral” within 2050
 - Carbon emission reductions may be domestic/offshore reductions or through purchase of international emission credits
 - However – the target is that 50%-65% of the reduction shall be domestically



Establishment of Gassnova

- Jan 2005: "Centre for Gas power technology"
 - Subsidiary of and advisor to Ministry of Petroleum and Energy
 - Mandate: Facilitate technology development through the CLIMIT R&D&D program
- July 2007 : "Norwegian center for CCS"
 - State owned company
 - Manage the Norwegian government interests and obligations within the area of CCS
 - Mandate: Full-scale CCS projects and realization; reduce costs associated with CCS; Maximize government benefits and synergies from CO2 projects



Norwegian CCS 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

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

CO2 capture installations

CO2-absorber and –stripper towers at the Snøhvit LNG plant in Northern Norway



Sleipner field CO2-absorber and –stripper towers are located on the T platform



CO2-absorber and –stripper towers at the Algerian In Salah gas processing plant

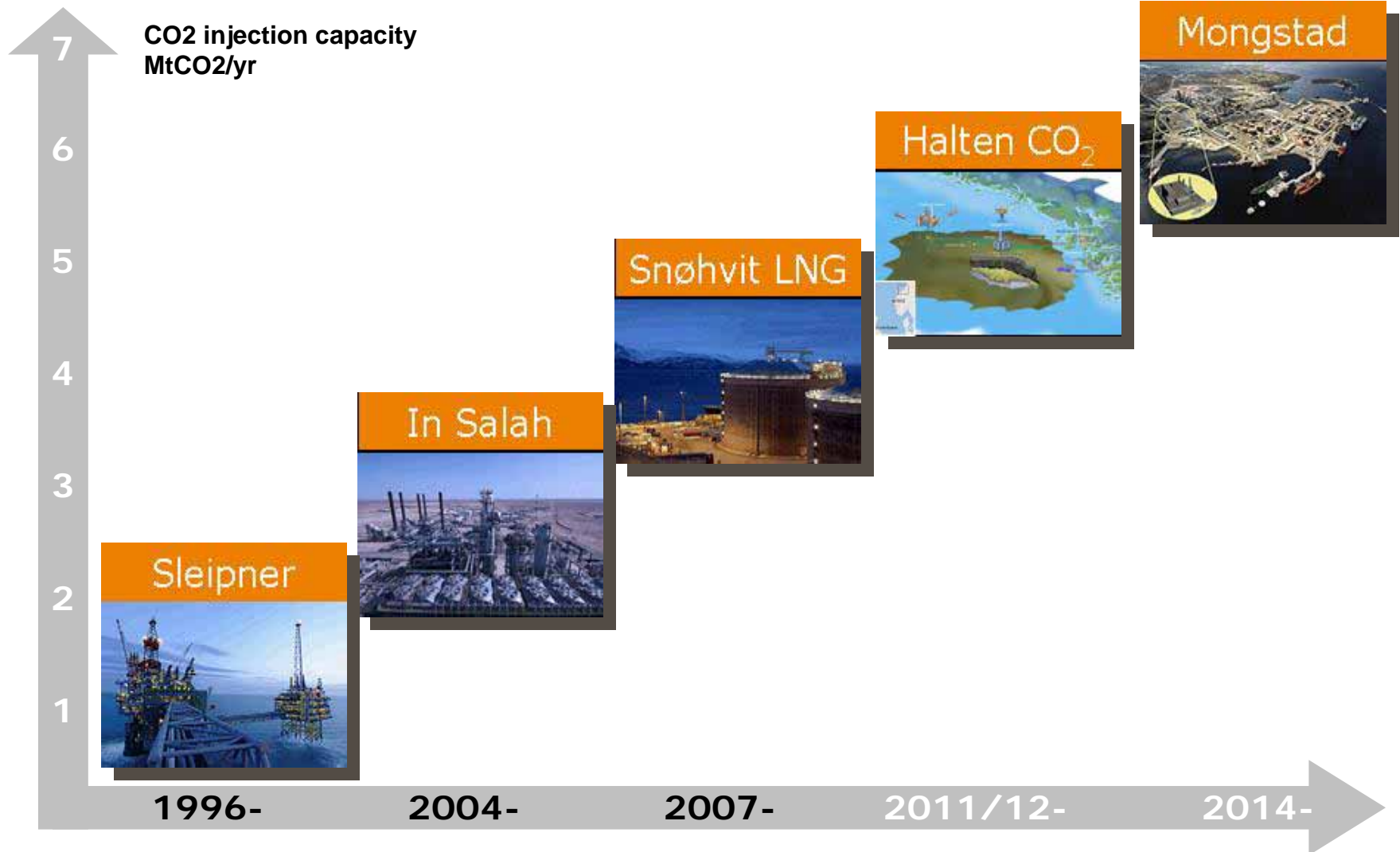


Norwegian capture technology – Just Catch and Just Catch Bio

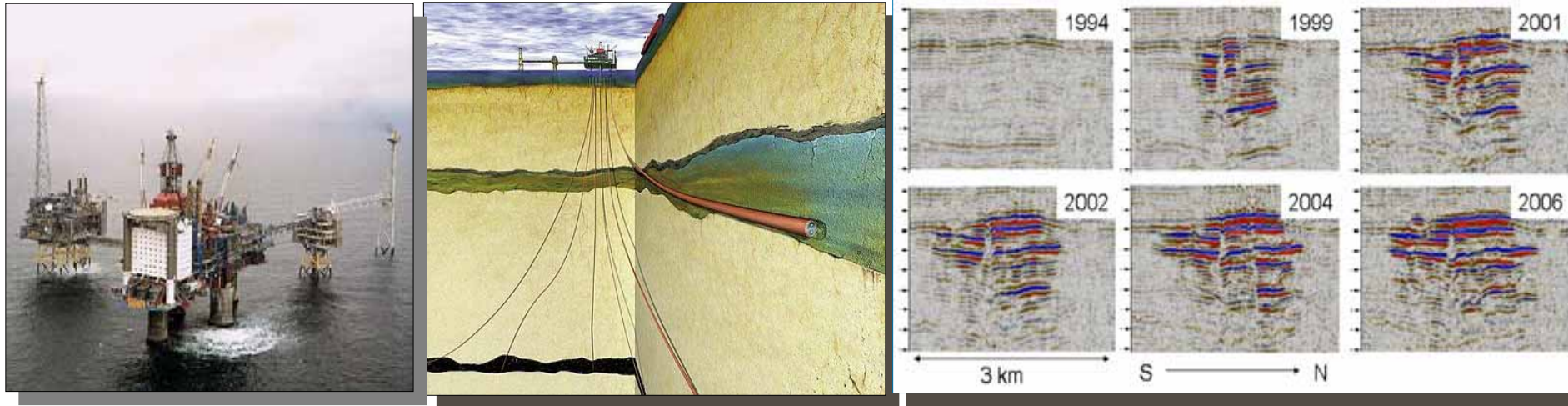
- Amine-based capture technology.
- Cooperation between Aker Kværner and 12 industrial partners.
- 2 year project with budget of 6 MUS\$
- Commercial technology by 2010
- Just Catch Bio: utilizing bio-fuel for regeneration heat for the amine.
- Targets: higher efficiency and lower price than available technology.



StatoilHydro's CO₂-prosjekter



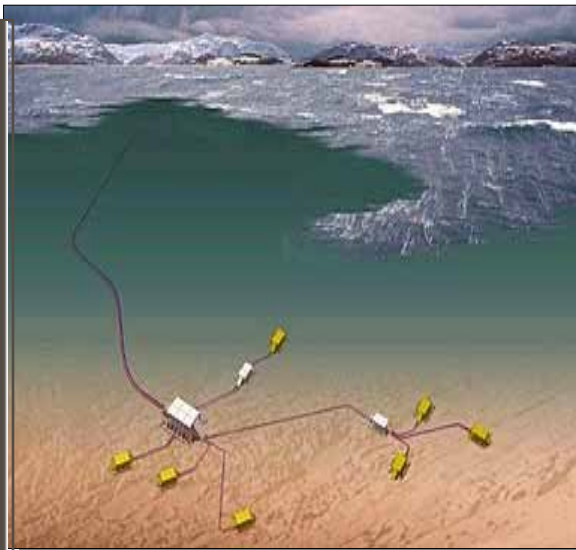
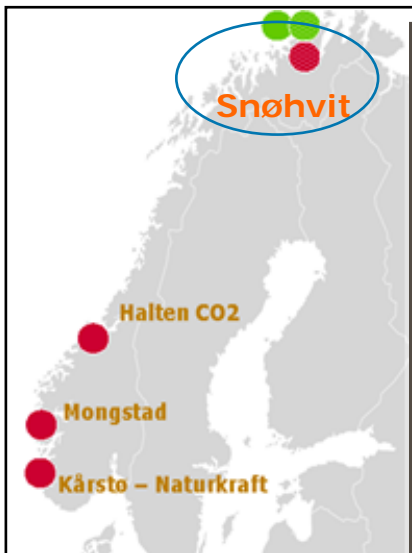
The Sleipner experience – the starting point



