Future of CCS Technology – Moving Ahead

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- Crystal ball
- Trends
- New drive?
- Conclusion

Conclusion

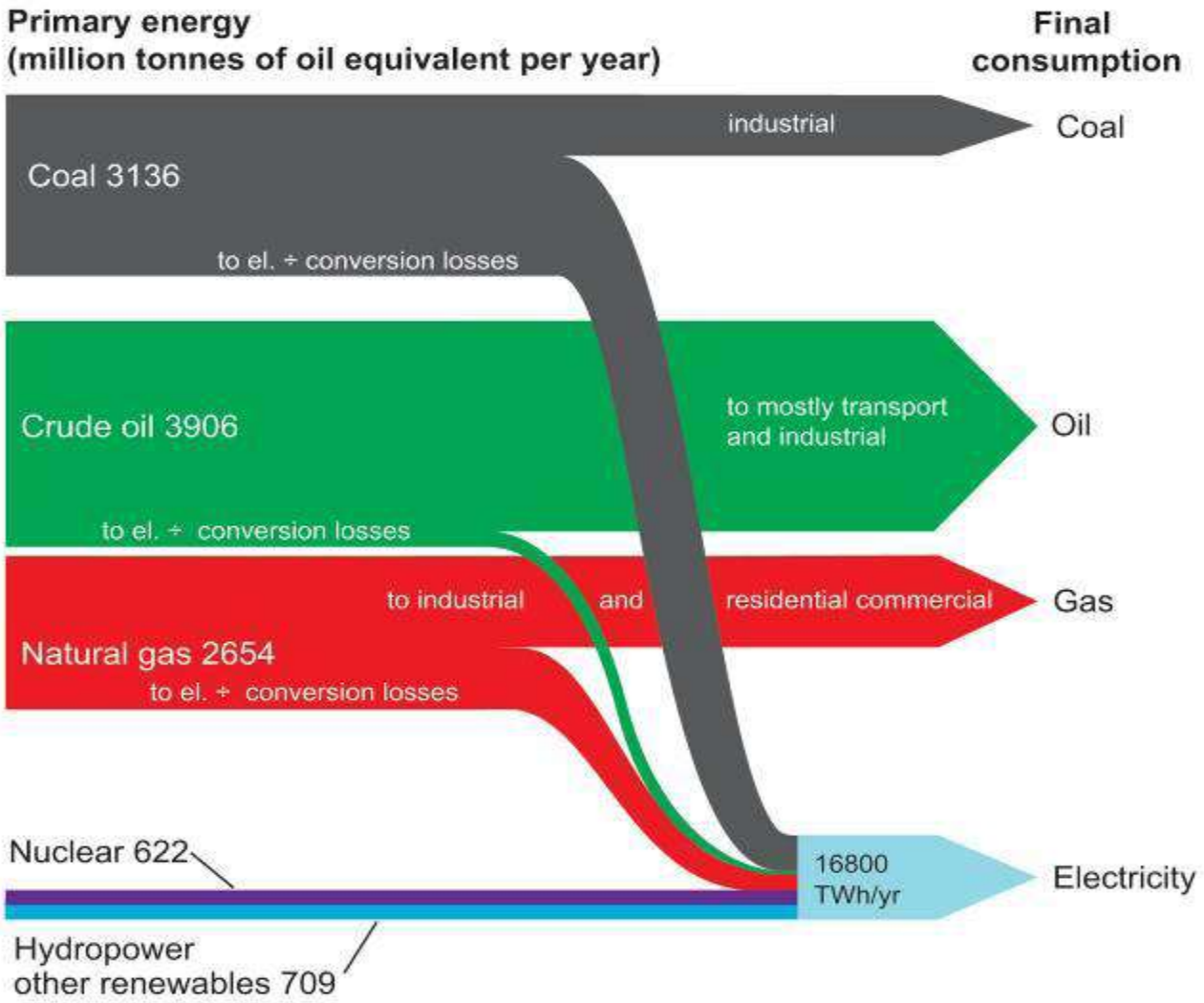
1. Slow progress – Do storage pilots!
2. Power expensive – Do industry!

Crystal ball

This is it!

