Fifth Annual Conference on Carbon Capture & Sequestration

Steps Toward Deployment

Programs

A Major European Initiative: the CASTOR Project (CO_2 from Capture to Storage) Objectives and Major Achievements

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Presentation outline

- Castor at a glance
- Post-combustion capture
- CO_2 geological storage
- The way forward

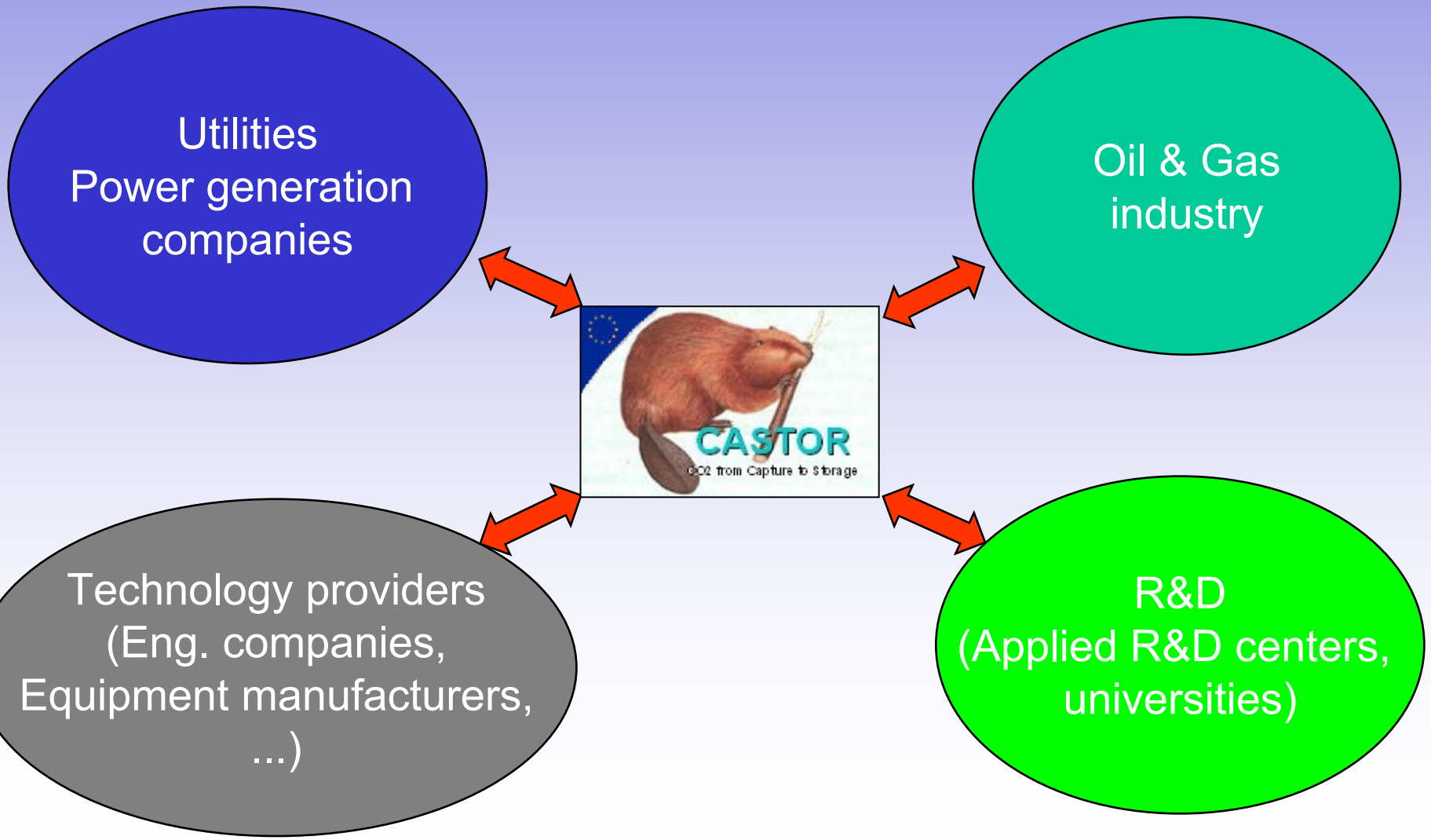
CASTOR targets

- Develop and validate innovative technologies needed to capture 10% of CO_2 emitted in Europe (30% of CO_2 emitted by power and industrial plants)
  - Reduce the cost of CO_2 post-combustion capture,

