BSTA-24 In-session Workshop on
O2 Capture and Storage,
onn 20 May 2006.

xperiences from Demonstrations & Pilots: SLEIPNER and more

ore A Torp, Statoil Research Centre, Trondheim, Norway

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Experiences and lessons learned from demonstrations and Pilot projects – CO2 Storage

CONTENT:

- "Low Carbon Diet"
- Industrial Experiences with CO2
- Sleipner, In Salah, K12B, Ketzin, Snohvit and ?
- What will Authorities and Public demand?
- VISION and Way forward?

SUSTAINABLE ENERGY TIME NEXT

INDUSTRY 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 0 km off the Norwegian coast, the facility s pumped about 55 billion standard cubic eters of natural gas for Statoil, Norway's te oil company, over the past eight years. t beneath this particular rig lies what uld turn out to be a cost-effective tech- que for fighting global warming.

Traditional drilling for fossil fuels like tural gas and oil releases millions of tons carbon dioxide (CO_2) into the atmos- ere. CO_2 is a greenhouse gas that is both turally present in oil and gas fields, and injected into the ground to boost the ex- ction 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-injeksjon

- Besluttet i 1992
- I drift siden 1996
- 1 million tonn CO_2 / år

Time Magazine, 17. Mai 2004

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revious Experiences with CO2 & Injection