Statoil

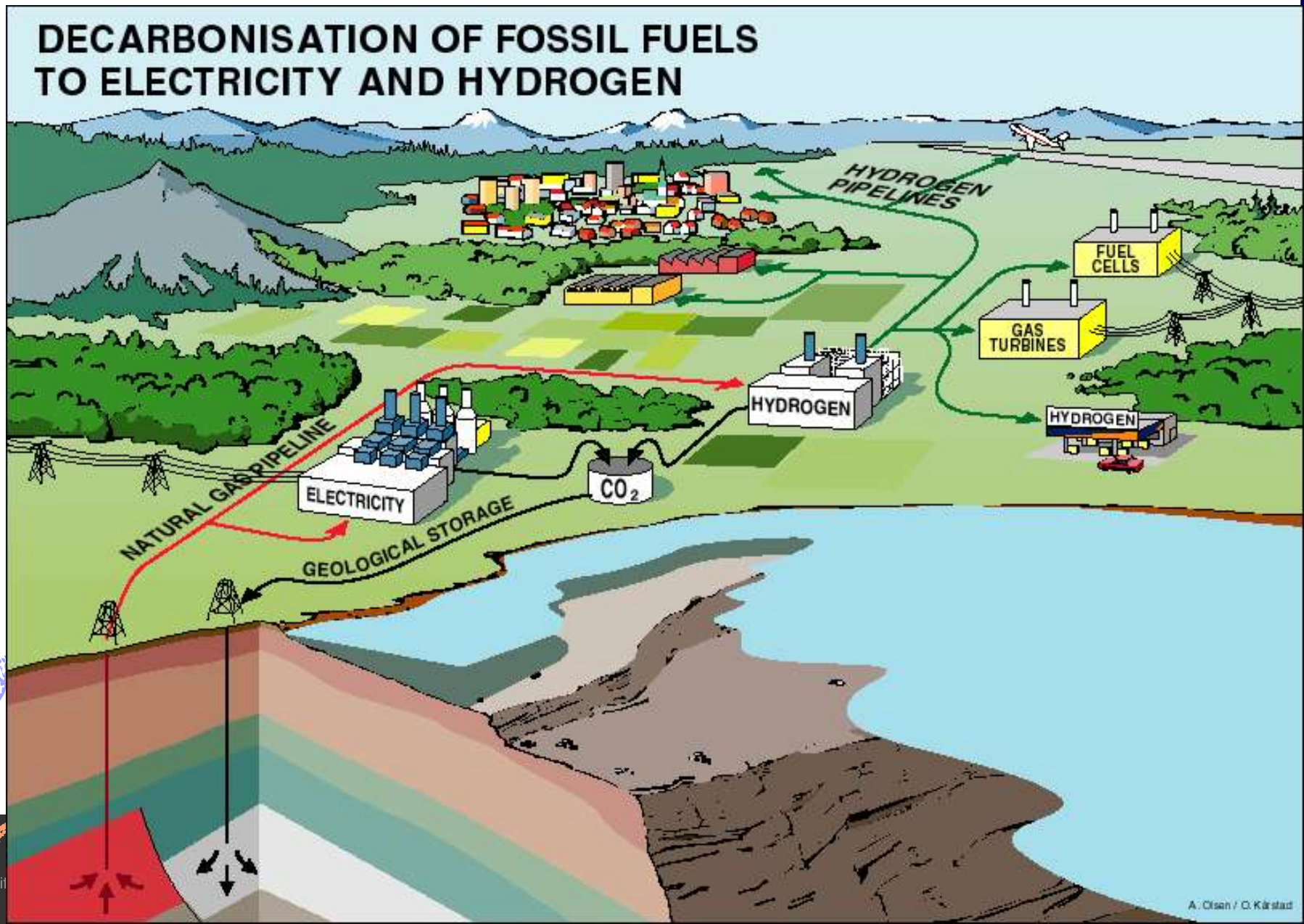
Simplified global energy flows 2007




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

Vision

STATOIL



Machiavelli «Il Principe» 1513:

There is no more dangerous act than trying to implement a new way

because

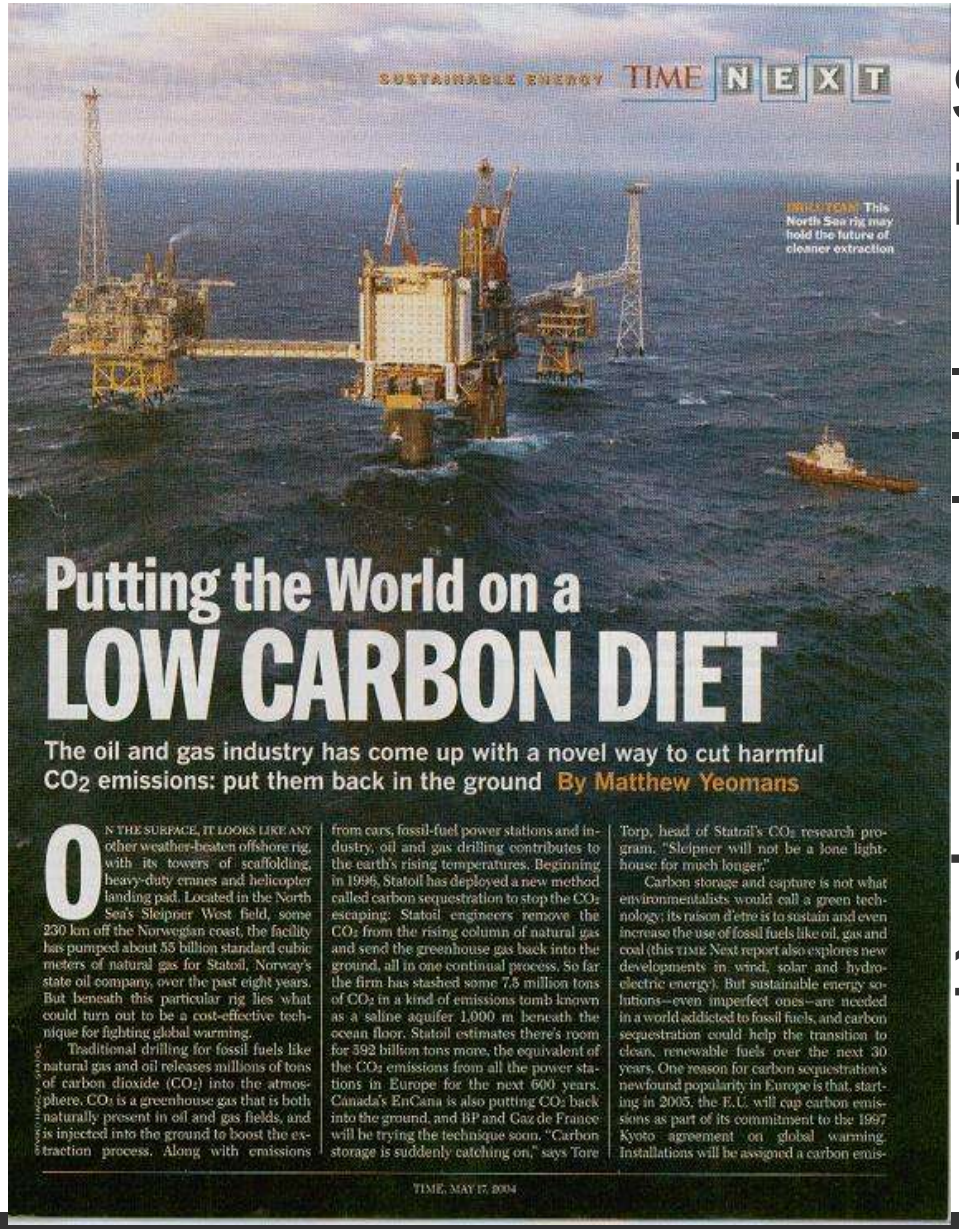
…the old way has formidable and numerous defenders and the new way only feeble and few supporters.

Arthur Schopenhauer:

“All new truths pass through 3 stages:

1. **Ridicule,**
2. **Violent opposition and**
3. **Accepted as obvious.**

Trends



SUSTAINABLE ENERGY TIME NEXT

BRAVE NEW: 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 33 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

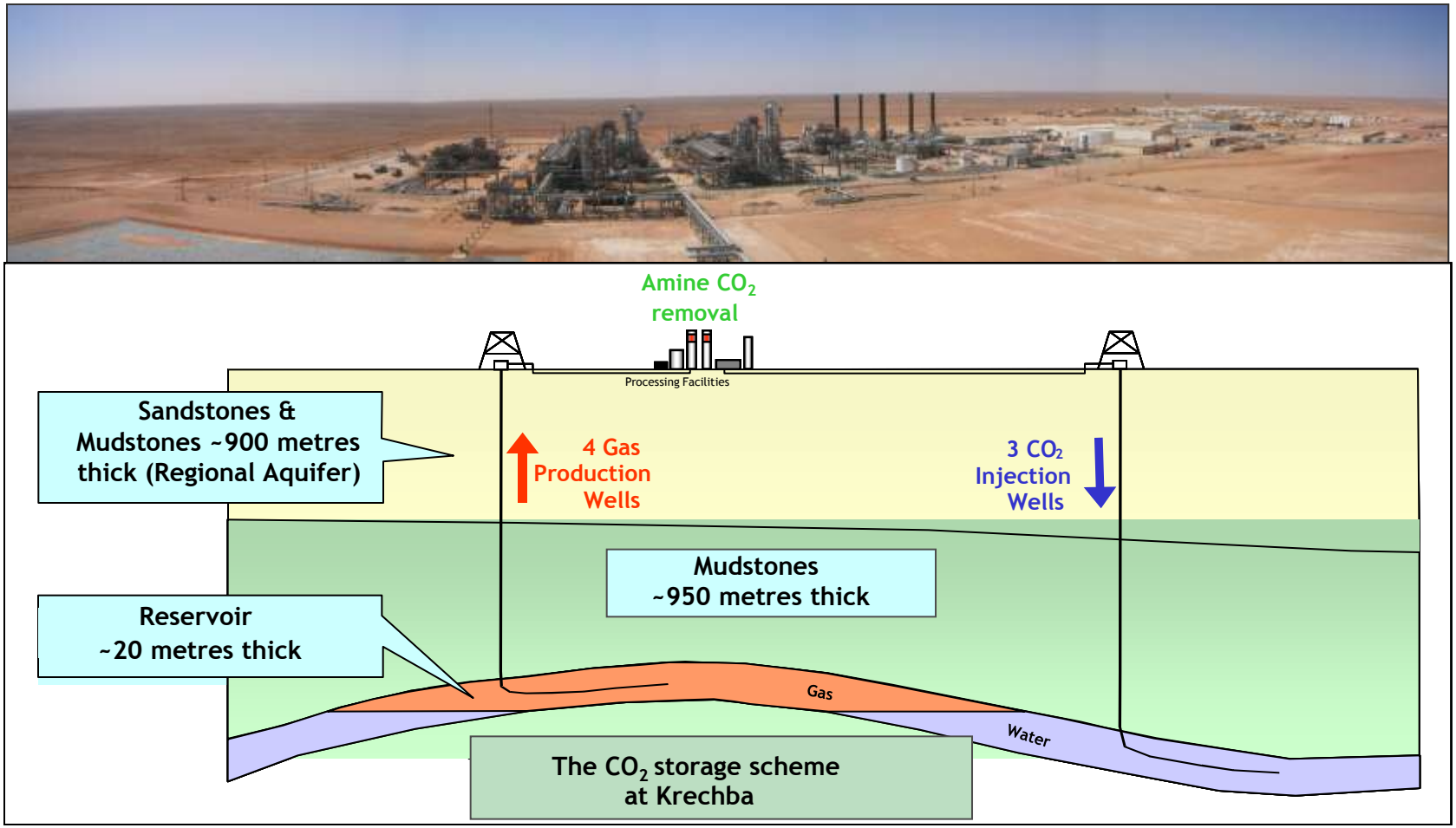
Sleipner CO_2 injection:

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

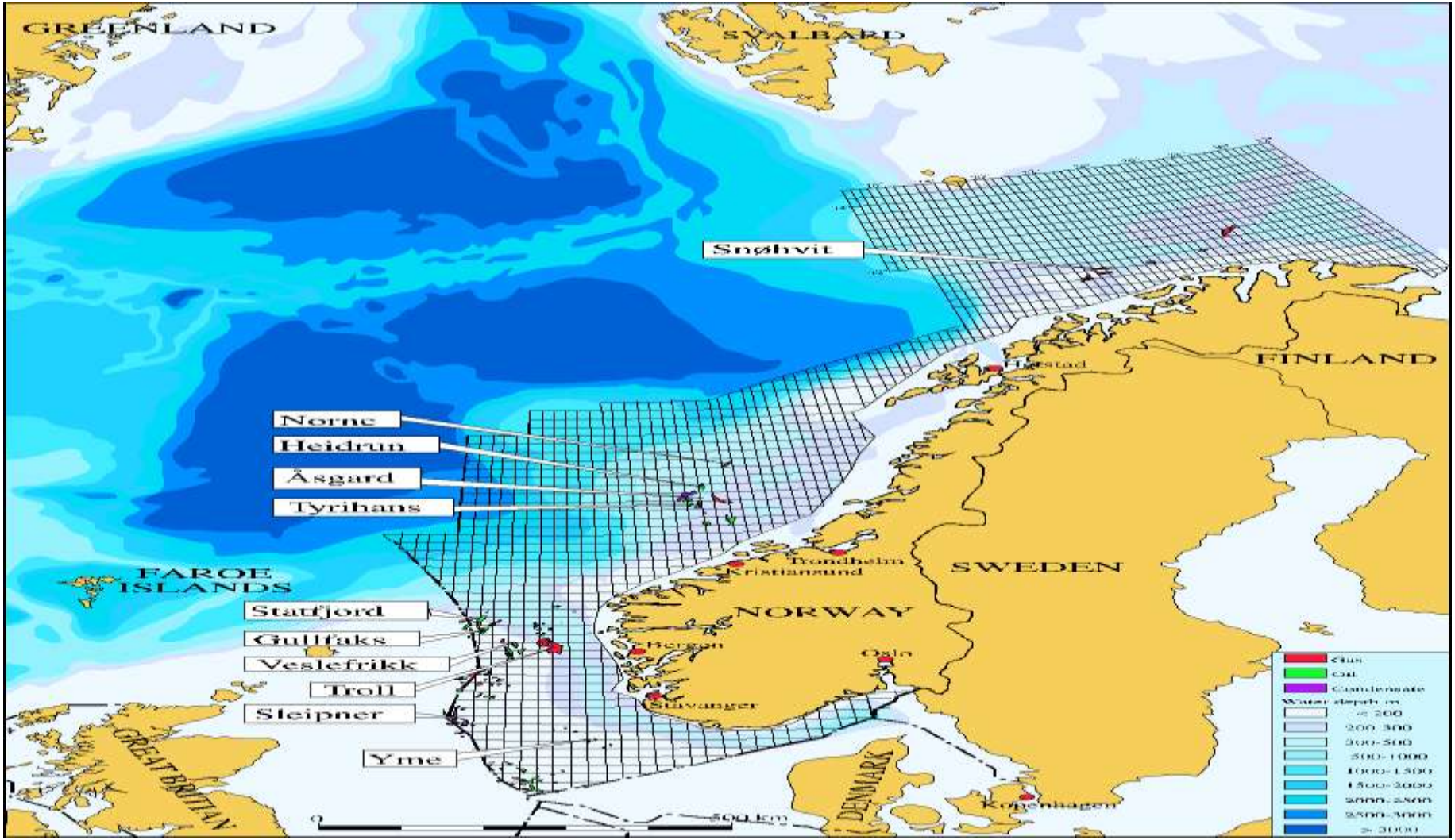
Time Magazine, 17. May 2004

Statoil

