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# **CO<sub>2</sub> Capture and Storage – An Update on Ongoing European R&D**

by

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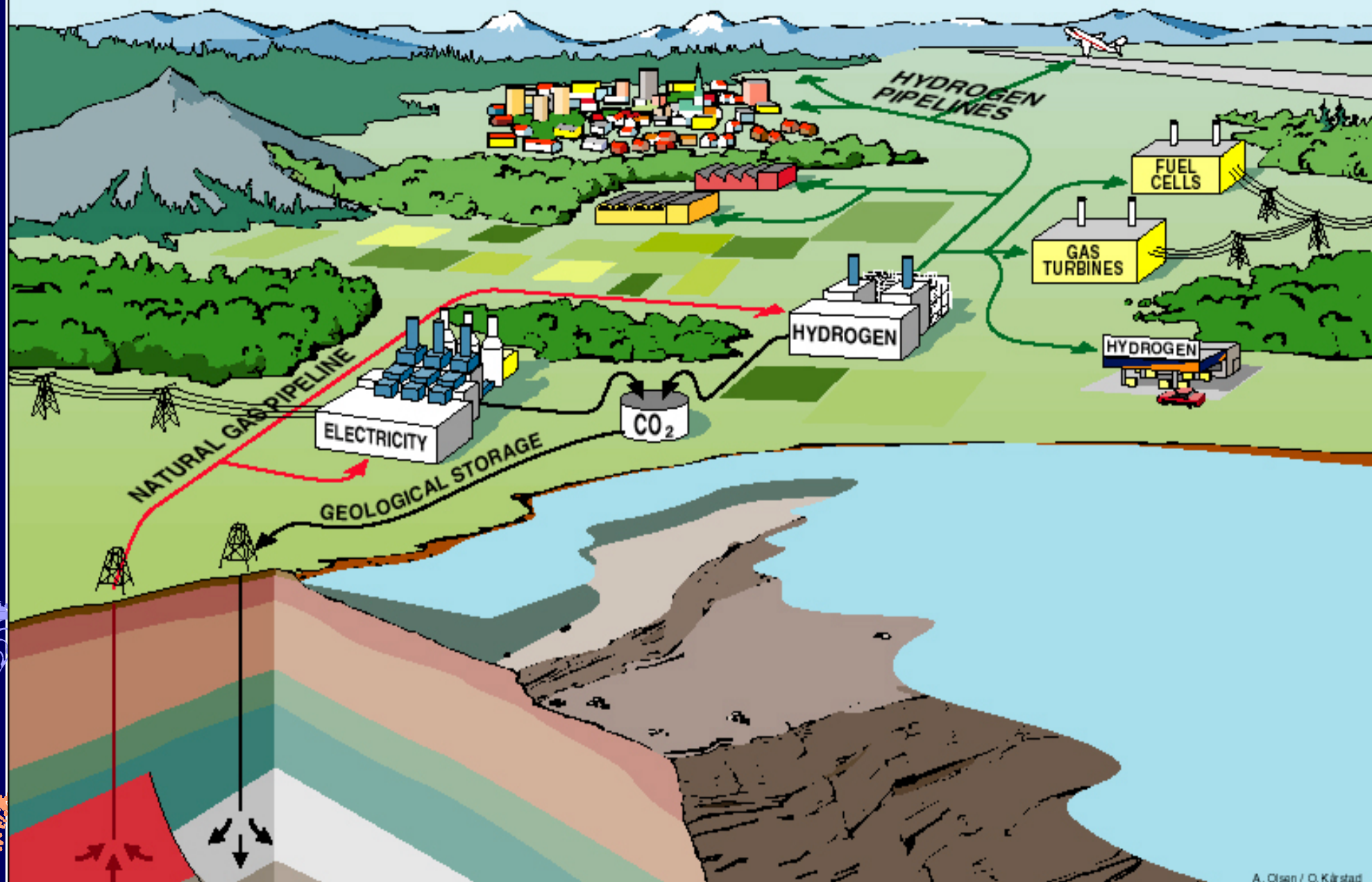
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# **CO2 Capture and Storage – An Update on Ongoing European R&D**

## **CONTENT :**

- **The Sleipner & Snøhvit CO2 Injections**
- **The SACS R&D Project**
- **What we did achieve and what's next?**
- **CO2STORE-CO2SINK-CASTOR-ENCAP-?**
- **Expectations – Cost, Legal, Public**