- 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: the ~45US\$/ton CO₂-tax imposed in 1992
- Learning and confidence building through a series of large EU-wide R&D programs

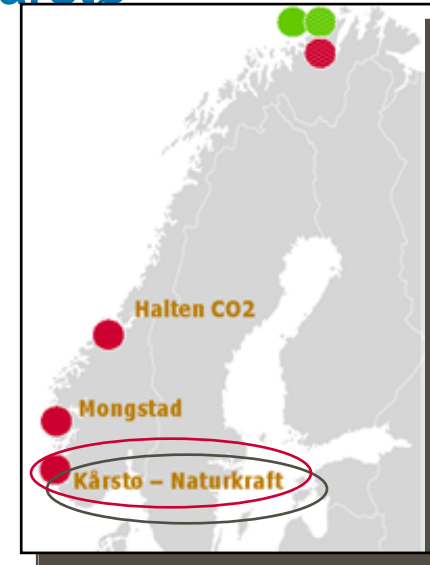
Snøhvit LNG – the next milestone

- Piped CO₂ separated from natural gas in onshore LNG plant, and re-injecting in sandstone below natural gas reservoir
- Storing 700.000 tons CO₂ annually from 2007
- Opening of LNG-plant Aug. 2007 – currently testing and flaring



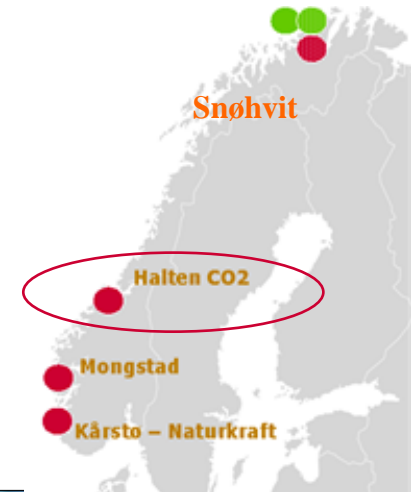
CO₂-capture at Naturkraft's gas fired power plant at Kårstø

- First large-scale gas power plant in Norway @ 420 MW
 - Cleanest gas power plant in Europe
 - NO_x < 2 ppm
 - NH₃ < 5 ppm
 - Started operations November 1st 2007
- CO₂ capture from 2011-2012
 - 1 Mton CO₂ / year
 - Post-combustion / Chemical absorption
 - Geological storage