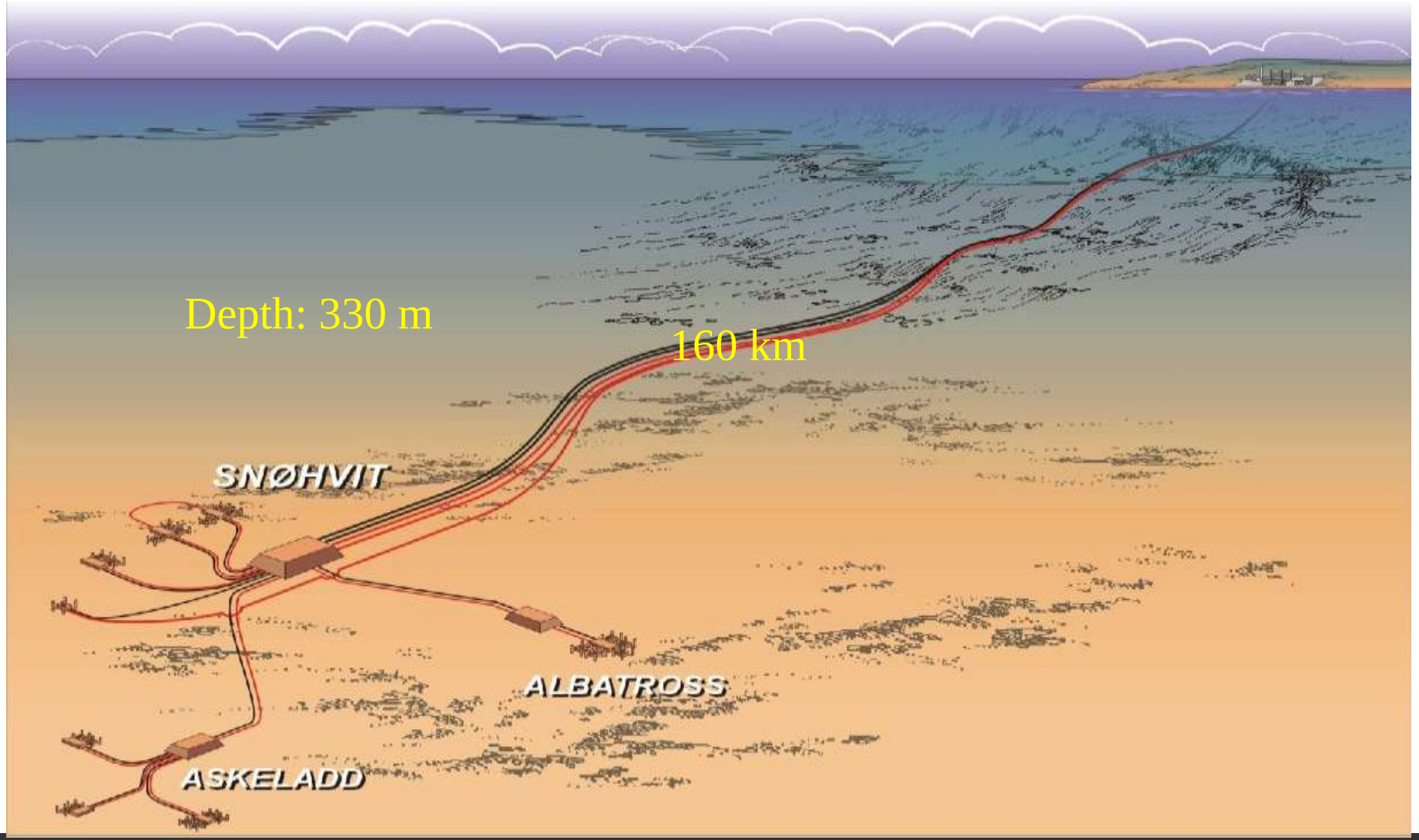
In Salah in Algeria



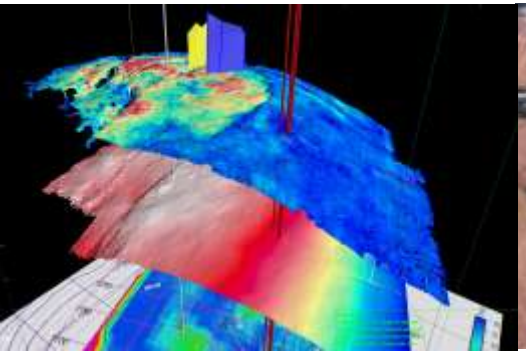
Snøhvit, implement CO_2 storage offshore in North Atlantic