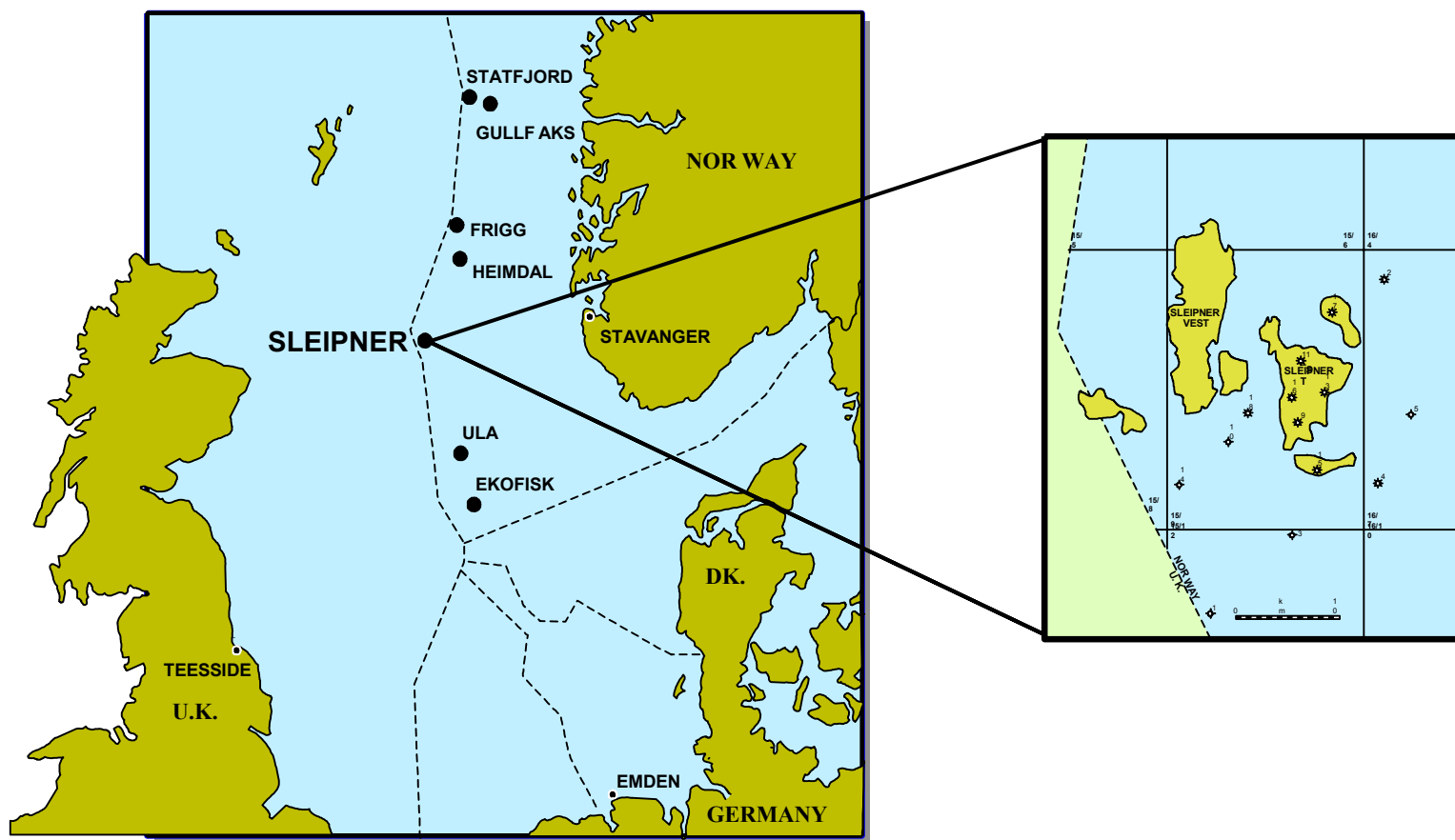
# DECARBONISATION OF FOSSIL FUELS TO ELECTRICITY AND HYDROGEN



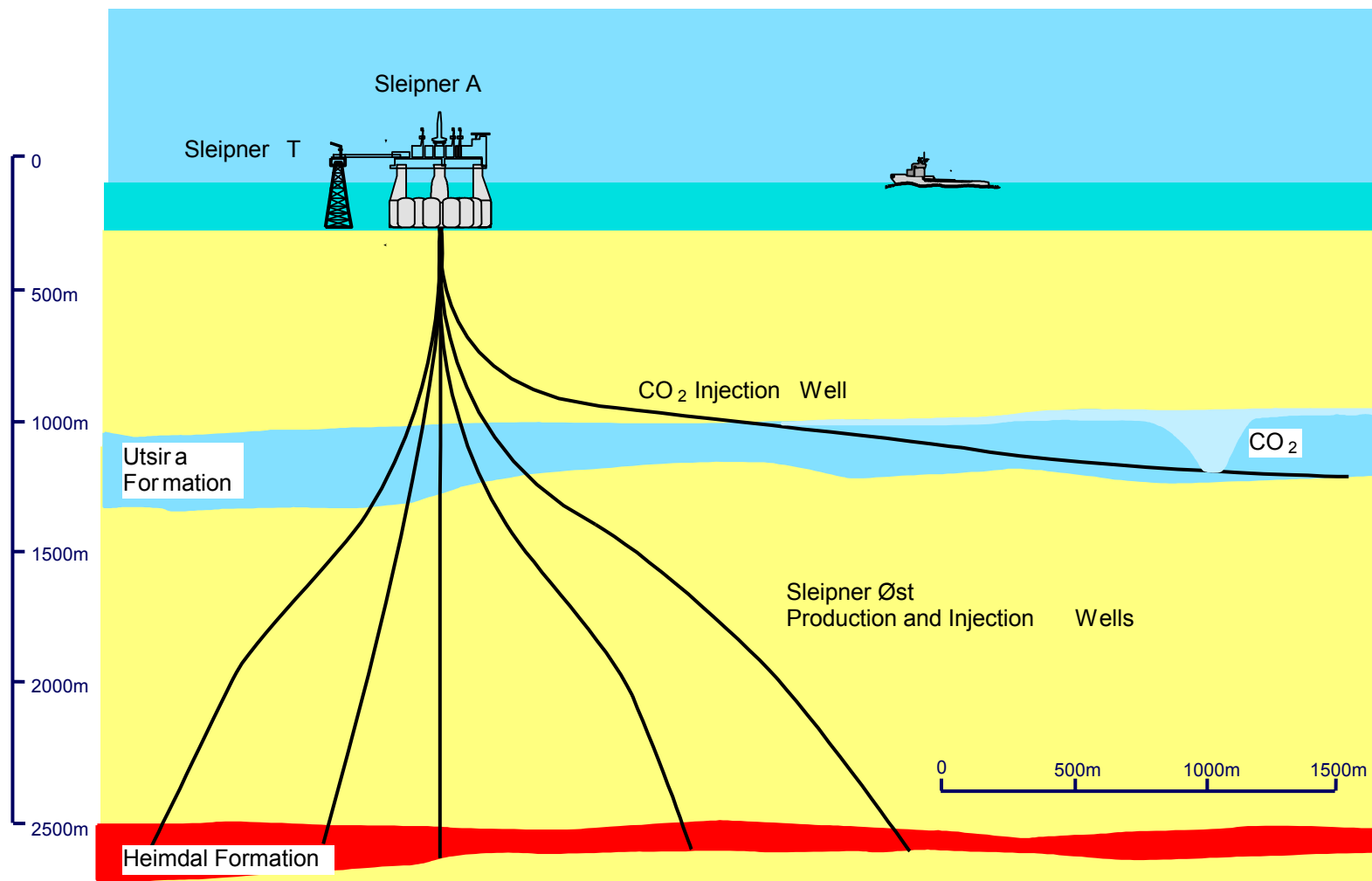
# The Sleipner field – CO<sub>2</sub> Treatment and Injection