    $\Rightarrow$ *from 50-60 € to 20-30 € / ton of CO_2 avoided*
  - Contribute to the feasibility & acceptance of the geological storage concept

    $\Rightarrow$ *study 4 new European storage sites*
  - Start the development of an integrated strategy connecting capture, transport and storage options for Europe

A wide representation of European actors



CASTOR at a Glance (1)

Funded by the European Commission under the 6th Framework Program

R&D	Oil & Gas	Power Companies	Manufacturers
IFP (FR)	STATOIL (NO)	VATTENFALL (SE)	ALSTOM POWER (FR)
TNO (NL)	GDF (FR)	ELSAM (DK)	MITSUI BABCOCK (UK)
SINTEF (NO)	REPSOL (SP)	ENERGI E2 (DK)	SIEMENS (DE)
NTNU (NO)	ENITecnologie (IT)	RWE (DE)	BASF (DE)
BGS (UK)	ROHOEL (AT)	PPC (GR)	GVS (IT)
BGR (DE)		POWERGEN (UK)	
BRGM (FR)			
GEUS (DK)			
IMPERIAL (UK)			
OGS (IT)			
TWENTE U. (NL)			
STUTTGARTT U. (DE)			

Co-ordinator: IFP

Chair of the Executive Board: Statoil

30 partners from 11 European Countries

Budget: 15,8 M€

EU funding: 8,5 M€

Industrial funding: 2,2 M€

Duration: 4 years

CASTOR at glance (2)

- Kick-off in February 2004
- Recognised by the Carbon Sequestration Leadership Forum, Melbourne, Australia, Sept. 2004

Post-combustion capture

- Objectives
  - 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 (natural gas, coal, lignite)
  - Pilot plant tests showing the reliability and efficiency of the post-combustion capture process

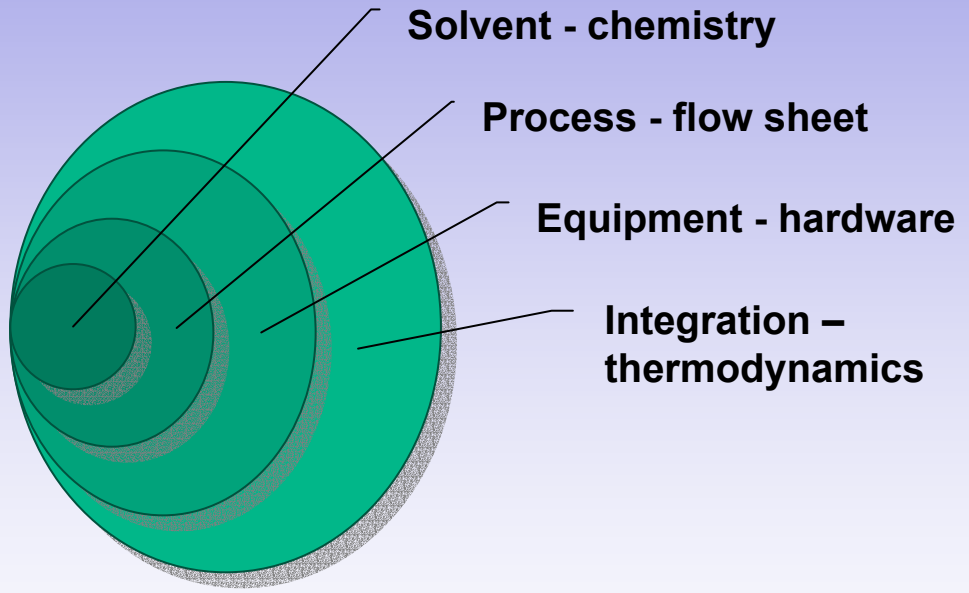
Why focusing on post-combustion capture ?

- Post-combustion capture is important because of large existing stock of power plants and boilers but also for new plants, as the cheapest will be conventional ones based on direct combustion of fuel
- Large-scale demos have been announced/scheduled:
  - RWE in Germany (coal-fired power station)