Enhanced Oil Recovery (Texas, Hungary, Turkey, Brazil,Croat

Natural gas cleaning

Transport – Pipelines & Ships

Natural gas re-injection

Natural gas underground storage

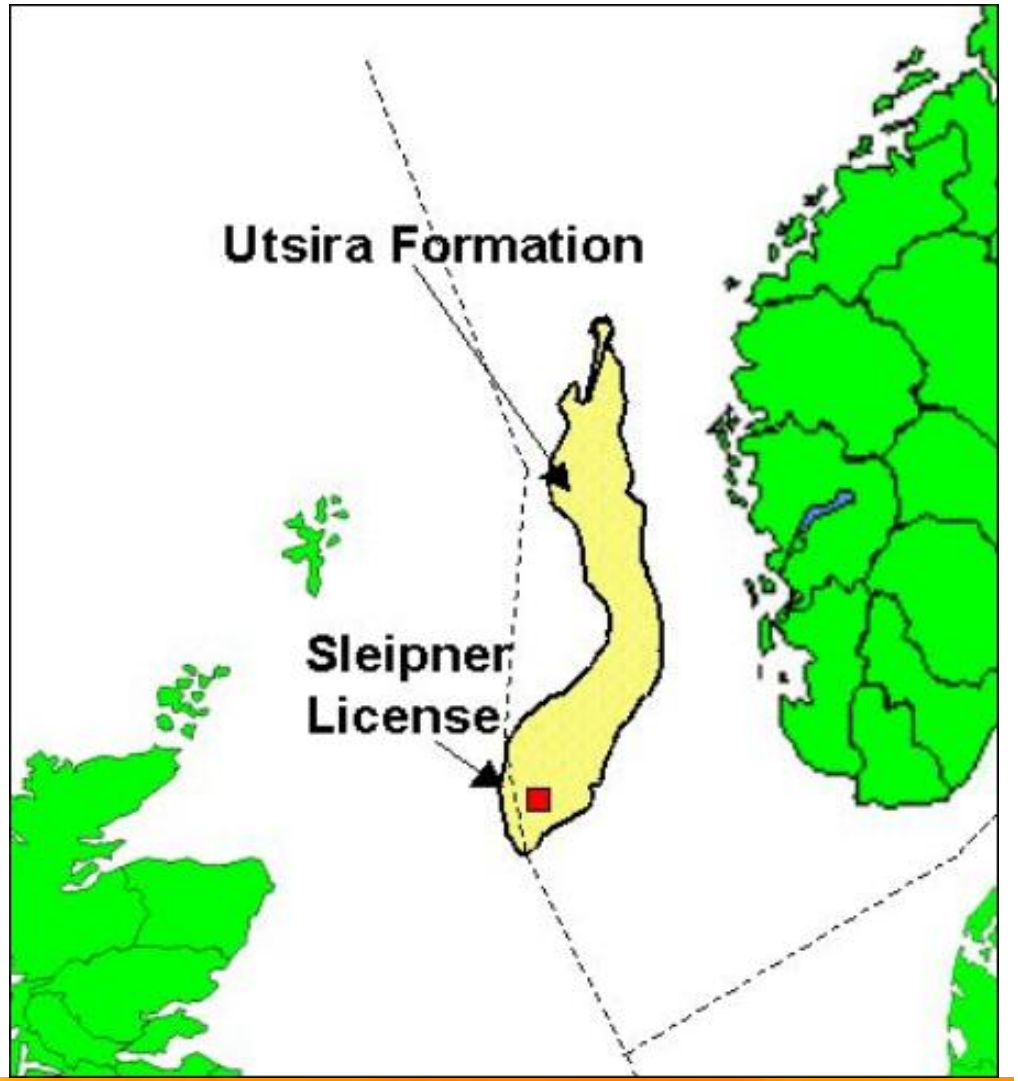
and

Beer & soft drinks, dry cleaning, food packaging – Every day life

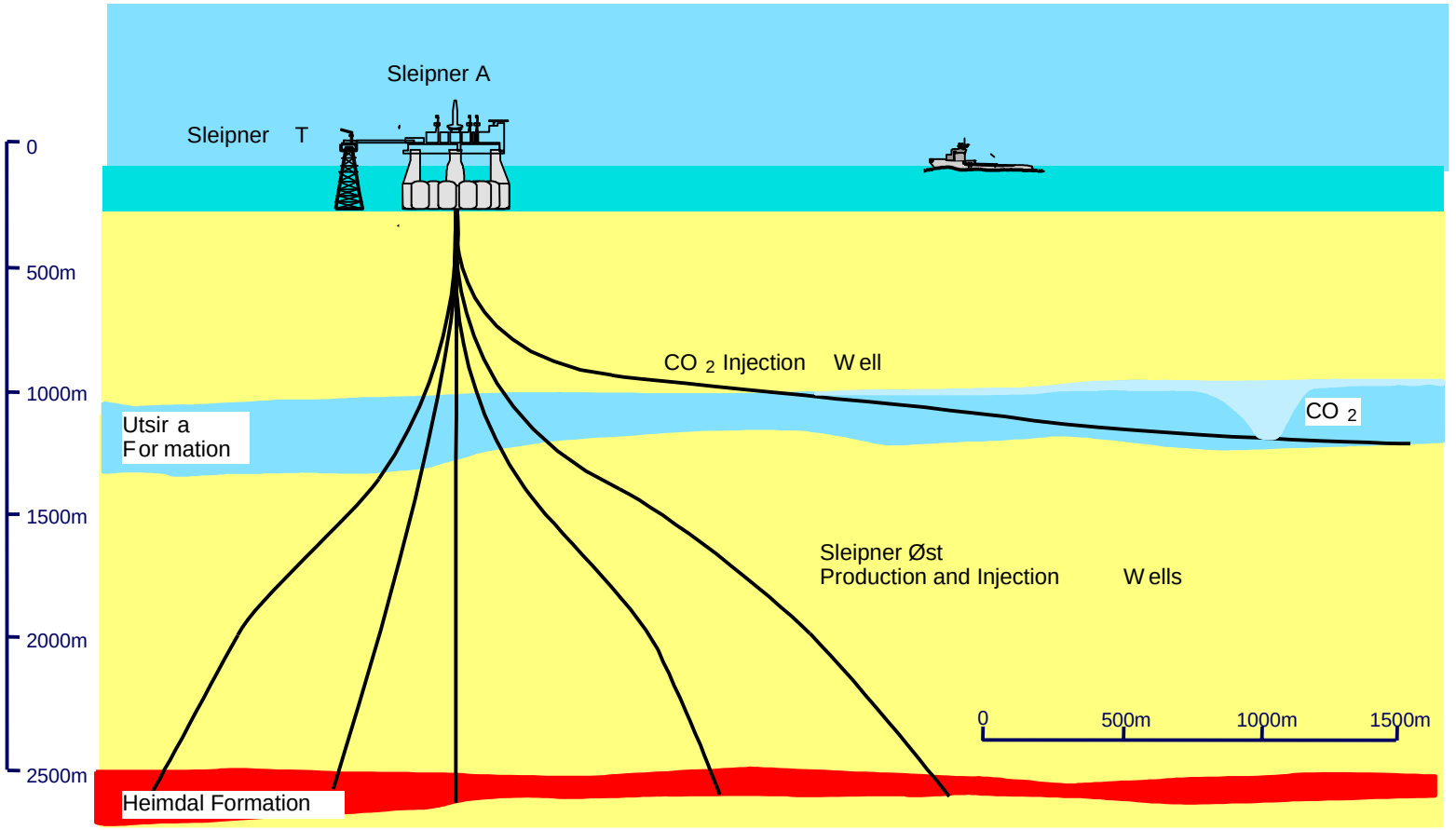
Yara CO_2-tankers, 1500 m^3 capacity

he Sleipner field – CO2 Treatment and Injection

he Utsira Formation



CO2 Injection Well in "Utsira"