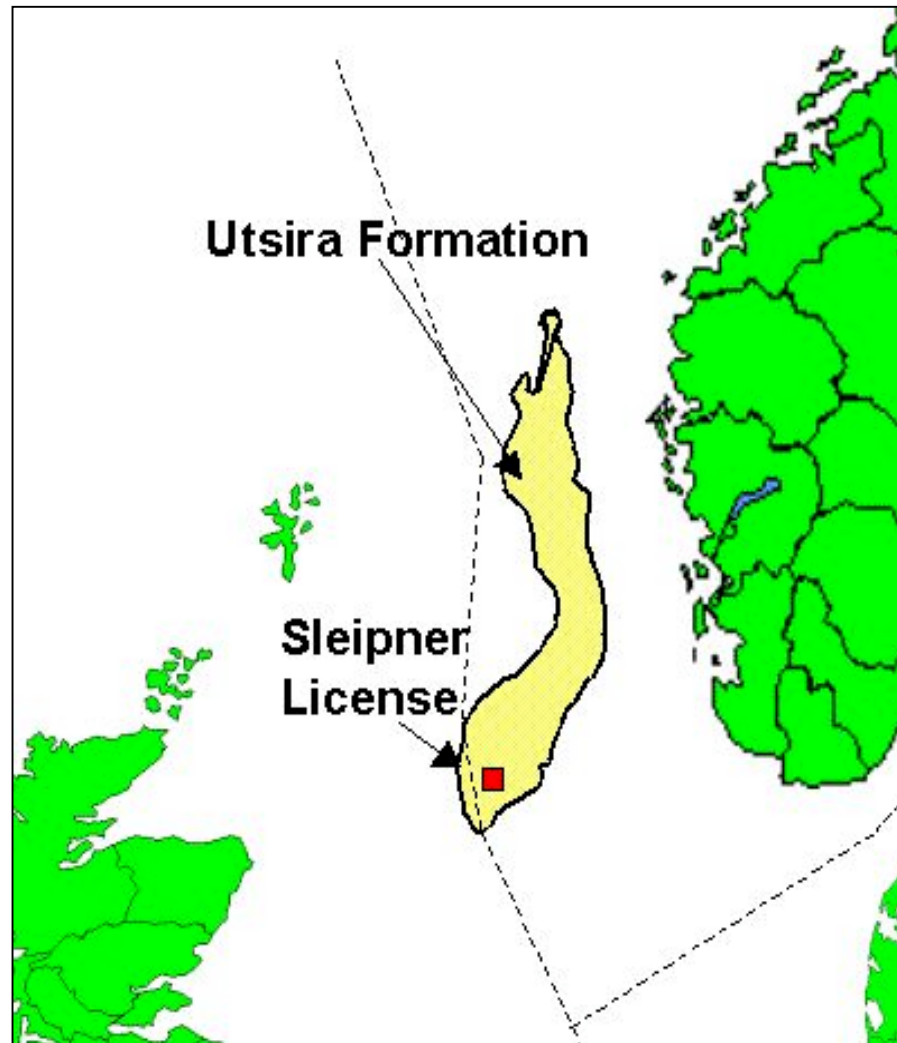
# Sleipner Field Map



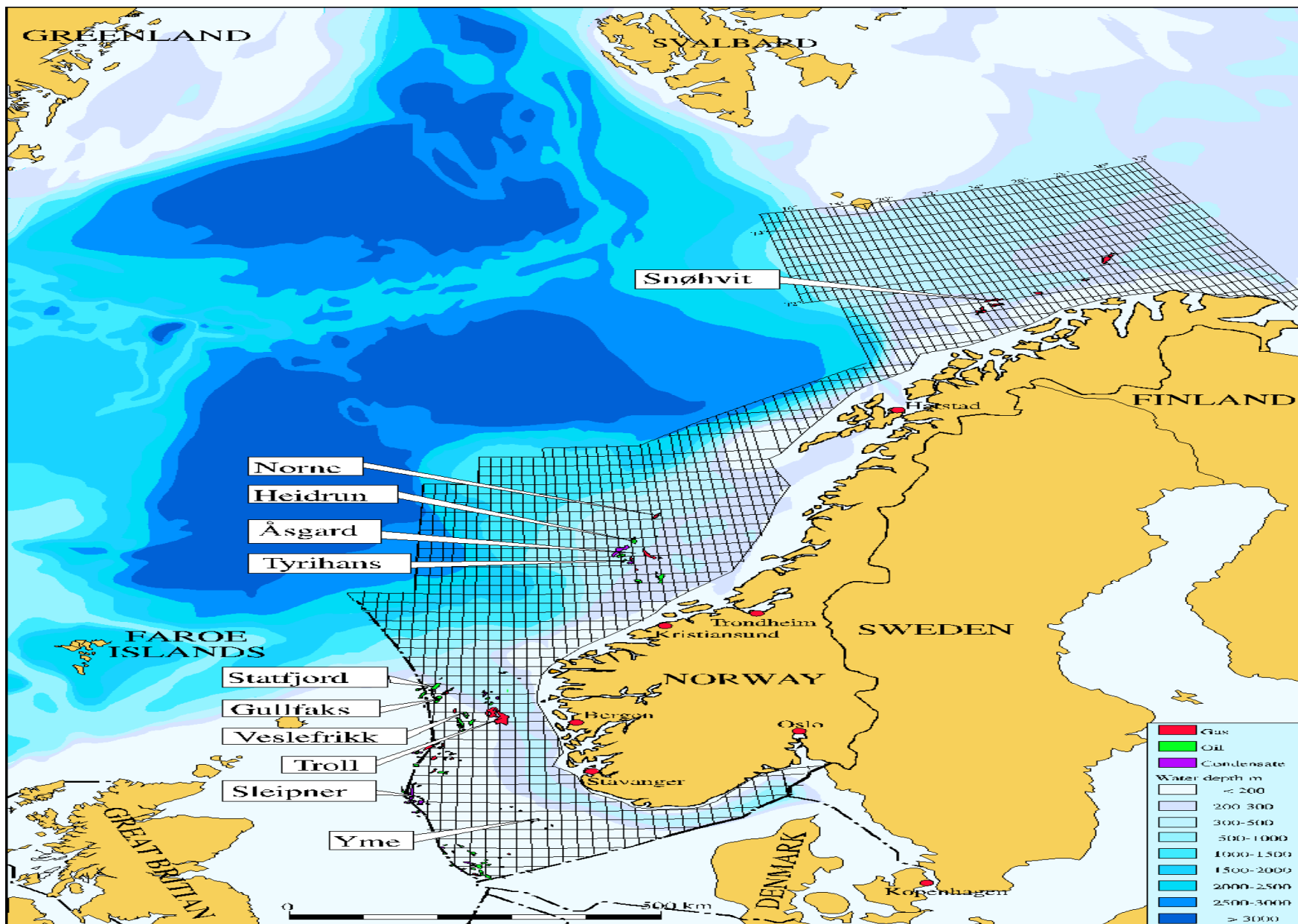
# CO<sub>2</sub> Injection Well in "Utsira"



