15 March 2006

CASTOR
CO_2, from capture to storage

Project outline

The overall goal of this project is to develop and validate, in public/private partnerships, a substantial part of the innovative technologies needed to capture CO_2 of industrial emissions and to store CO_2. The Castor R&D target is to enable the capture and geological storage of 10% of the CO_2 emissions of Europe, which corresponds to about 30% of CO_2 emitted by European power and industrial plants. To reach this goal, Castor will improve current techniques and develop, validate and generalise previously non existent methodologies and technologies for the capture of CO_2 and its subsequent secure underground storage.

Key targets of Castor are the following:

- a major reduction in post-combustion capture costs, from 50-60 € down to 20-30 € per ton of CO_2 (large volumes of flue gases need to be treated with low CO_2 content and low pressure)
- to advance general acceptance of the overall concept in terms of storage capacity, residence time, storage security and environmental acceptability.
- to start the development of an integrated strategy connecting capture, transport and storage options for Europe.

Castor is planned to 4 years (Feb. 2004- Feb. 2008) and is funded by the European Commission within the 6th European Framework Program. Total budget is 16 M€ (8,5 M€ funded by EU). 30 partners will carry out the work - R&D organisations, oil & gas companies, power companies and manufacturers - representing 11 European countries.

For **capture**, a pilot plant has been built in an existing coal-fired power plant operated by ELSAM in Denmark and will be operated during 2 years in order to validate the flue gas processes developed (new solvents, new membrane contactors, new process flow sheets, integration methods) in the project.
Work on **storage** aims at studying European injection sites and performing risks assessment studies. New methodologies will be developed by improving the knowledge with 4 new storage cases.

The project consortium is the following:

R&D organisations	**Oil & Gas companies**	**Power companies**	**Manufacturers**
IFP (FR)	Statoil (NO)	Vattenfall (SE)	Alstom Power (FR)
TNO (NL)	Gaz de France (FR)	Elsam (DK)	Mitsui Babcock (UK)
SINTEF (NO)	RIPSA (SP)	Energi E2 (DK)	Siemens (DE)
SINTEF Ener. Res. (NO)	Rohoel (AT)	RWE (DE)	BASF (DE)
SINTEF Pet. Res. (NO)	ENITecnologie (IT)	PPC (GR)	GVS (IT)
NTNU (NO)		E.ON UK (UK)	
BGS (UK)			
BGR (DE)			
BRGM (FR)			
GEUS (DK)			
IMPERIAL (UK)			
OGS (IT)			
Univ. Twente (NL)			
Univ. Stuttgart (DE)			

CASTOR web site: http://www.co2castor.com

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Work performed and main results obtained

Strategy for CO_2 reduction (10 % of the budget)

This activity aims to define the overall strategies required to effect a 10% reduction of EU CO_2 emissions and to regularly monitor the effectiveness of the strategies (from capture to storage) from a techno-economical point of view. Research work is also focused on obtaining data on CO_2 sources and potential geological storage capacities from Eastern Europe (extension of GESTCO European project). At the same time solutions will be identified for legal and public acceptance of the concept of CO_2 storage as a viable option for CO_2 mitigation. The overall impact of the project on EU countries, including Candidate Countries, is therefore taken into account.

The first roadmap for large scale implementation of the concept has been outlined. The relative importance of the major controlling economic incentives has been estimated and the non-technical incentives and obstacles have been identified.

The data base on storage capacity in Europe have been improved by that eight more countries have been included, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia.

CO_2 capture in industrial emissions (65 % of the budget)

The objectives of work on post-combustion capture are:

- development of absorption liquids, with a thermal energy consumption of 2.0 GJ/tonne CO_2, at 90% recovery rates
- resulting costs per tonne CO_2 avoided not higher than 20 to 30 €/tonne CO_2, depending on the type of fuel
- pilot plant tests showing the reliability and efficiency of the post-combustion capture process.