SALINE AQUIFER CO_2 STORAGE PROJECT

Statoil
BP
ExxonMobil
TotalFinaElf
Norsk Hydro
Vattenfall

BGS
BRGM
GEUS
IFP
NITG-TNO
SINTEF

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

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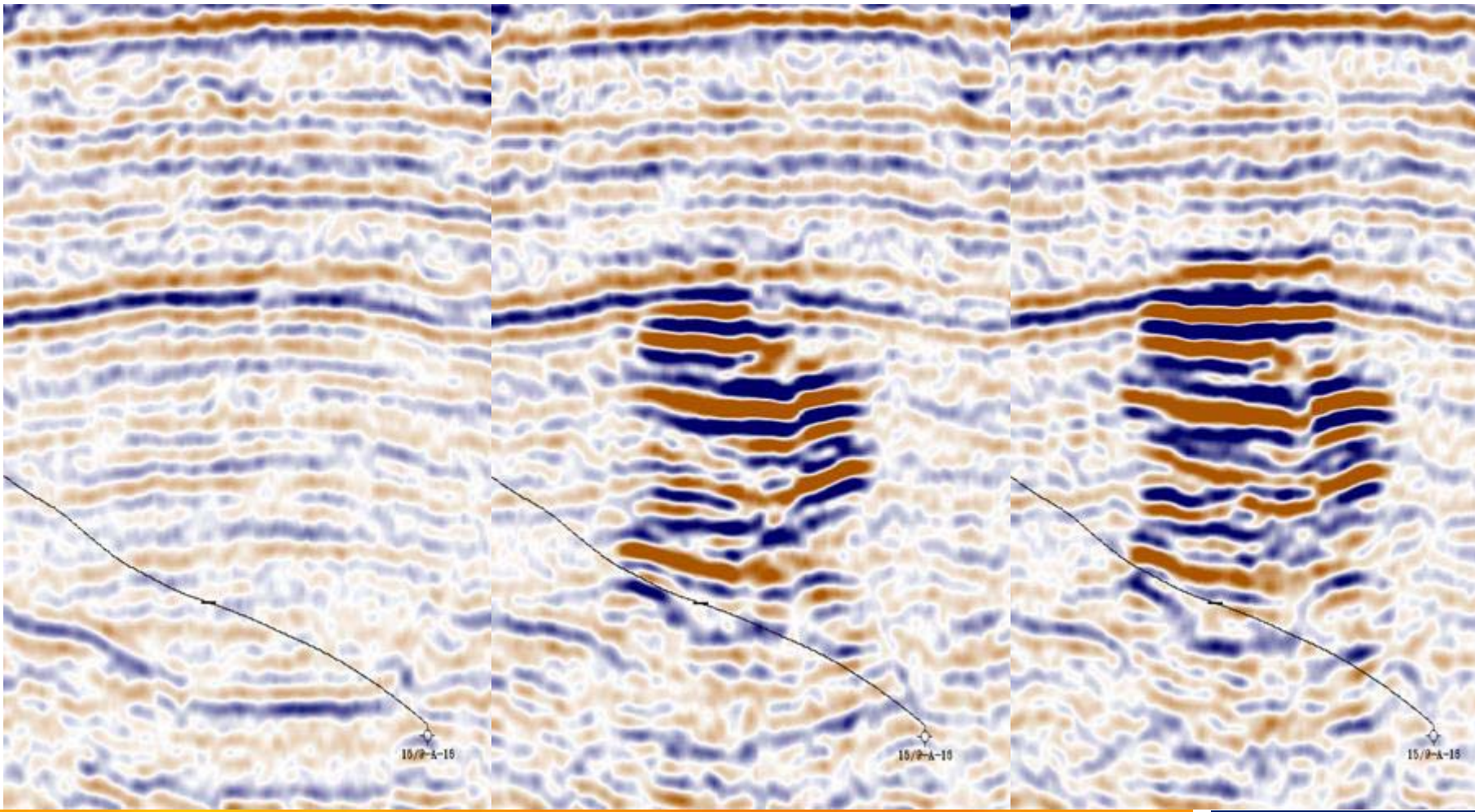
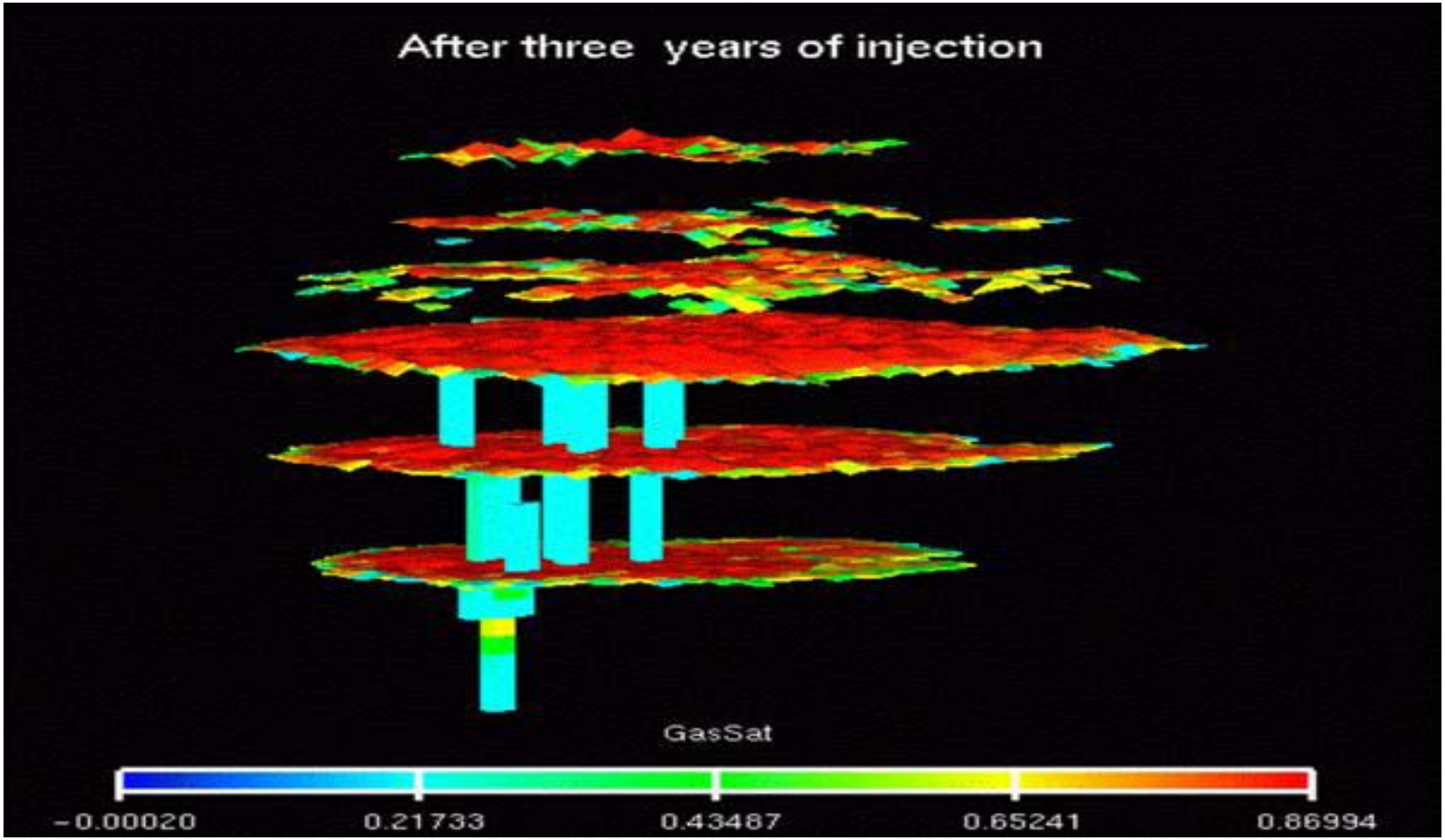
D Seismic surveys at Sleipner





imulated picture of the distribution of CO_2 after three years. adius of largest bubble 800 m and the total plume 200 m high.

ef: SINTEF Petroleum 2001

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”.

emonstration K12-B

ection of CO_2

a depleted gas field

Operator:

