OPERATIONAL CO_2 SEQUESTRATION PROJECTS AT GAZ DE FRANCE

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WGC – 2006

RESEARCH DIVISION

June 2006

Technical solutions for reducing CO_2 emissions

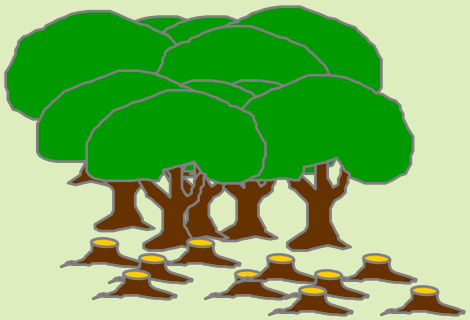
Change in the energy mix

Coal, oil ⇨ **Natural gas** ⇨ **Renewables**

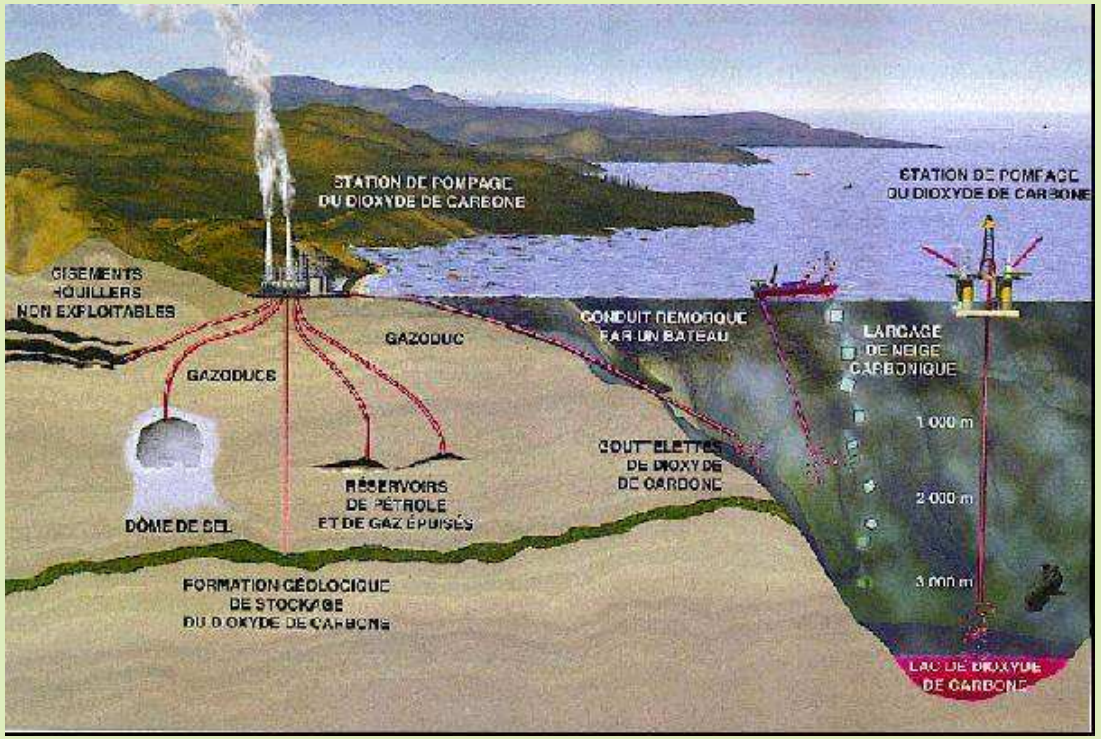
Energy management

Improvement in energy efficiency and rational energy use

Carbon cycle management



Natural carbon stocks



Industrial techniques for capturing and storing CO_2 emissions

What are the costs of CCS?

- **Capture**

  Different techniques are available

  About 75% of the CCS costs

  NEED to REDUCE COSTS

- **Transport**

  Pipe or ships

  Costs depend strongly on the volumes being transported and on the distances involved : 2 to 7 €/t CO_2 for 100 km

  NO BIG TECHNICAL CHALLENGE

- **Storage**

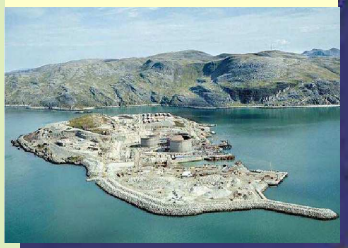
  Natural underground reservoir (depleted O&G fields, coal seams, saline aquifers…)