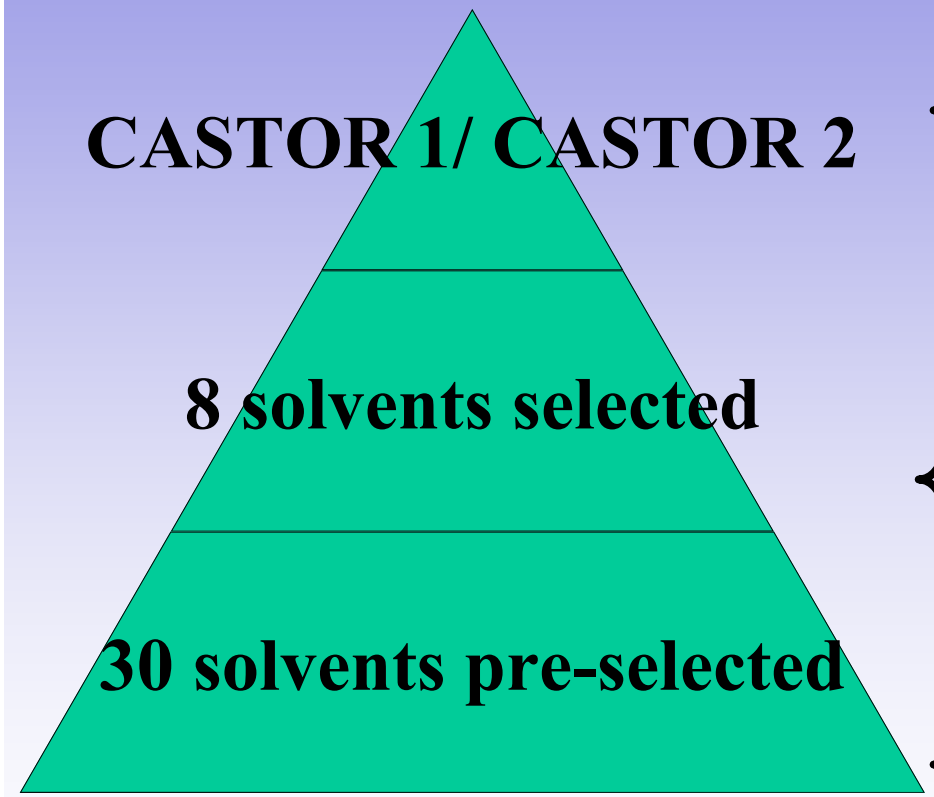
  - Shell-Statoil in Norway (gas-fired power station in 2012, with EOR)

Major technical results/deliverables

- New solvents resulting in less heat for regeneration
- Advanced processes resulting in lower power output losses
- Advanced equipment (membrane contactors) resulting in lower investment costs
- Pilot plant operating with real flue gas allowing hands-on-experience with absorption technology
- Methods for integration and optimisation resulting in lower power output losses



Solvent development procedure



Pilot plant experiments

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Lab-pilot experiments

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Process design studies
Degradation studies
Corrosion studies
Solvent characterisation

↑

Solvent screening studies

European post-combustion test facility: the CASTOR pilot plant

Capacity: 1 t CO_2 / h

5000 Nm3/h fluegas (coal combustion)

In operation since early 2006

The greatest post-combustion pilot worldwide

CASTOR pilot plant (3)

Official inauguration 15th of March 2006
200 participants from governments/administrations (EC, DOE) , industry, research, press, TV ...

The CASTOR Pilot plant (2)

January – April 2006: MEA-testing for 1000 hrs
May – December 2006: CASTOR1-testing 5000 hrs
January – November 2007: CASTOR2-testing 5000 hrs

CO_2 Storage performance and risk assessment studies

No capture without storage!

- General objectives
  - 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
  - Improve the "Best Practice Manual", started with the SACS/Sleipner project, by adding 4 more real-site cases