Gaz de France PRODUCTION NEDERLAND B.V

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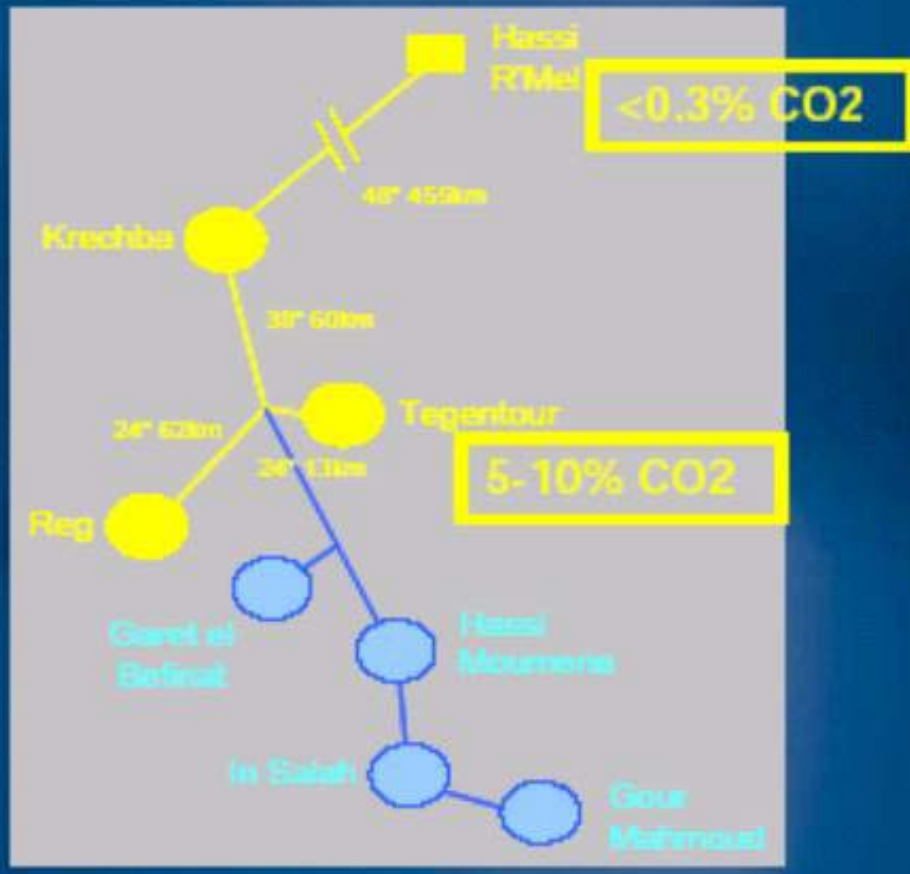
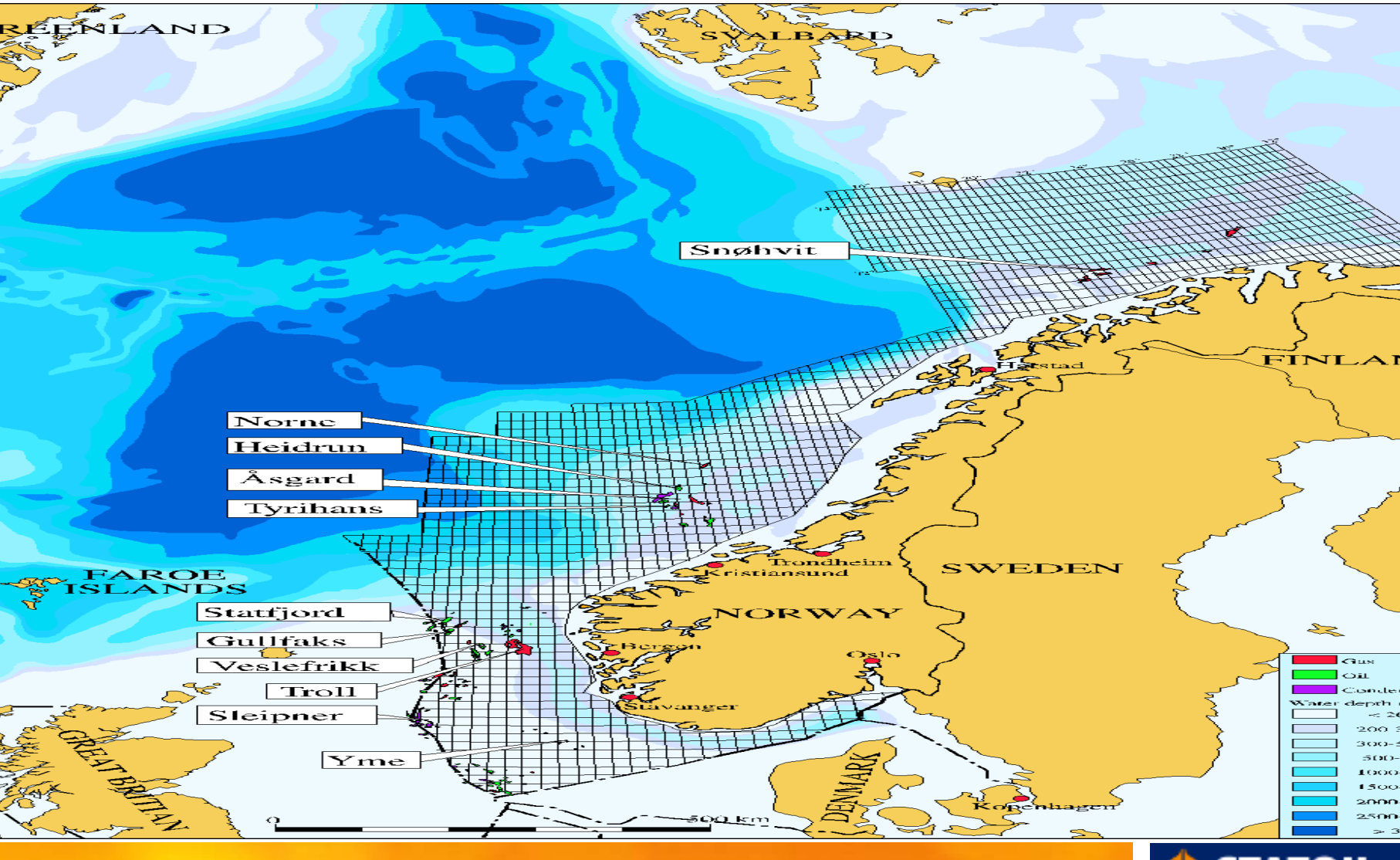
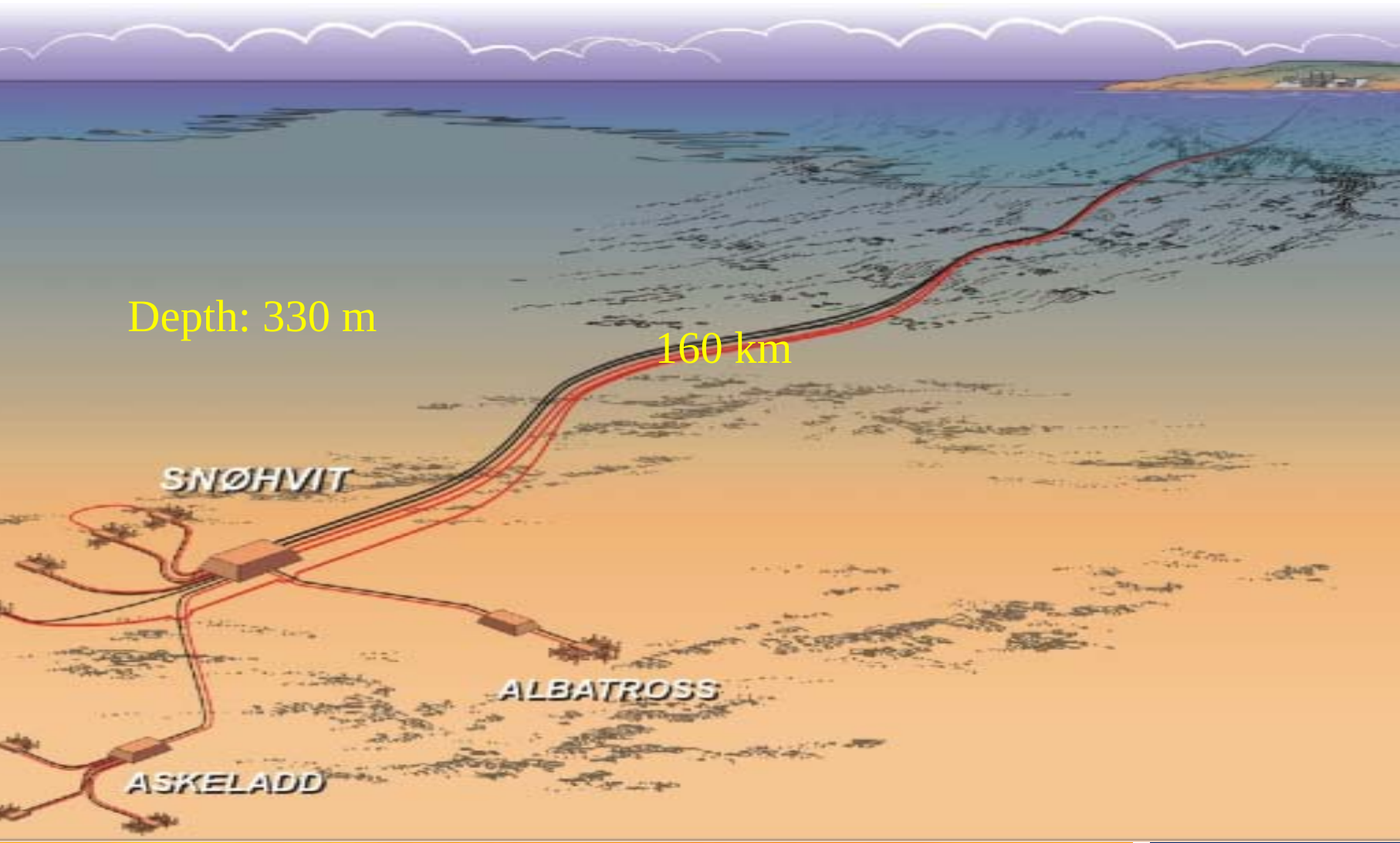
n Salah Gas Project Location, Algeria