  Costs depend on the site, its location : 2 to 10 €/t CO_2

  NEED to DEMONSTRATE the FAISABILITY through PILOT PLANTS

Gaz de France and operational CCS

SNOVHIT

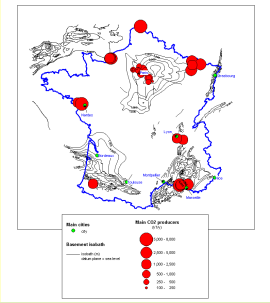


CASTOR (EU)

K12B (CRUST)

RECOPOL (EU)

PICOREF



CASTOR project (EU - FP 6)

« CO_2, from Capture to Storage »

- **Objectives**
  - Reduce the cost of CO_2 post-combustion capture
  - Contribute to the feasibility & acceptance of the geological storage concept
  - Validate the concept on real sites
    - Pilot testing for capture (25 t CO_2 / day)
    - Detailed studies of future storage projects

CASTOR project

- Budget: 15,8 M€
- EU funding: 8,5 M€
- Duration: 4 years (2004 – 2008)
- 30 partners from 11 European countries

R&D
IFP (FR)
TNO (NL)
SINTEF (NO)
NTNU (NO)
BGS (UK)
BGR (DE)
BRGM (FR)
GEUS (DK)
IMPERIAL (UK)
OGS (IT)
TWENTE U. (NL)
STUTTGARTT U. (DE)

Oil & Gas
STATOIL (NO)
GAZ de FRANCE (FR)
REPSOL (SP)
ENITecnologie (IT)
ROHOEL (AT)

Power Companies
VATTENFALL (SE)
ELSAM (DK)
ENERGI E2 (DK)
RWE (DE)
PPC (GR)
POWERGEN (UK)

Manufacturers
ALSTOM POWER (FR)
MITSUI BABCOCK (UK)
SIEMENS (DE)
BASF (DE)
GVS (IT)

Co-ordinator: IFP
Chair of the Executive Board: Statoil

CASTOR project : capture

Esbjerg Power unit (Elsam)

- Application in modern coal-fired power station: Esbjerg PS operated by ELSAM
- Capacity 1 ton/h CO_2
- Pilot plant is the largest test facility in the world

CASTOR project : storage

Objectives

☞ Focus on field cases to cover some geological variability

Casablanca case (Repsol, Spain):
Depleted offshore oil field, deep.

Atzbach-Schwanenstadt case (Rohoel AG, Austria):
Depleted onshore gas field, shallow.

K12B case (Gaz de France, Netherlands)
Enhanced gas recovery, offshore, deep; injection started in 2004.

Snøhvit case (Statoil, Norway)
Aquifer below gas/condensate field, offshore; injection will start in 2007.

K12-B

Diapo 9

K12-B is part of the dutch CRUST project

***C**O$_2$ **R**euse through **U**nderground **ST**orage*

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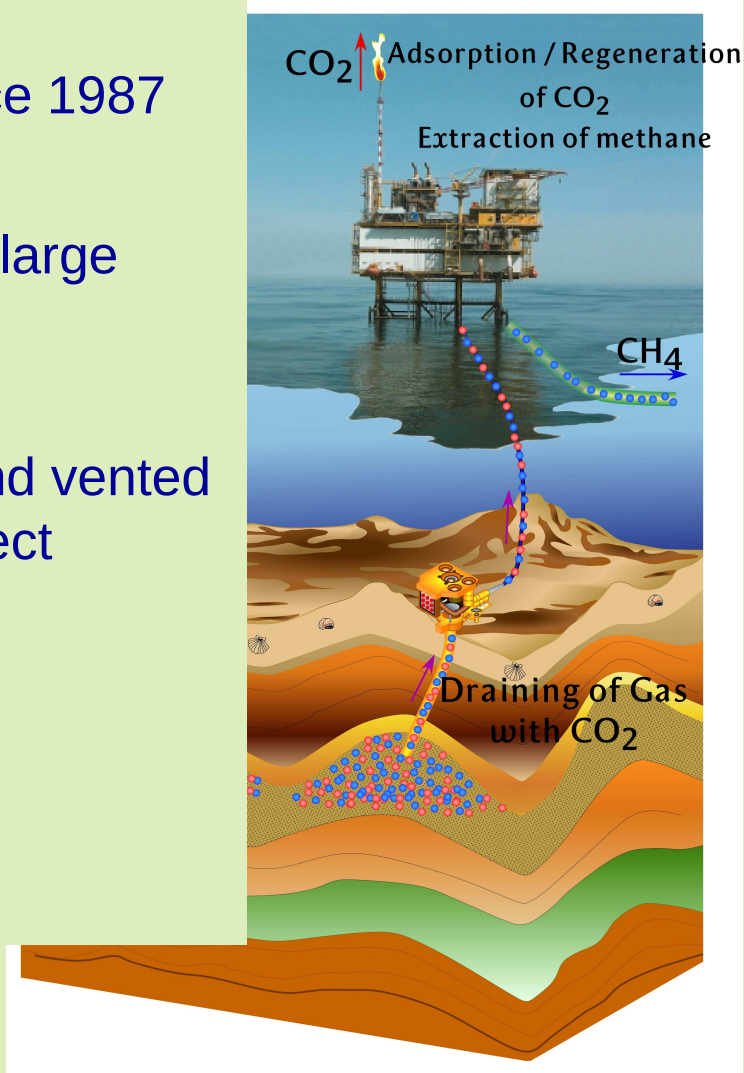
K12-B , The Netherland