# The Utsira Formation

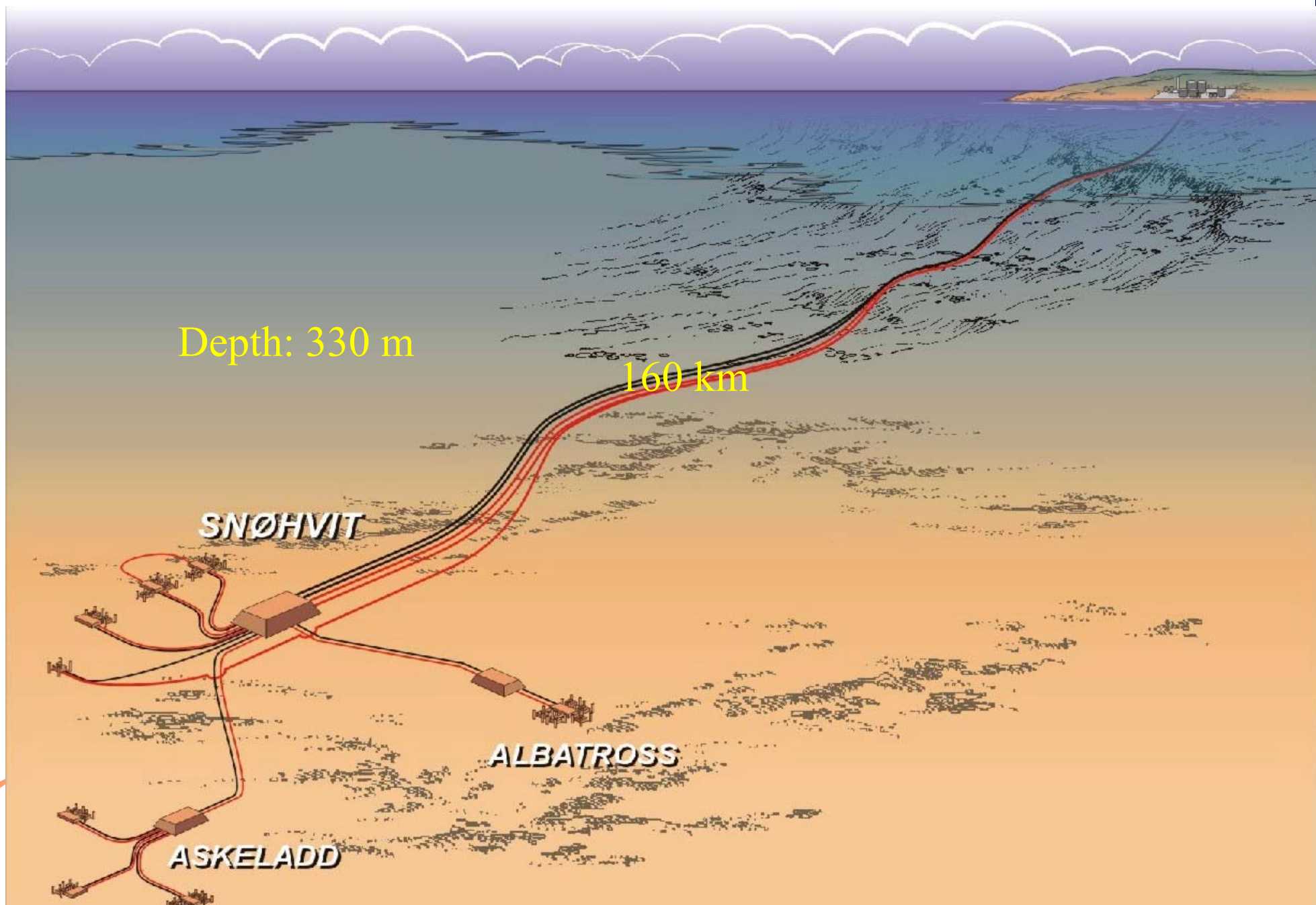


# Snøhvit Location

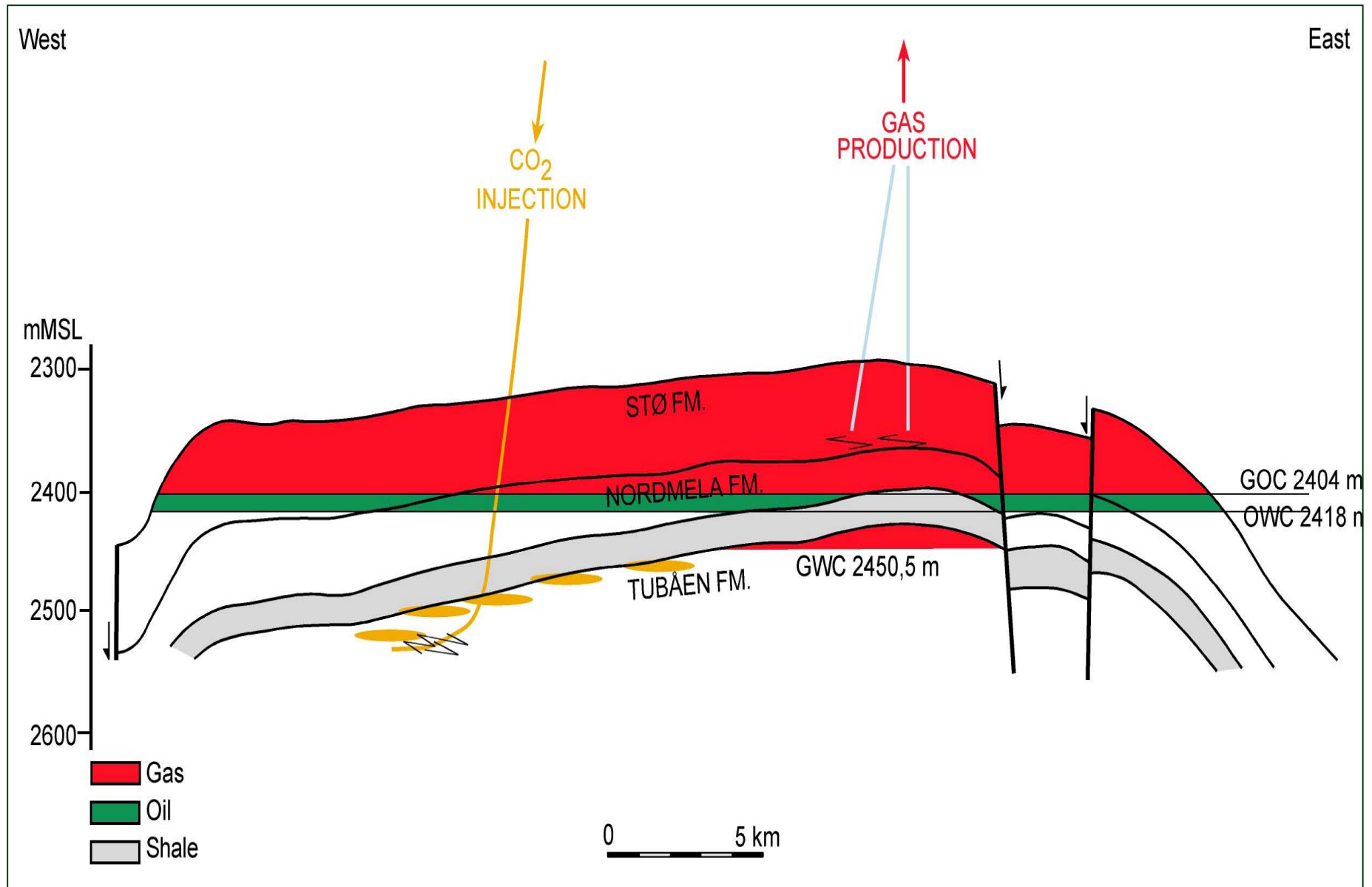




# Snøhvit Pipeline Routing



# The Snøhvit CO<sub>2</sub> Injection



# **SALINE AQUIFER CO<sub>2</sub> STORAGE PROJECT**

**Statoil  
BP  
ExxonMobil  
Total  
Norsk Hydro  
Vattenfall**



**BGS  
BRGM  
GEUS  
IFP  
NITG-TNO  
SINTEF**