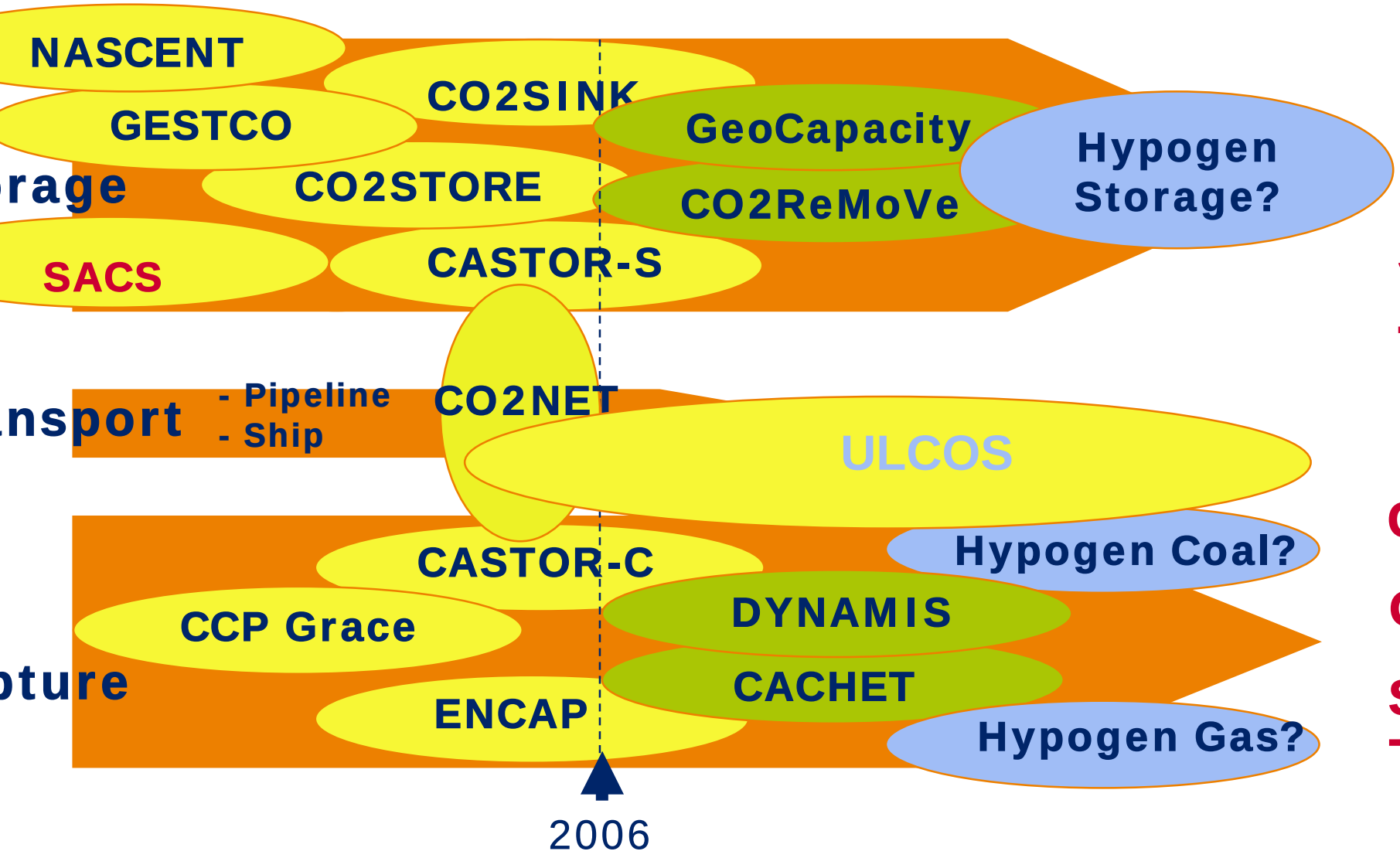
øhvit, the next field to implement CO2 storage