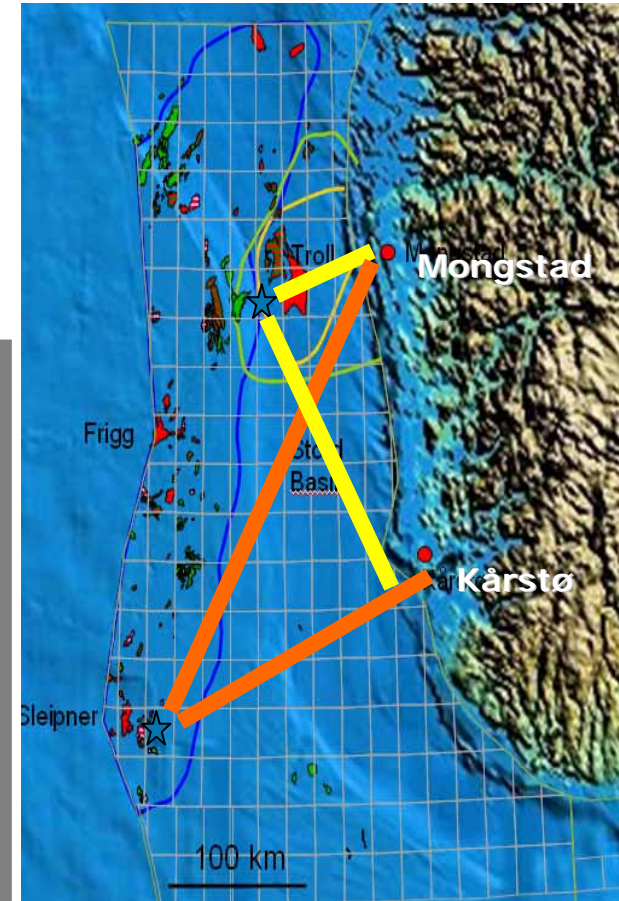
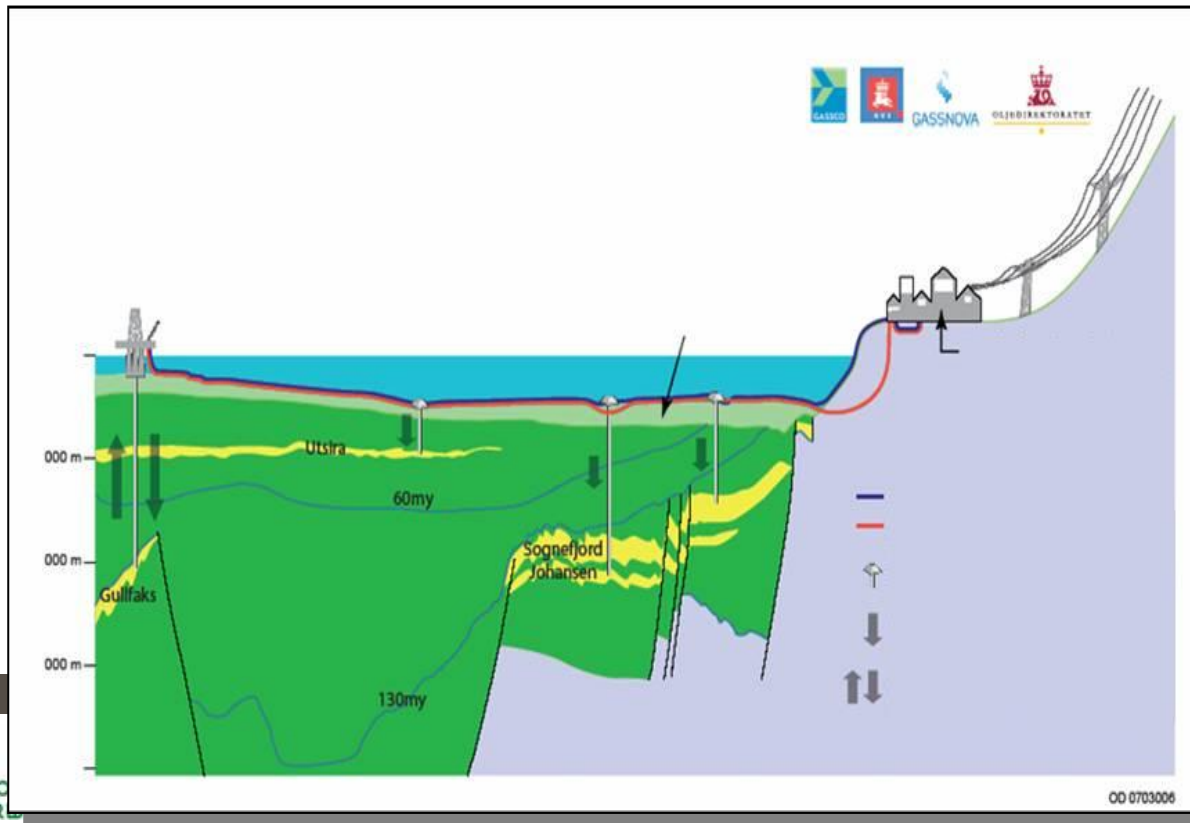
Need for integrated CCS value chains: The StatoilHydro – Shell “Halten CO2 Project”

- Announced March 2006 –
- 860 MW gas power plant
- Capture 85% of CO2 emissions
 - ~2.5 Mton CO2/yr
- Storage:
 - Initial plan: Transport to the “Draugen” gas field for EOR
 - Now: deposition in the e.g. “Sleipner” formation
- Currently technical/financial evaluations
 - Will require substantial governmental support
- Startup earliest 2009