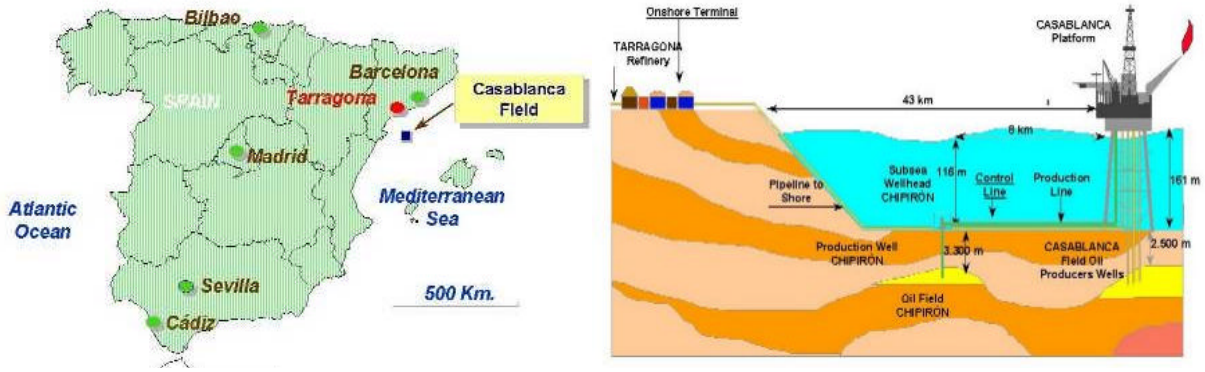
For post-combustion capture, absorption technology is a leading option but its implementation in a power station will decrease the efficiency of generation by 15-25% and increase the power cost up to 50%. Some breakthrough in absorption technology is needed and Castor will address the following key issues: energy consumption, reaction rates, contactor improvements, liquids capacities, chemical stability and corrosion, desorption process improvements.

The pilot plant for process integration and validation is installed in a modern coal-fired plant: Esbjerg Power Station operated by Elsam in Denmark. This test facility with a capacity of 1 t CO_2/hour will operate during more than 2 years with real flue gas, allowing hands-on experience with absorption technology. **This is the greatest pilot in the world for post-combustion capture of CO_2 on a coal combustion.**

Storage performance and risk assessment studies (25% of the budget)

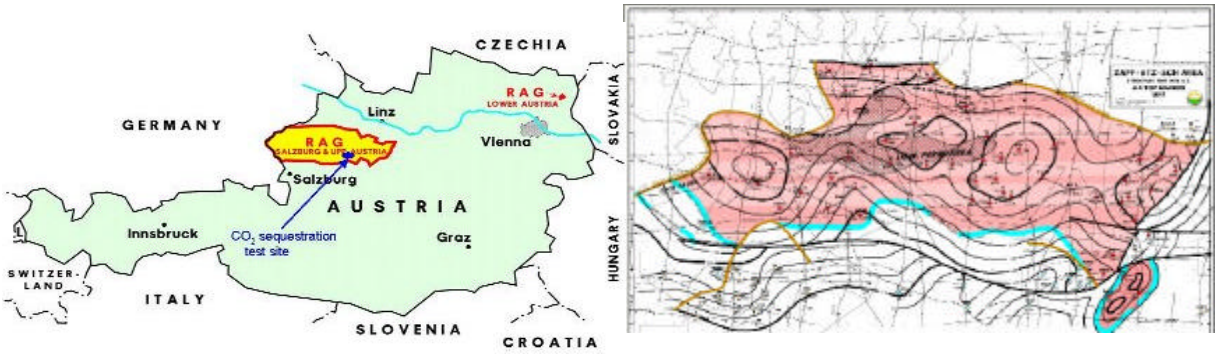
The objective is to develop and apply a methodology for the selection and the secure management of storage sites by improving assessment methods, defining acceptance criteria, and developing a strategy for safety-focussed, cost-effective site monitoring. The "Best Practice Manual" will be improved by adding four European cases.