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

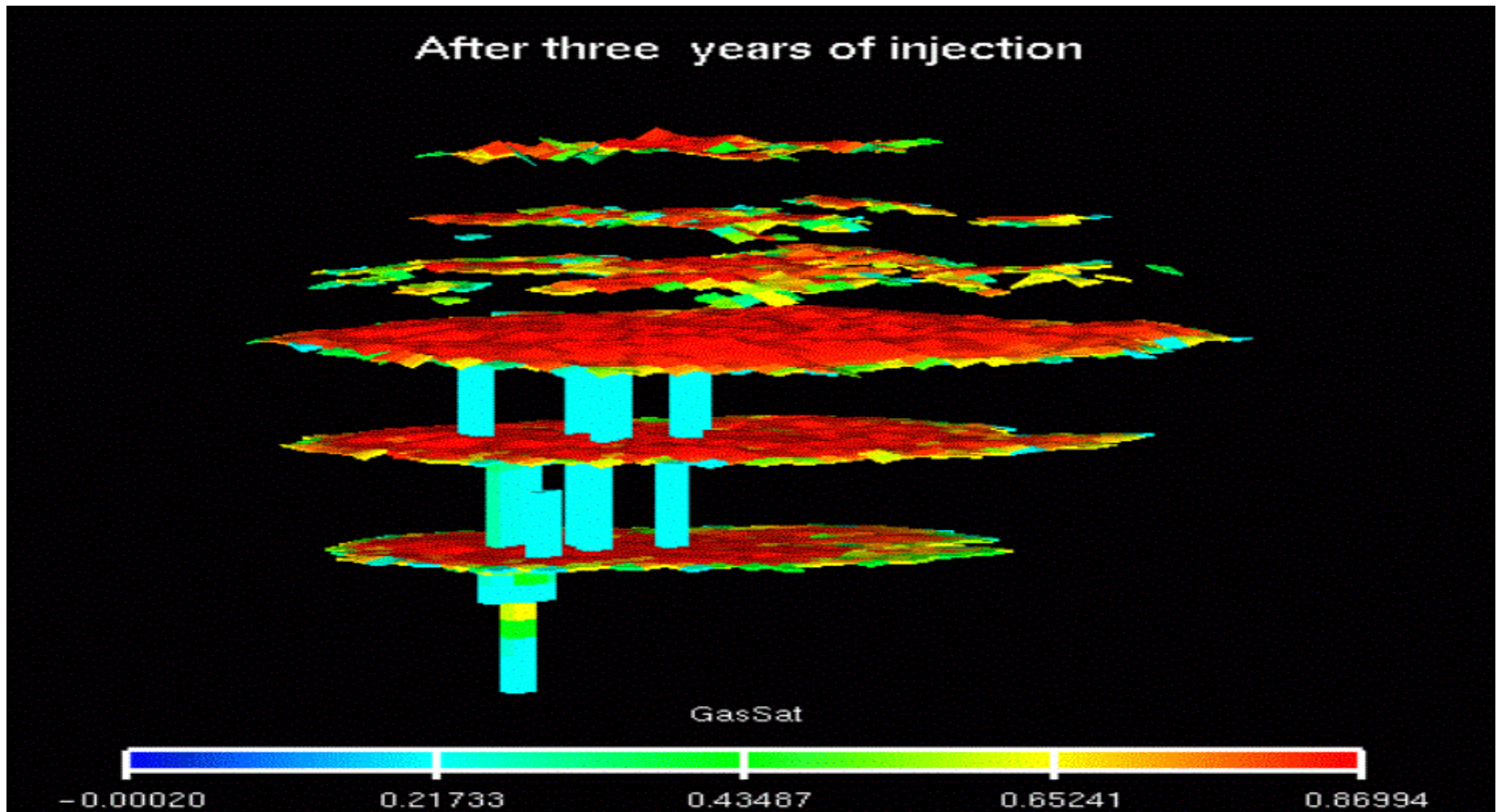


# Saline Aquifer CO2 Storage - SACS

## GOALS:

- **Verify under what circumstances CO2 storage in an aquifer is safe and reliable**
- **Validate models for geology, geochemistry, geophysics and reservoir tools**
- **Initiate new R&D related to above topics**
- **Start development of "Manual of Good Practice"**