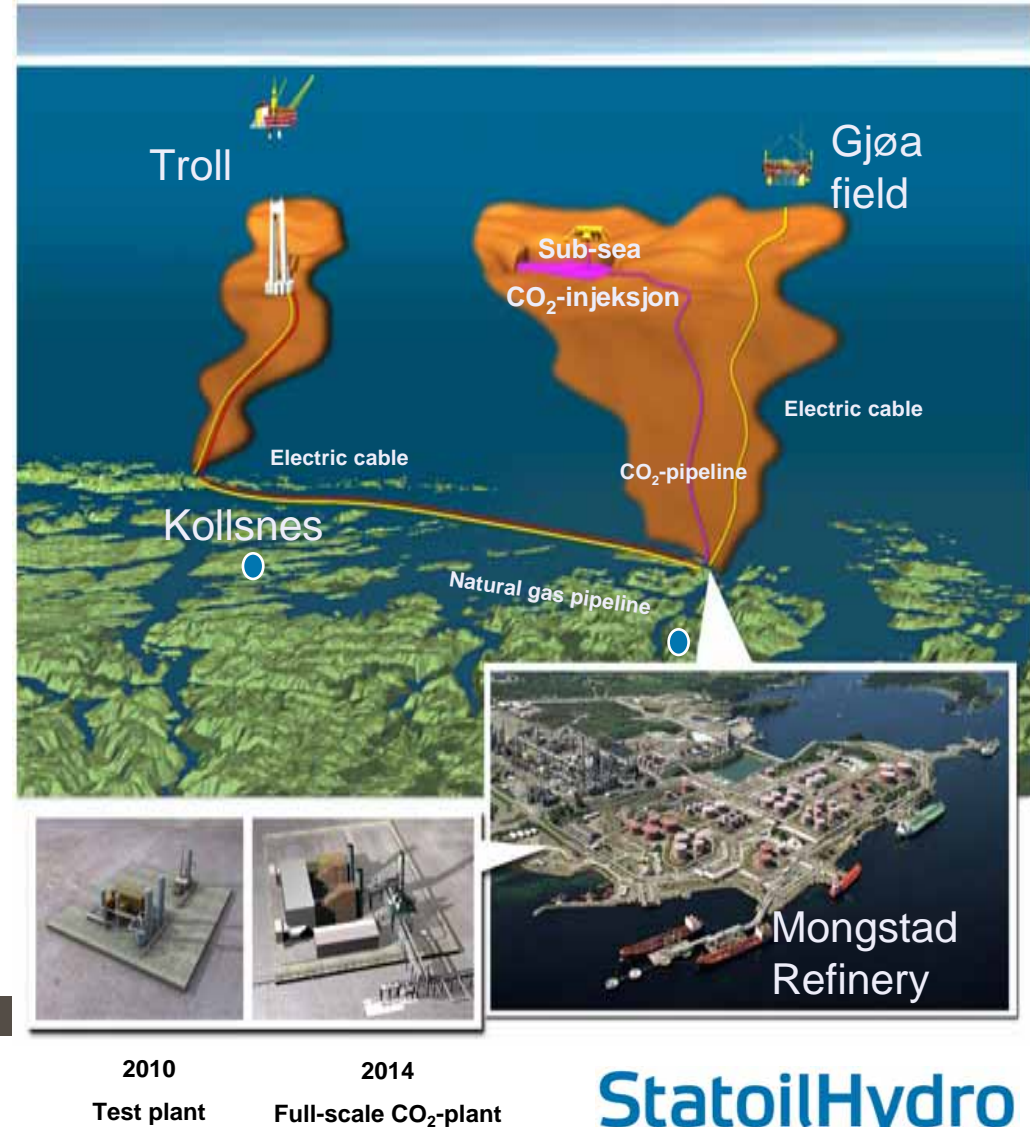
Storage alternatives for the Norwegian North Sea

- Pipelines from Mongstad and Kårstø
- Deposition sites:
 - Utsira (Sleipner)
 - Johansen formation (south of Troll)