Snøhvit – All subsea



CO2SINK - First European On-shore CO_2 Storage Project at Ketzin (Germany)



SIXTH FRAMEWORK PROGRAMME

Federal Ministry of Education and Research

Federal Ministry of Economics and Technology

Coordinator: GFZ, Potsdam

Industry: E.ON, RWE, Schlumberger, Shell, Siemens, Statoil, Vattenfall, VNG

Statoil

Test Centre Mongstad – inaugurated June 2012

Amine and chilled ammonia CO_2 capture demos,

100 000 t CO_2/a combined capacity – “Catch and release”

Legal Framework

OSPAR & London Protocol

- since February 2007:

- CO_2 storage permitted sub-seabed, if:
  1) Content as captured, no additions
  2) Sea bottom monitored – HOW?
  3) EIA - Environmental Impact Assessment – WHICH?

- since 2010?

- CO_2 trans-border (over or under), if:
  1) Both states agree
  2) Both states follow OSPAR & London standards

Research on Environmental Impact

PAST:

- **NASCENT** – Natural Analoges for geological CO2 Storage.
  Terrestrial and sea-bottom impacts of volcanic seepages

ONGOING:

- **RISCS** – ”Research into Impacts and Safety in CO2 Storage”.
  Terrestrial and sea-bottom impacts of possible seepage

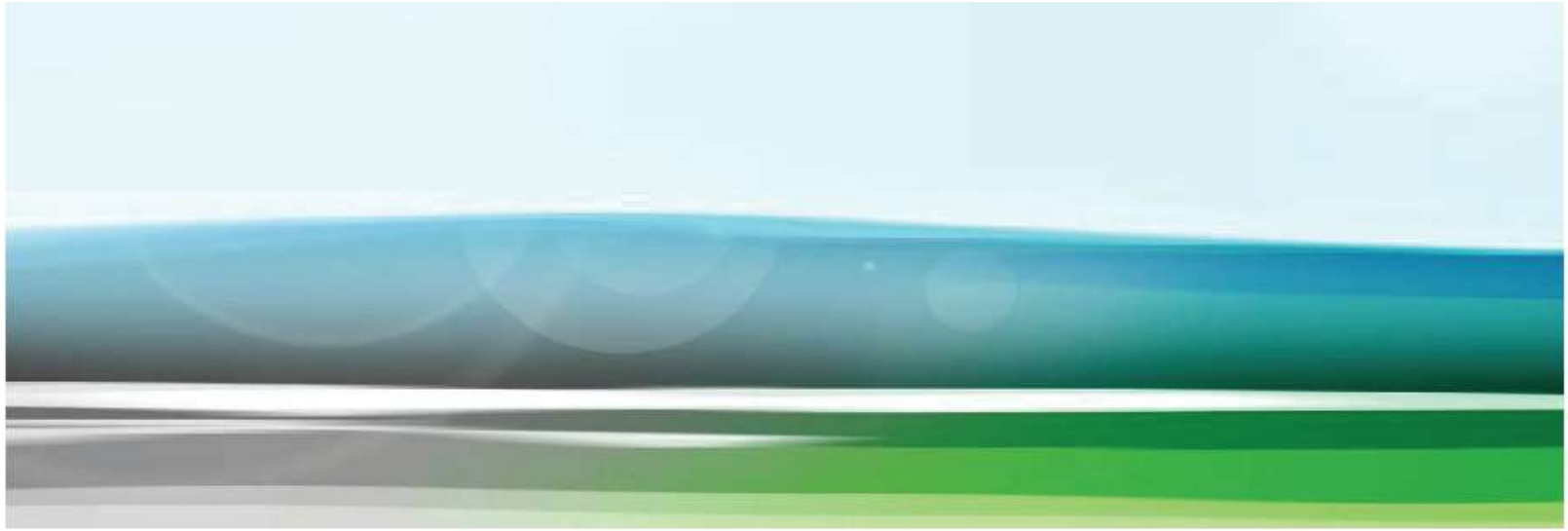
- **ECO2 –** “Sub-seabed CO2 Storage; Impact on Marine Ecosystems**“.**
  1) CO2 appearance (if seeping)
  2) Detection
  3) Sensitivities of marine species
- **QUICS** – Controlled release of CO2 in the sub-seabed in Scotland

Pressure vessel 25 bar at SINTEF Sealab, Trondheim

SAFETY STRATEGY

- **Prepare**
- **Monitor**
- **Remediate**

CO2QualStore – Site selection



CO2QUALSTORE – Guideline for Selection and Qualification of Sites and Projects for Geological Storage of CO_2