- K12-B gas field has been operated since 1987
- The gas produced contains a relatively large amount of CO_2 (13%)
- CO_2 was separated from natural gas and vented to the atmosphere before injection project
- Since 2004, CO_2 is re- injected

Before 2004



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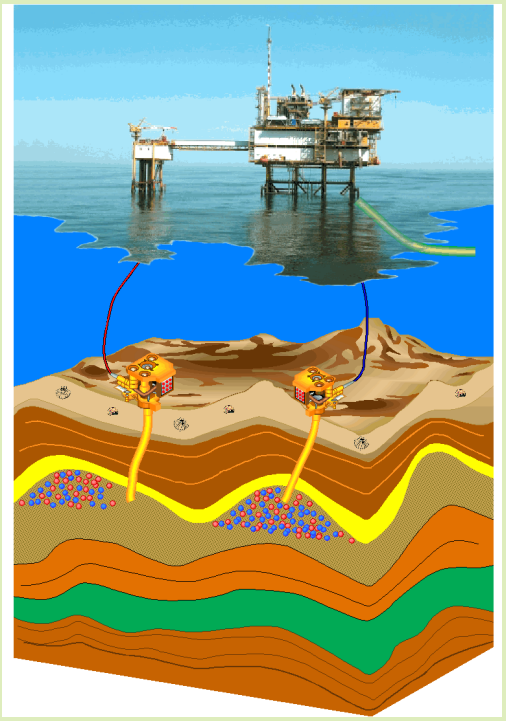
In the framework of :

CO2 Reuse though Underground Storage (NL)
CO2GEONET and CASTOR (EU)
Partner : Gaz de France, TNO (NL)

K12-B – a 3 phases project

- Feasibility study **(2002-2003)**
- Operational implementation test (2004-2006)
  - ☞ 20 kt CO_2/y – about 22 €/t CO_2
- Scale-up
  - ☞ potential of 400 kt CO_2/an – about 8 €/t CO_2
- Reservoir size estimated to 8Mt CO_2, i.e. 0.5% of the industrial emission of the Netherlands over 20 years.



PICOREF project (RTPG - ANR)

«CO_2 trapping in reservoir in France »

Main objectives

☞ Identify injection sites in France and define pilot operations from a selection of geological reservoir targets

☞ Elaborate and test a methodological work-flow chart able to address a site evaluation for a CO_2 storage project