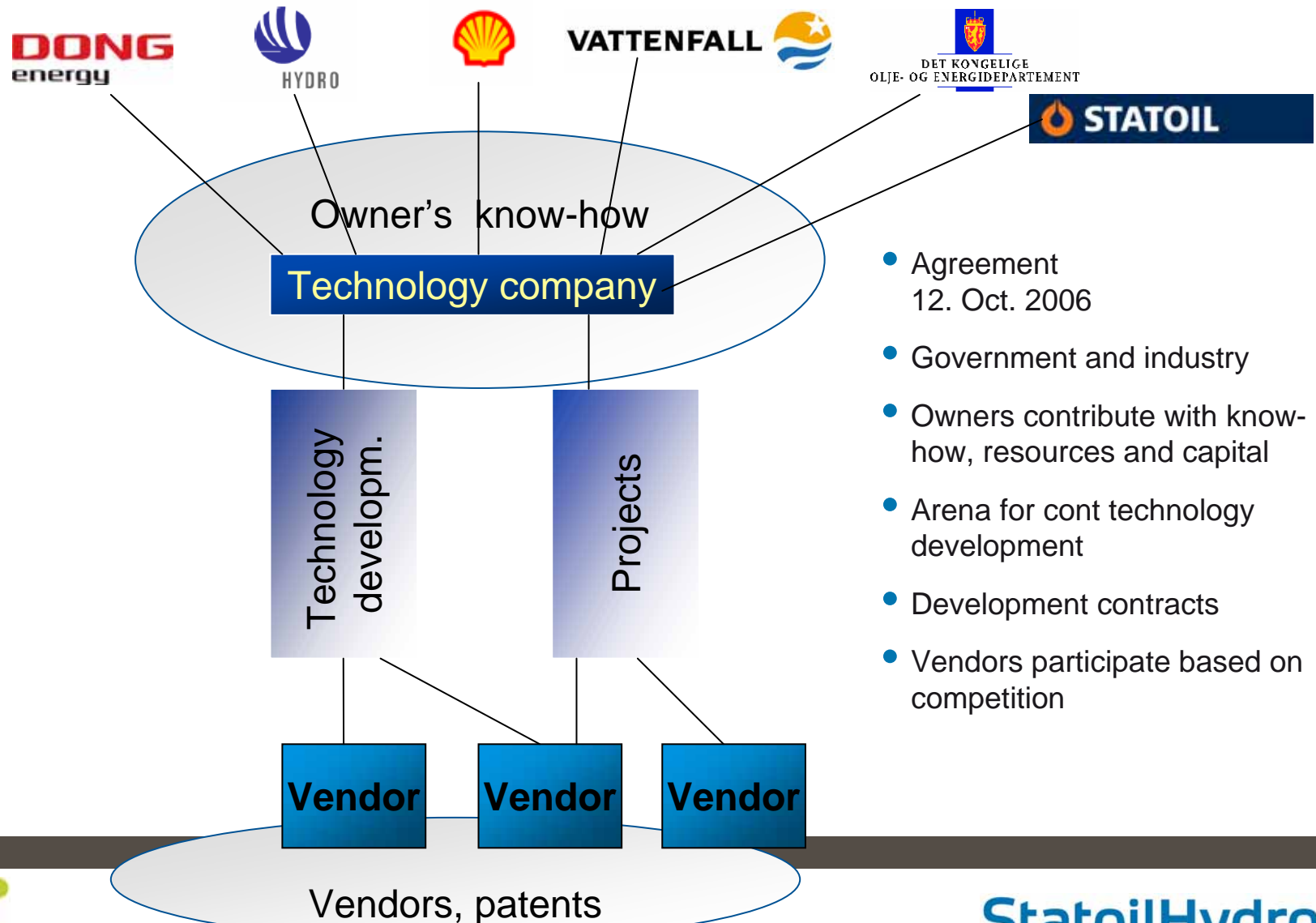


European CO₂ Test Centre Mongstad (TCM)