CLIMIT GASSCO Schlumberger

Statoil bp BG GROUP PETROBRAS RWE The energy to lead

ieaghg DONG energy ARUP VATTENFALL

MANAGING RISK DNV

Statoil

Licensing – Start and End

START – Site Selection and Characterisation:

- SITECHAR – ”Characterisation of European CO2 Storage”
  Characterise European cases and show
  How Guidelines work in Practice

END – Closing and Handover:

- CO2CARE – ”CO2 Site Closure Assessment Research”
  1) Wells closure for long-term,
  2) CO2 behaviour prediction and
  3) Handover procedures drafted.

Public Communication – Local!

”Europe needs 10 – 12 Demonstration sites to verify…”

- Geology

and

- Geography

➔PILOTS:

1 well, 30 kt CO2 over 3 years, Monitoring = 15-10 M€ ?

+ OPENNESS

New drive?

Why delays?

1. New technology & underground – Hesitate?
2. Governmental crisis in GR, IT, ES, PT, IR – No public money ?

Decisive factors:

1. IPCC 4.assessment Report 2013 -2014 – Climate change?

2. Financial crisis hits bottom – New optimism?

Critical path?

1. Site characterisation – “Long lead item” - 3 – 10 years?
2. Injectivity and capacity – Critical factors for full CCS chain
3. Underground storage – Public uncertainty
4. Drill one well , inject 10-50 kT CO2 - Low costs

➔ **Storage pilots!**

Conclusion

1. Slow progress – Do storage pilots!
2. Power expensive – Do industry!

THANKS for your attention!

QUESTIONS?