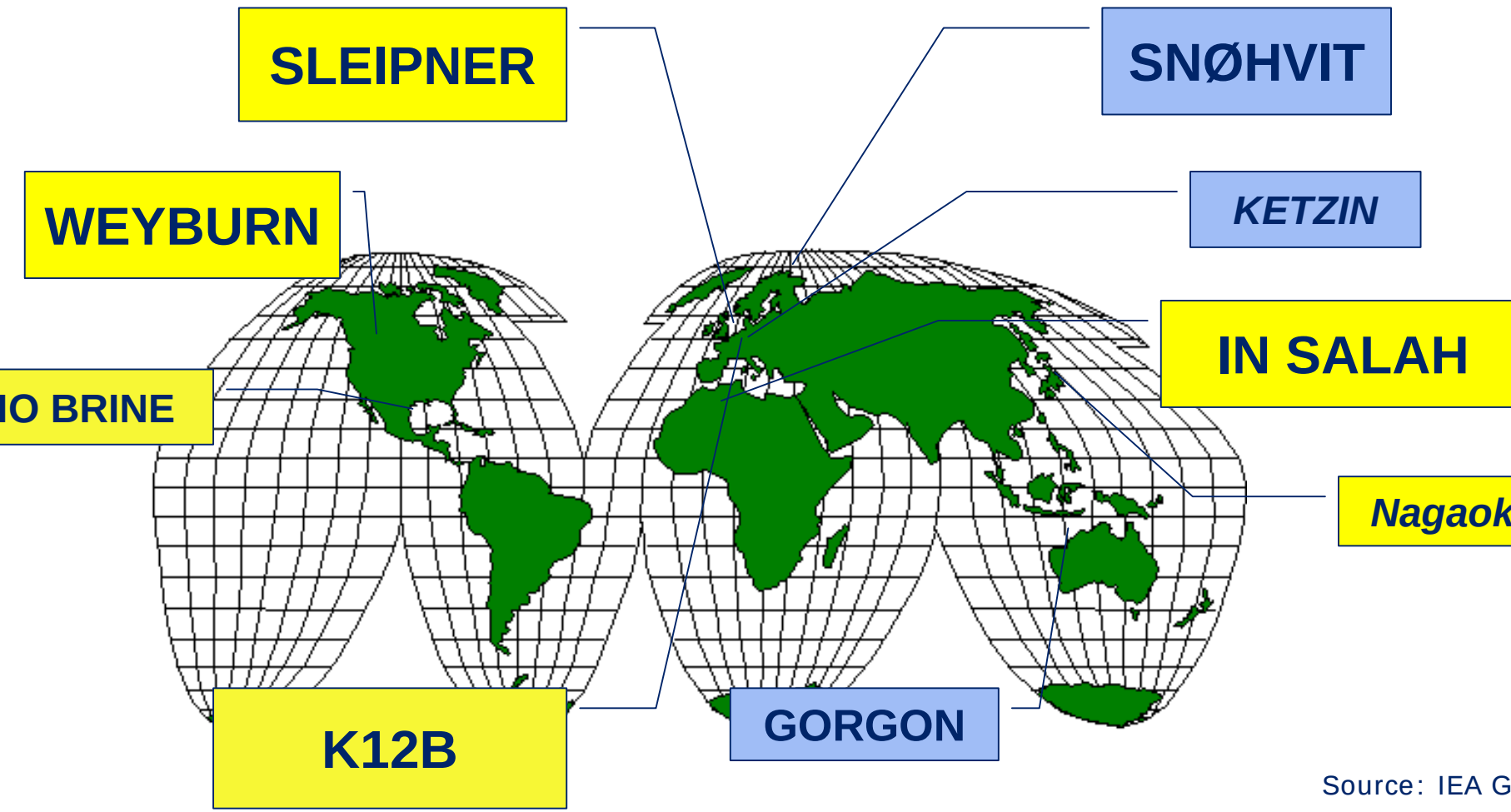
Snøhvit – All subsea



owards Large Scale Implementation?