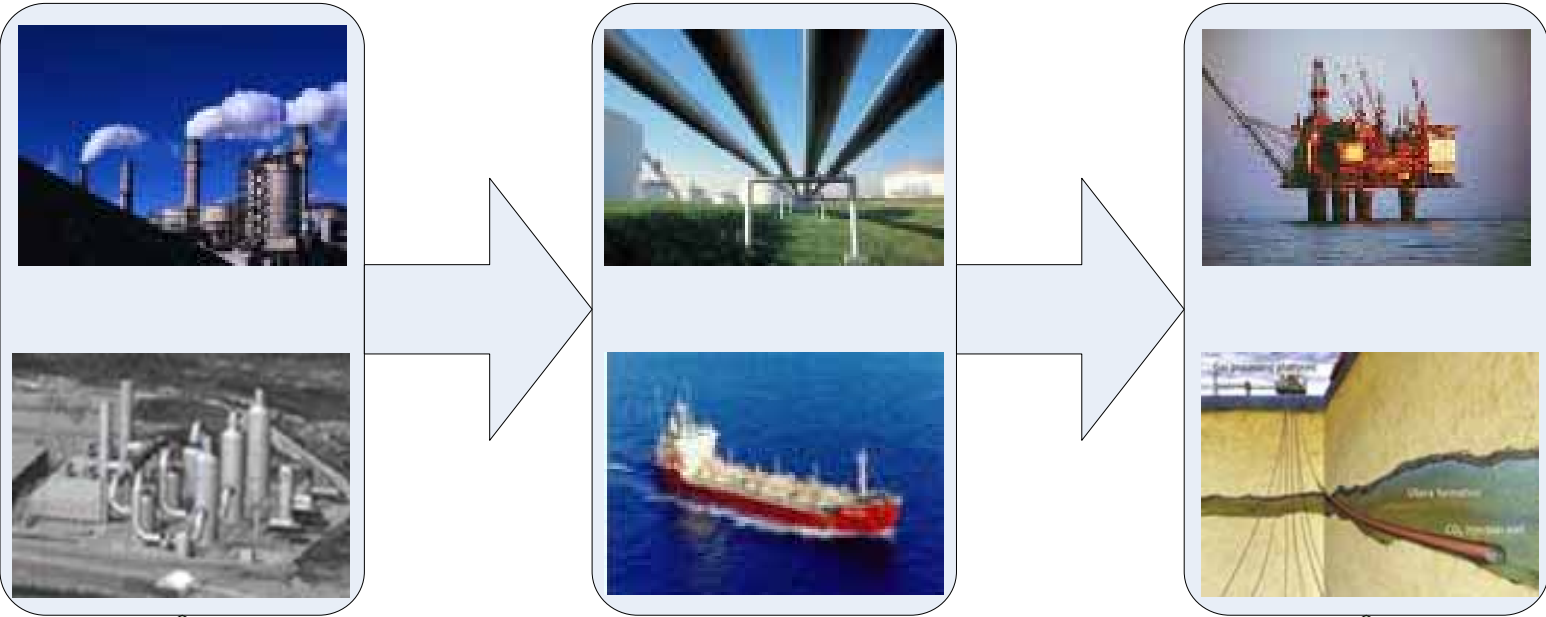
- Gas power plant / combined heat and power
 - 400 MWe
 - Heat for refinery
- Test-center for CCS technologies
- Capture plant from 2011-2012
 - 2010: 0.1 MtCO₂/yr
 - 2011/12: 1.1 MtCO₂/yr
 - 2014: 1.3 – 2.2 MtCO₂/yr



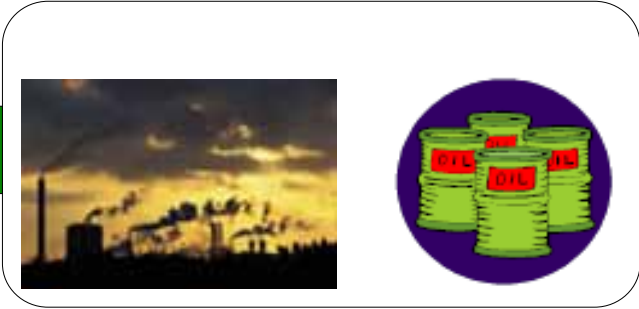
European CO2 Test Centre Mongstad (TCM)



CO2 value chain with revenue streams → income is needed!