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

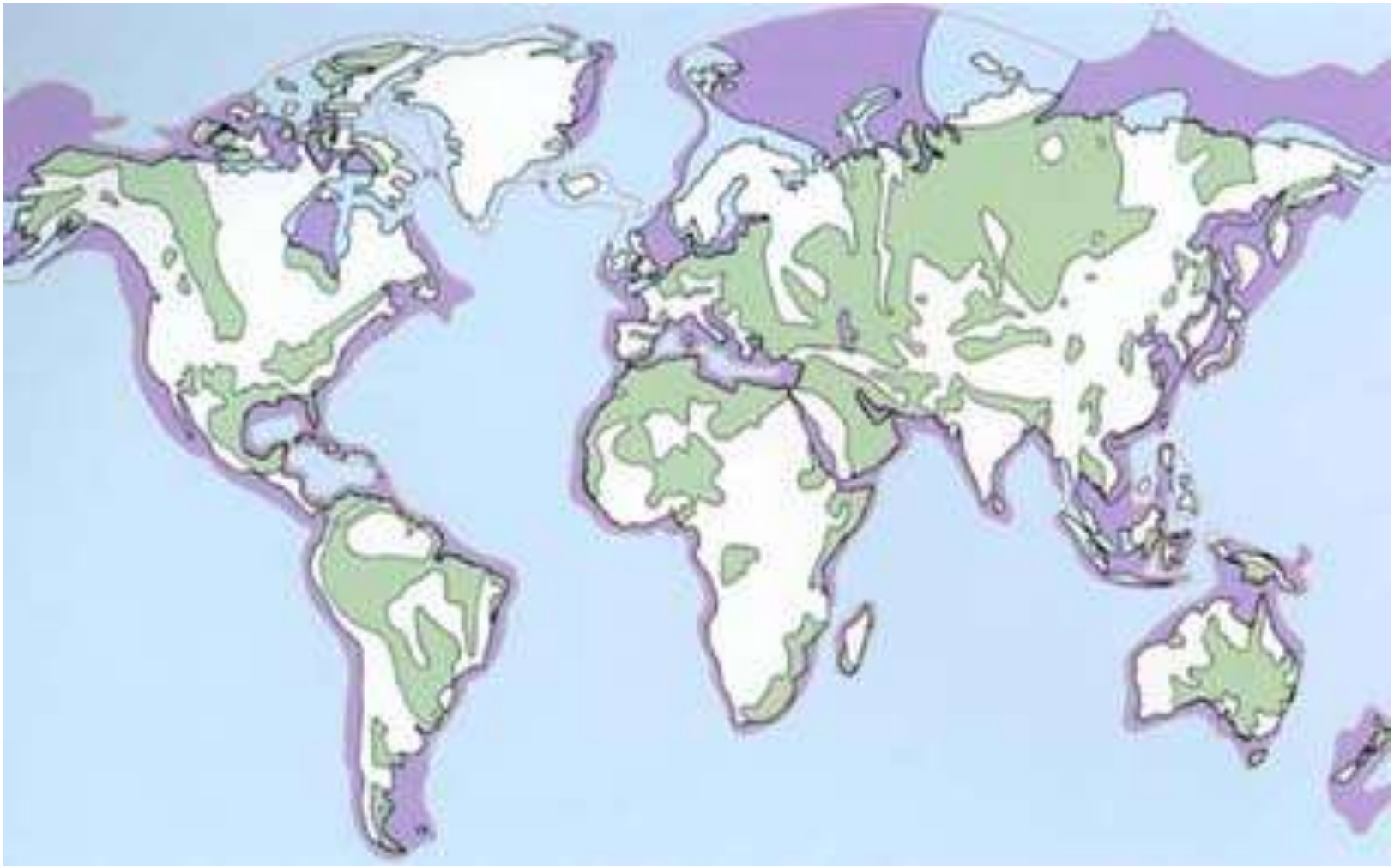
Laying a new pipe-line in the ocean

Kårstø gas power station – with CO_2 capture

Statoil

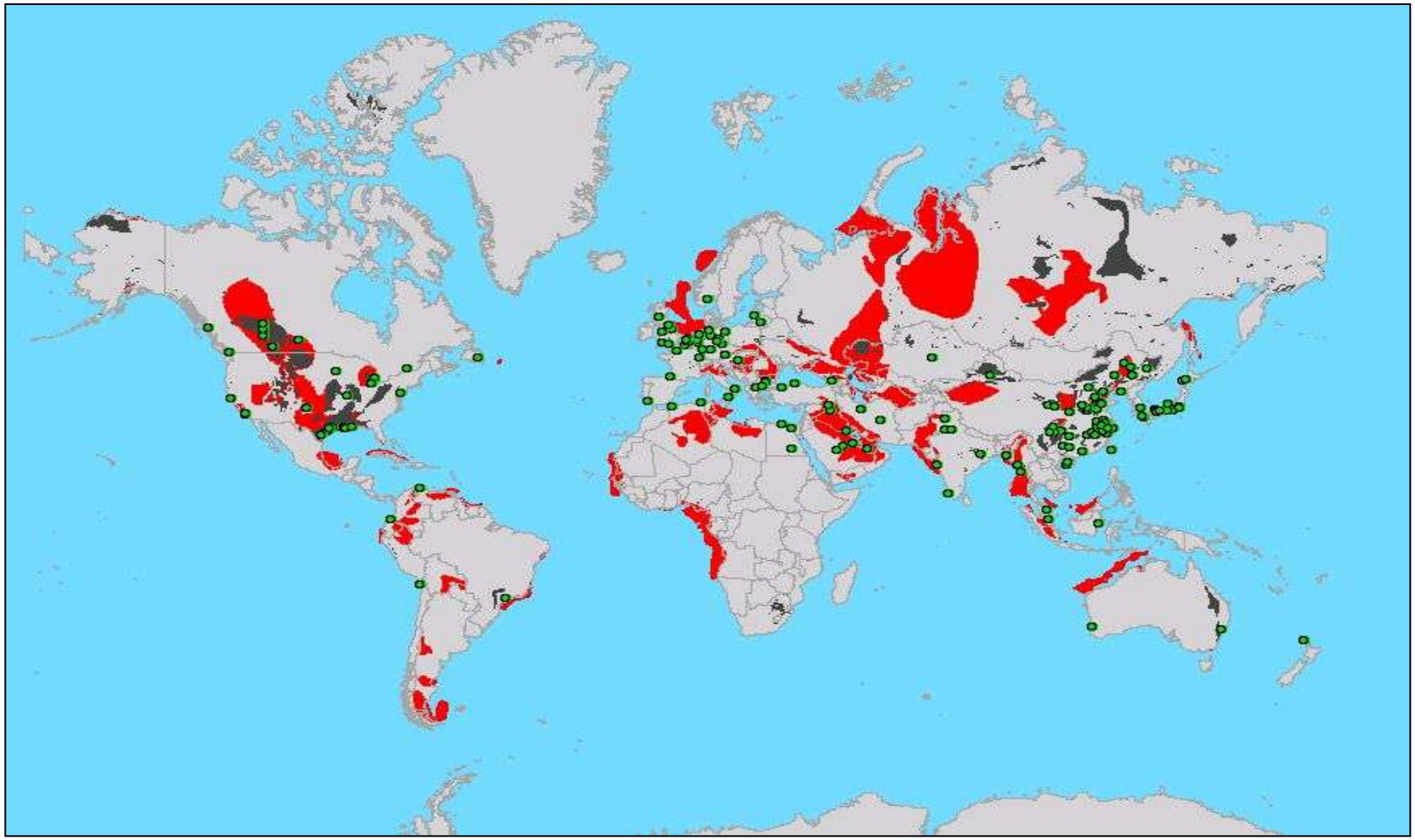
Sedimentary basins of the world.

Onshore - Green. Offshore - Lavender.



Source: Schlumberger

Point sources of CO2 (green dots)



Courtesy of IEA Greenhouse Gas R&D Programme

Statoil