# SACS Results: Seismic Monitoring Works !



**Simulated picture of CO<sub>2</sub> after three years.**

**Largest bubble 800 m wide and the total 200 m high.**

Ref: 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 CO<sub>2</sub> stay for thousands of years**

## WHAT'S NEXT ?

- **“CO<sub>2</sub>STORE” 2003 – 2005:**
- **Continued study of CO<sub>2</sub> in “Utsira”**
- **4 Field Cases in DK, DE, UK and NO**

# CO2STORE project 2003-2006

## CONTENT :

- \* **Transfer Sleipner & SACS Experience:**
  - 4 Field Cases in DE, DK, NO and UK
  
- \* **Long Term Behaviour:**
  - Geochemistry
  - Reservoir Simulation (incl. dissolution)
  
- \* **Monitoring**
  - 4<sup>th</sup> Seismic
  - 2<sup>nd</sup> Gravimetry

Schwarze Pumpe 2 x 900 MW Lignite fired Power Plant







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## EUROPEAN 6FP Negotiating November 03: Projects 2004-2008?

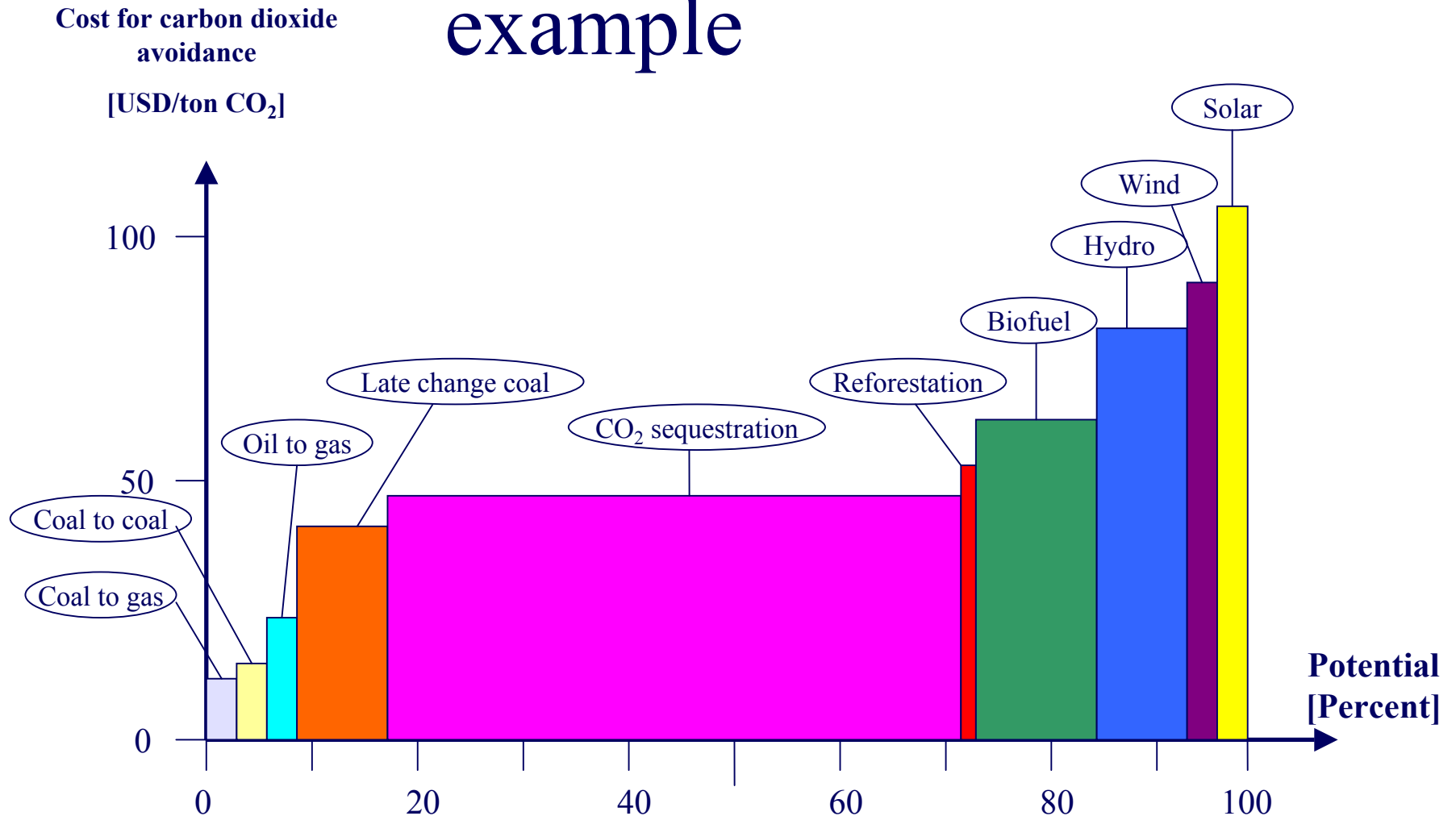


### **Integrated Projects:**

- \* **CASTOR – Post-Combustion Capture to Storage**
  
- \* **ENCAP – Pre-Combustion Power Plants**
  
- \* **CO2SINK – Capture from Biomass and Gas Field Storage**
  
  
- **Networks-of-Excellence**
- **CO2GEOSEQ – Geological Storage**



# Cost and Potential of options to reduce CO<sub>2</sub> emissions. Principal example



The picture will look different when different time perspectives are adopted

# Use CO<sub>2</sub> Commercially?

## NEW SITUATION:

- ❖ Kyoto Protocol – European decision to comply
- ❖ Emission Trading Directive – from 2005
- ❖ Concentrated Emissions from Ammonia, Plastics, etc
- ❖ Capture Technology - exists for Power, Cement, Steel
- ❖ Transport: Pipelines - Thousands of km in operation  
Ships – Small scale to be upgraded
- ❖ Storage Underground – Sleipner 1 Mt/y since 1996
- ❖ North Sea Oil Fields – Several in decline and need boost
- ❖ Enhanced Oil Recovery – USA/Canada since 1970's