Casablanca oil field (Spain, operated by Repsol YPF)



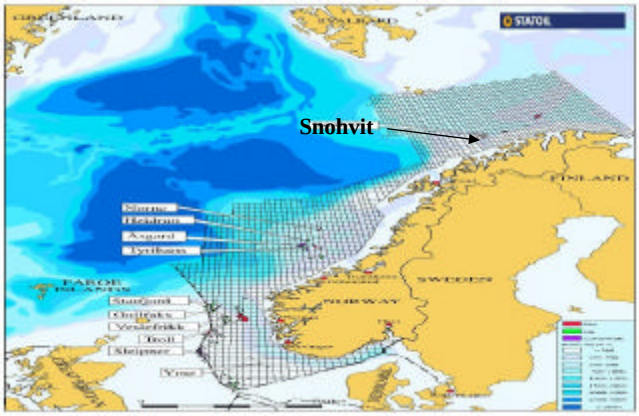
The Casablanca oil field is situated offshore northeastern Spain. This carbonate oil field at a depth of approximately 2500 m below the sea floor has reached its production tail, and production will soon cease. Repsol considers to use this field for storage of approximately 500 000 tonnes CO_2 per year, which is to be captured at the Tarragona refinery at 43 km distance from the field.

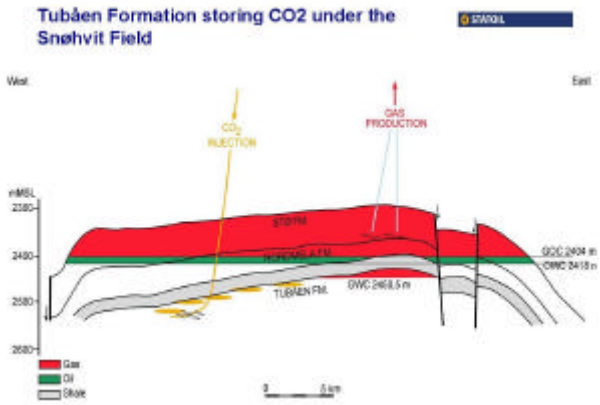
Atzbach-Schwanenstadt gas field (Austria, operated by Rohoel)



The Atzbach-Schwanenstadt gas field is situated in central northern Austria, between Salzburg and Linz. This onshore sandstone gas field at approximately 1600 m below the surface is almost empty. Rohoel AG considers its transformation into a CO_2 storage site and possibly test the suitability of CO2 injection for Enhanced Gas Recovery. Potential CO_2 sources are a paper mill (emitting about 200 000 tonnes CO_2 per year) and a fertiliser plant (emitting about 100 000 tonnes CO_2 per year). Transport of CO_2 may be by trucks. Injection into the field may start towards the end of the project period, given positive results of the study and financing by industrial partners.

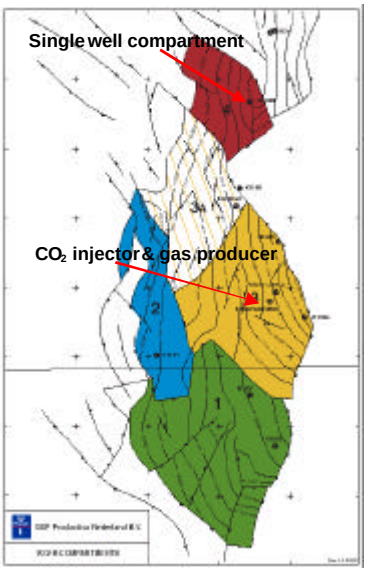
Snøhvit aquifer (Norway, operated by Statoil)





The Snøhvit field is located offshore in the northern Norwegian Sea. Statoil has got official approval to inject CO_2 separated from produced gas from the Snøhvit field into an aquifer below the reservoir (depth: 2500 m). Injection of 0.75 Mt/year is planned to start in late 2006 and will last for more than 20 years.

K12B gas field (The Netherlands, operated by Gaz de France)



The K12B gas field is situated offshore the Netherlands. Gaz de France has carried out a feasibility study for Enhanced Gas Recovery. Small scale CO_2 injection of about 30 000 tonnes/year has started in mid 2004 and large scale injection of approximately 400 000 tonnes/year is intended to start in 2006 with a duration of up to 20 years. The reservoir is at 3500 - 4000 m in Rotliegend clastics. A seismic baseline survey exists.

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