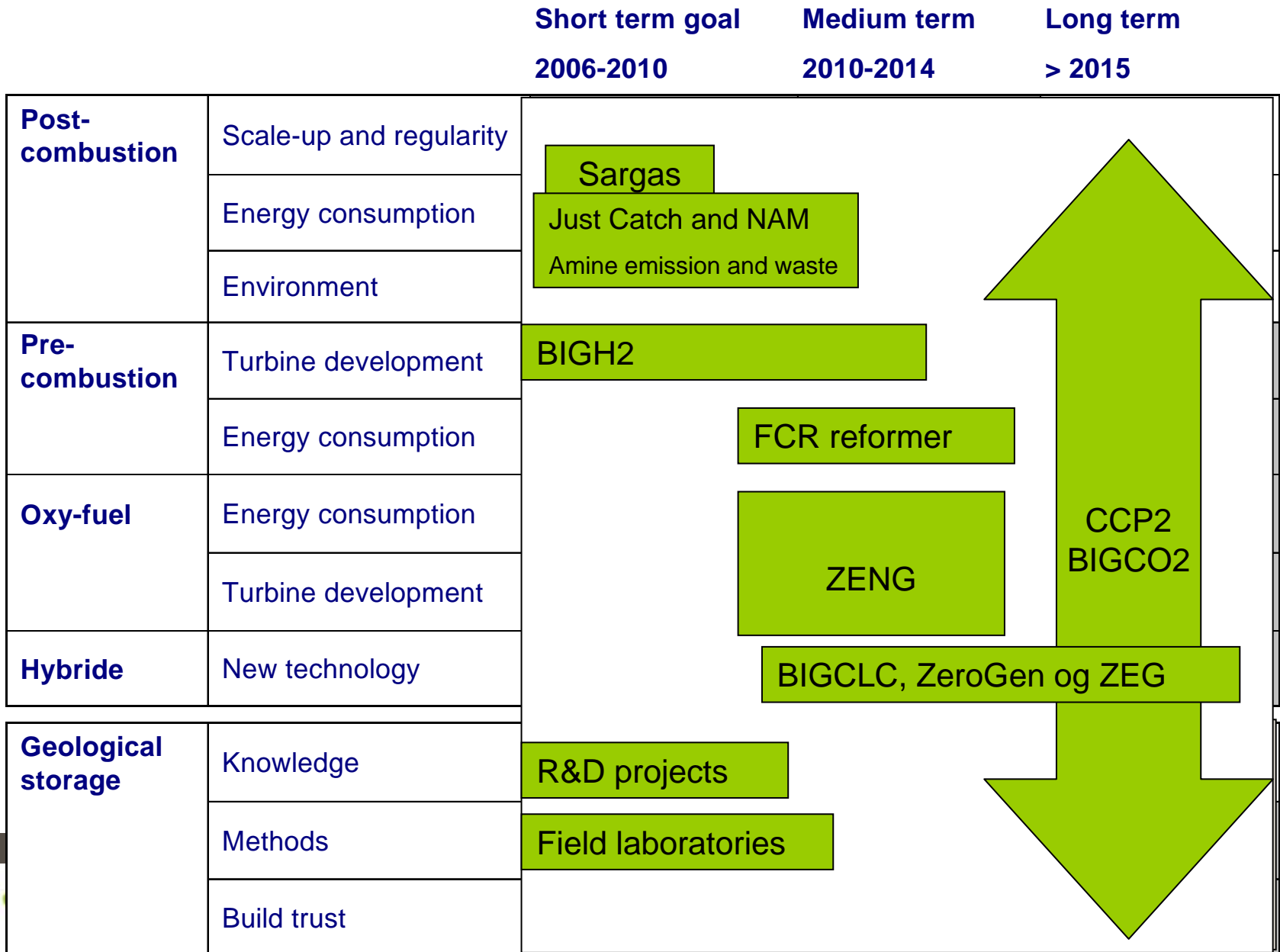


**Kyoto
Mechanisms and
emission trading schemes**



**Additional oil
if CO₂-enhanced oil
recovery feasible**

The Norwegian CCS roadmap:



Conclusions:

- Norway has been an early mover on the CCS arena
- Strong governmental attention since late 1980's
 - “Brundtland Report” 1987
 - CO2 tax from 1992
 - Increased focus from 2006/2007
- Strong industrial and research engagement
 - StatoilHydro – storage since 1996
 - AkerKværner – capture technology
 - SINTEF-NTNU – CCS R&D
- Mongstad Test Center
 - Invites international partnership
 - “Laboratory” for CCS technology providers