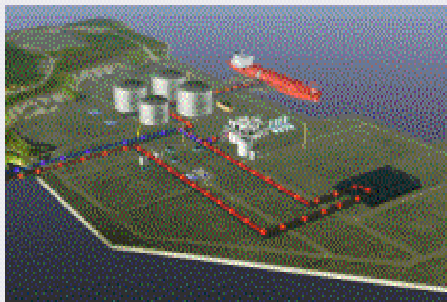
**=> Opportunities?**

# The CO<sub>2</sub> Value Chain

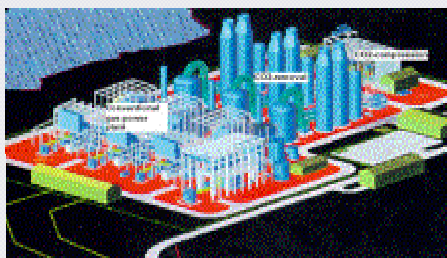
## Sources



Reformer and gasification plants



Gas processing



Power plants

## Transport

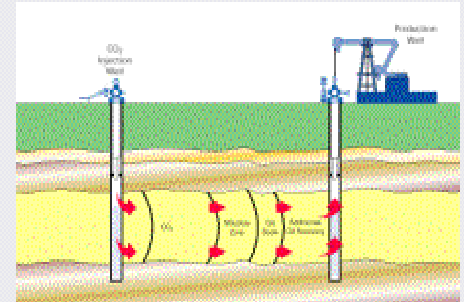


Ships

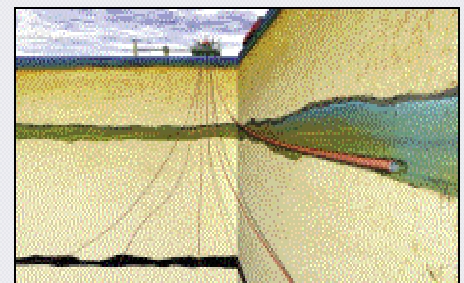


Pipelines

## Market



Enhanced oil recovery



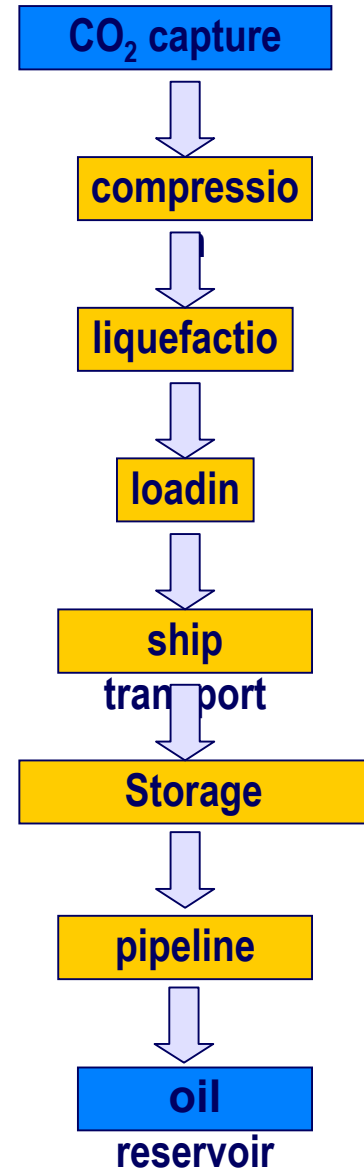
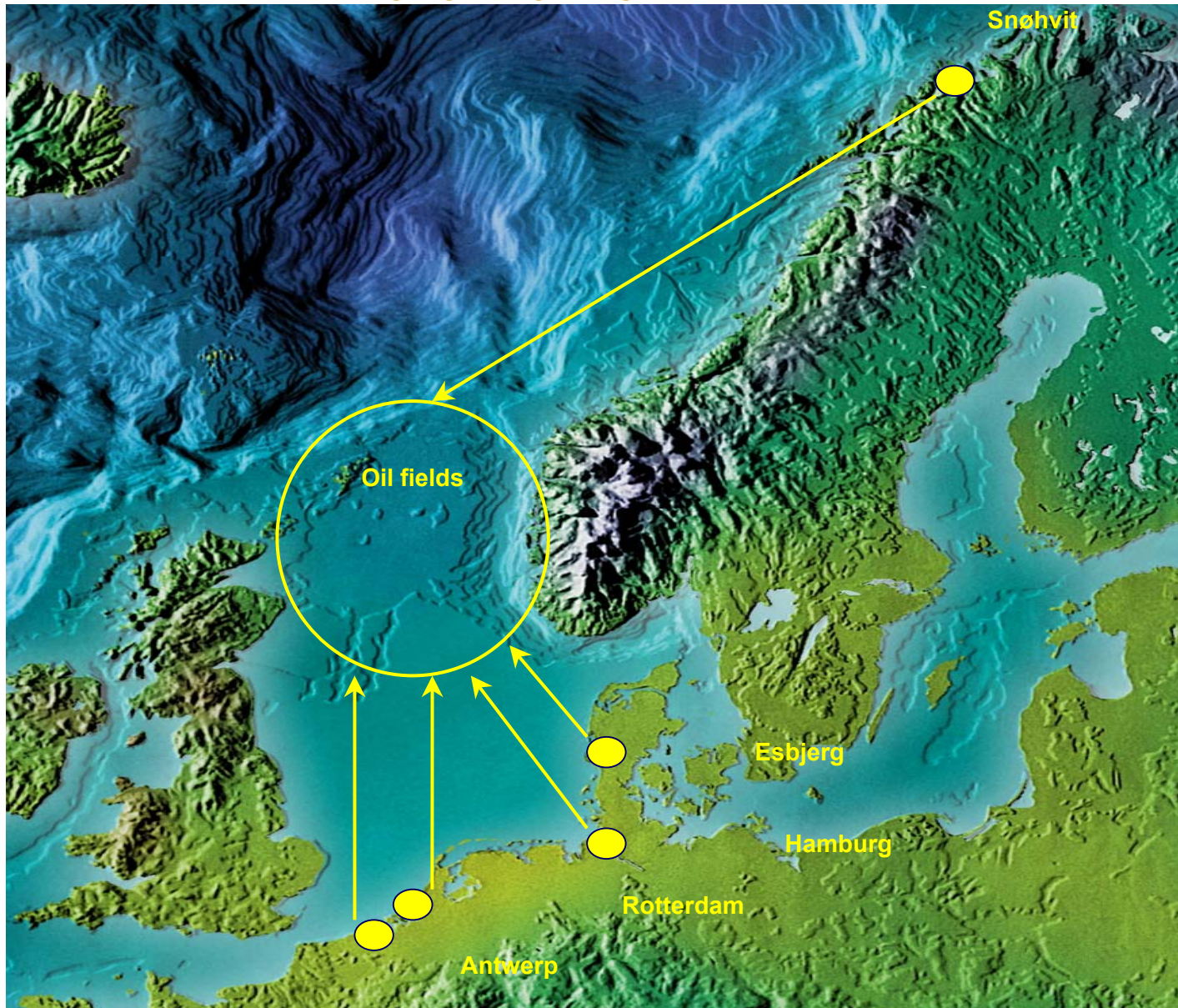
Storage in saline aquifers