Demonstrations of CO_2 storage



Source: IEA G

rapping and Leakage

rapping Mechanisms

Containment

Micro-pore trapping

Dissolution in water

Mineral binding

eakage ways?

WELLS

Faults/Cracks

Underground mobility

nvironmental impacts

ain potential LOCAL impacts:

- Humans and animals – if concentrated
- Plants – if in root systems
- Soil
- Sea bottom – More R&D!

atural analogues:

- Natural CO2 seeps (vulcanoes)
- Under sea vents

What will the Authorities demand?

- Access rights and Licence
- Site characterisation and Plan
- Monitoring & Verification
- Reporting to UNFCC and ETS
- Remediation?
- Decommissioning and ”Hand shake”
- Monitoring until “stability”?

What will the Public demand?

- Safe operation
- No leakage
- Monitoring & Verification in full openness
- Acceptance from UNFCC and ETS
- Long term stability

leed two legs to walk !

educe capture COST:

Technologies exists

Another chemical factory

Extra investment and energy consumption

Costs too high for industry

NEED NEW TECHNOLOGY

Build TRUST in storage:

- Is it staying there long enough
- Experience and large scale dem
- Experience from EOR and stora
- Oil&gas methods and tools wo
- Geology varies from site to site

➔ **MORE DEMO SITES**

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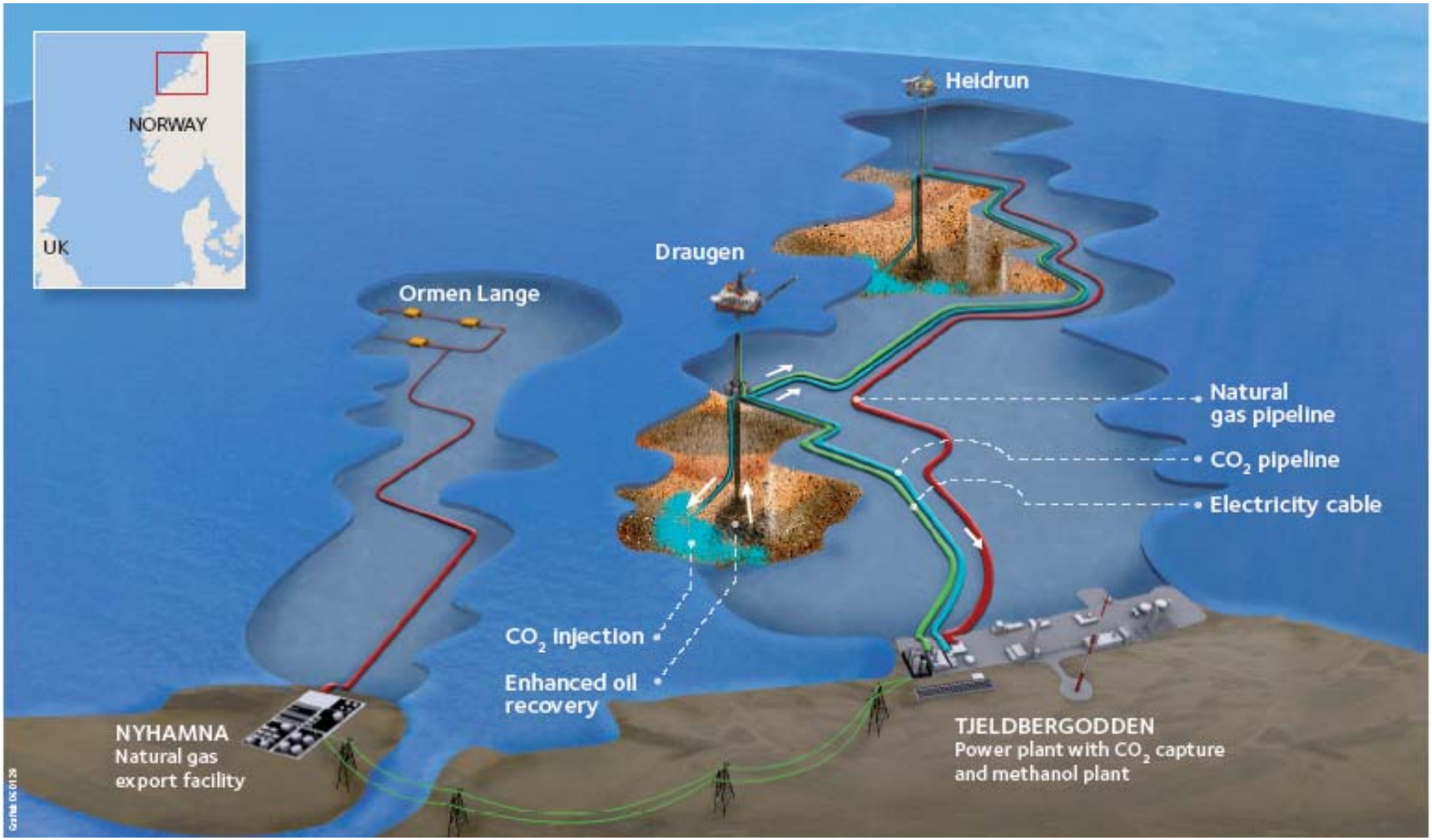
Schwarze Pumpe 2 x 900 MW Lignite fired Power Plant