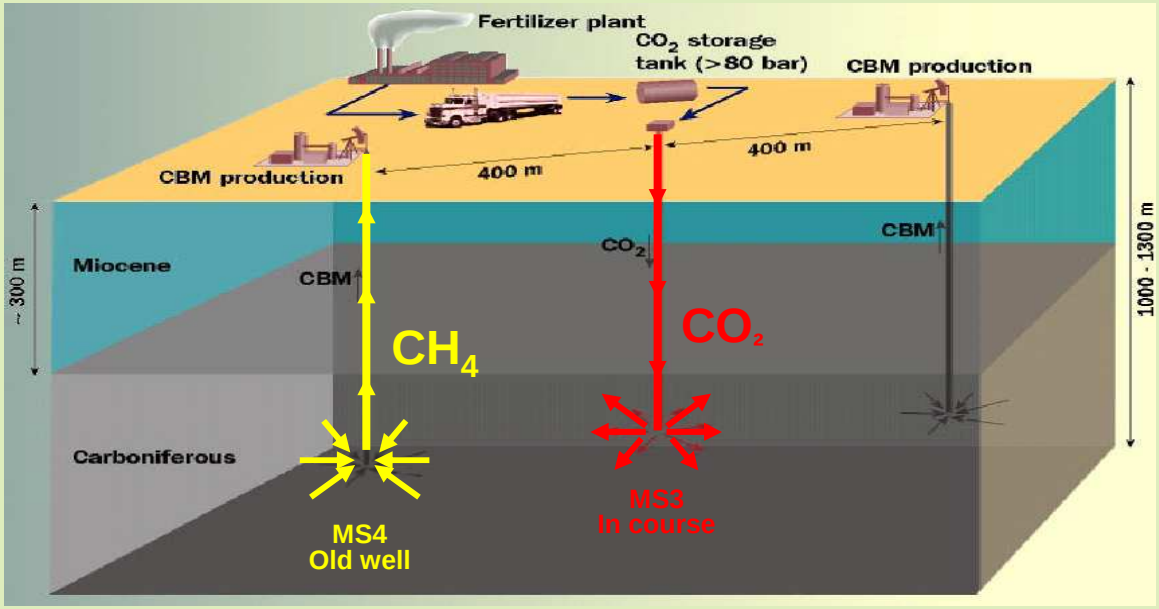
R&D	Industry		Universties
BRGM	Air Liquide	Gaz de France	ARMINES-ENSM
IFP	Alstom	Géostock	ICMCB-CNRS
INERIS	CFG Services	Magnitude	LMTG-CNRS
	CGG	La SNET	LGIT-CNRS
	Correx	Total	TPHY-ISTEEM
	Gaz de France		LAEGO-INPL

RECOPOL project (EU - FP 5)

« Reduction of CO_2 emission by means of CO_2 storage in coal seams in Silesian Coal Basin in Poland »

Main objectives

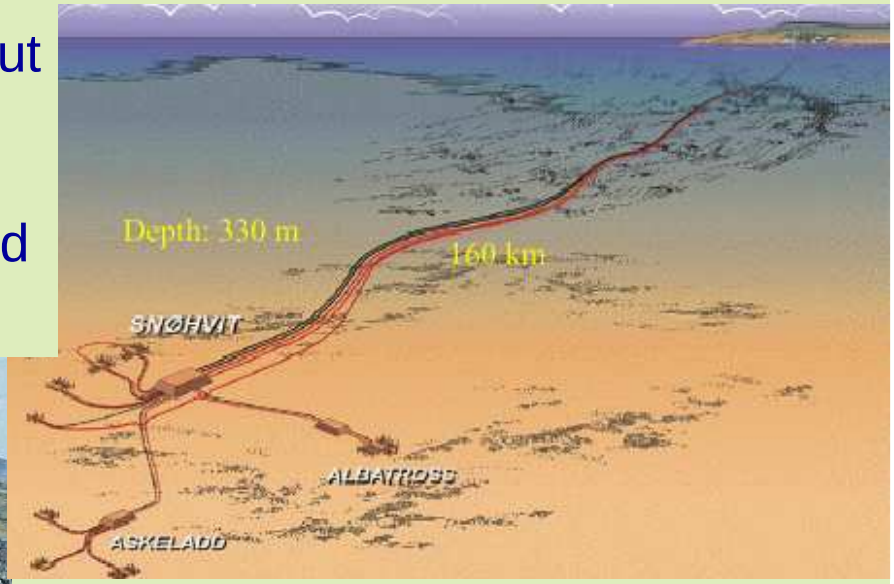
- Evaluate the feasibility of CO_2 sequestration in coal beds
- Combine CO_2 sequestration with natural gas production



Partners: TNO, IFP, Air Liquide, Gazonor, Gaz de France, SBI-GUT, Advanced ressources International, Aachen University, Delt Technical university, Central mining Institute, CSIRO, IEA.

SNØHVIT , Norway

- The gas produced will contain about 6-12% of CO_2
- Production will begin late 2006, and 0.75 Mt CO_2/y injected



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Partners : Statoil, Petoro, Total, Gaz de France, Amerada Hess and RWE

CONCLUSIONS

- Following IPCC, Carbon Capture and Storage can make a significant contribution to GHG emission reduction

It is estimate to 2000 Gt CO_2 and may represent 15%- 55% of the mitigation effort to 2100, depending of economic conditions.

- Carbon capture and storage challenges :

  - ✓ Capture costs reduction
  - ✓ Pilot and demonstration plants
  - ✓ Public awareness and acceptance
  - ✓ Legal and regulatory framework
  - ✓ Long-term policy framework