# Hydro Agri CO<sub>2</sub>-tankers, approximately 1500 m<sup>3</sup>

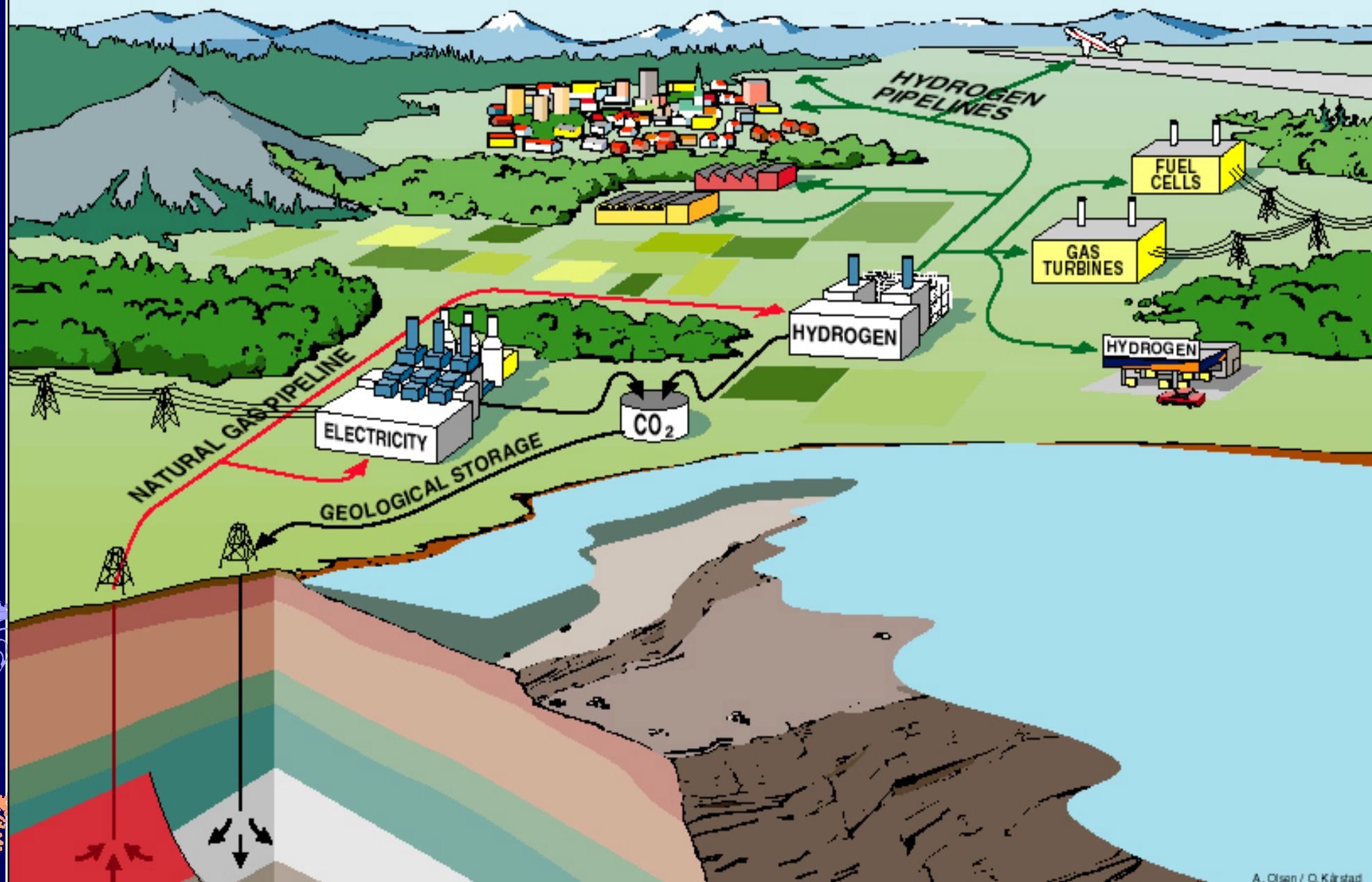


# Ship Logistics

Possible shipping routes and cost elements



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EUROPEAN STANDARD

EN 1918-1

NORME EUROPÉENNE  
EUROPÄISCHE NORM

February 1998

ICS 75.200

Descriptors: storage, natural gas, definitions, specifications, environmental protection, design, safety, leaktightness, inspection, maintenance, operating requirements, wells, tests

English version

Gas supply systems - Underground gas storage - Part 1:  
Functional recommendations for storage in aquifers

Réseaux de gaz - Stockage souterrain de gaz - Partie 1:  
Recommandations fonctionnelles pour le stockage en  
nappes aquifères

Gasversorgungssysteme - Untertagespeicherung von Gas -  
Teil 1: Funktionale Empfehlungen für die Speicherung in  
Aquiferen

This European Standard was approved by CEN on 22 January 1998.

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