TJELDBERGODDEN
- Statoil & Shell industrial realization



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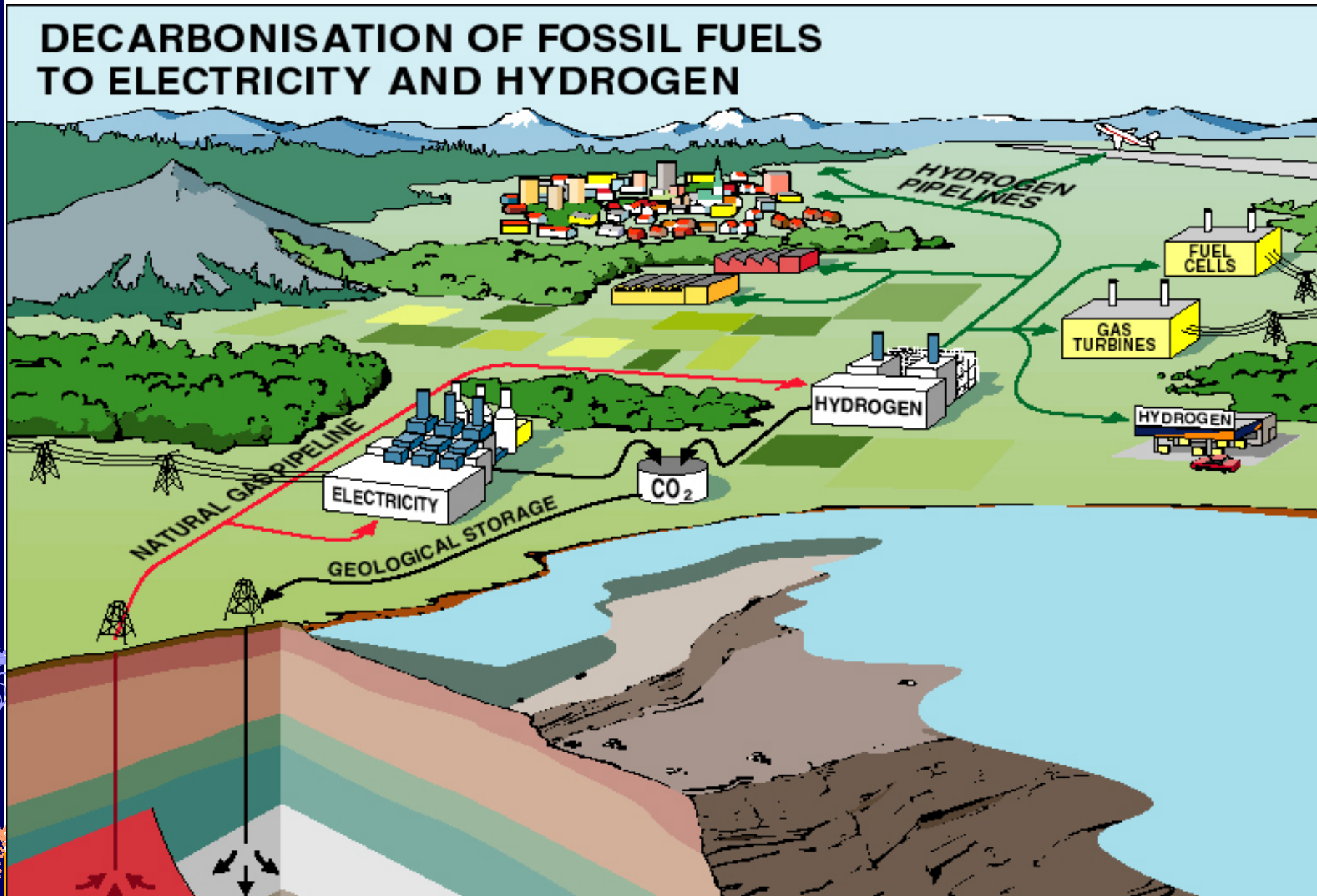
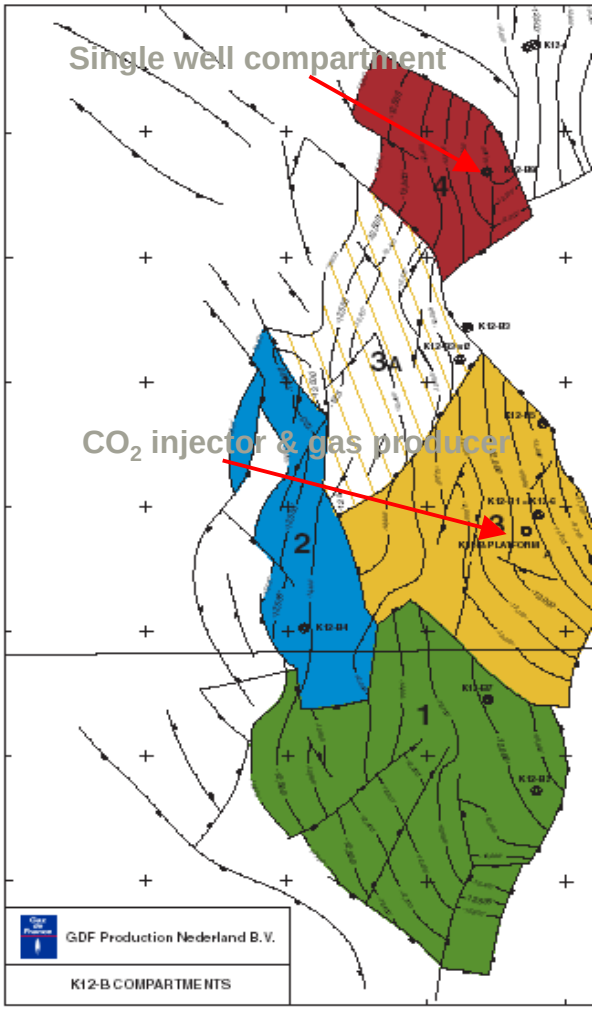

DECARBONISATION OF FOSSIL FUELS
TO ELECTRICITY AND HYDROGEN
HYDROGEN PIPELINES
FUEL CELLS
GAS TURBINES
HYDROGEN
HYDROGEN
NATURAL GAS PIPELINE
ELECTRICITY
CO_2
GEOLOGICAL STORAGE

K12B Gas Field (Gaz de France, The Netherlands

Gasfield in Rotliengen clastics, offshore
Depth: 3500-4000 m
High temperature: 128 °C, low pressure: 40 bars
Small-scale injection test: 20 000 t/year
in mid-2004
480 000 t/year in 2006, 8 Mt total

Gaz de France



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