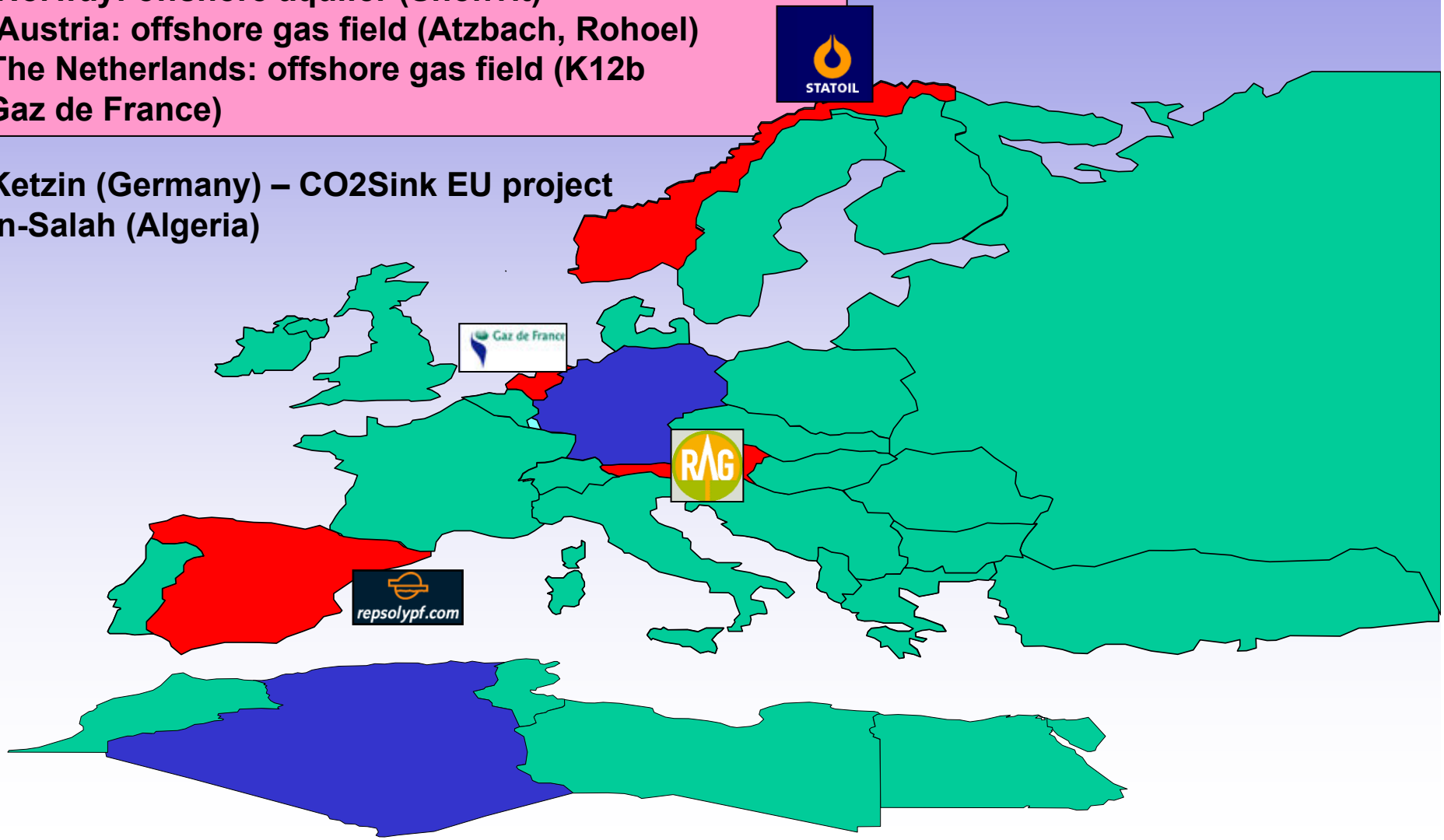
CO_2 Storage performance and risk assessment studies

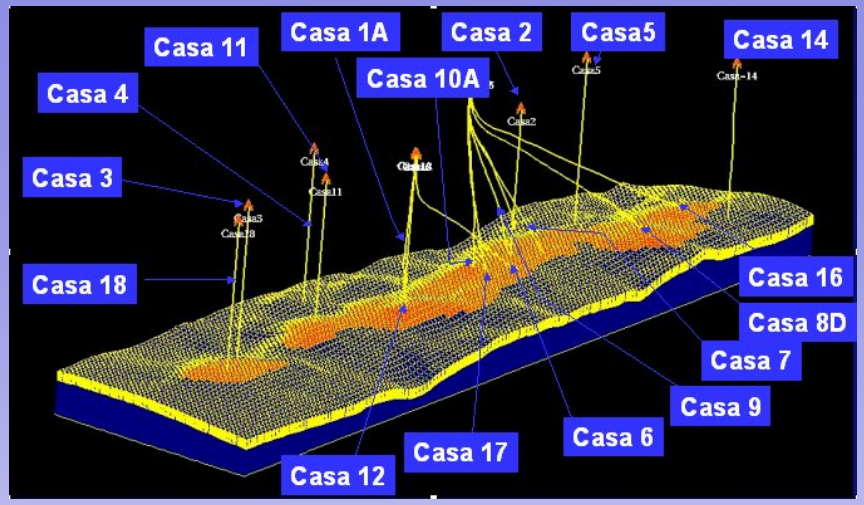
- Four field cases to cover some geological variability:
  - clastics (sandstones) vs. carbonates
  - onshore vs. offshore (consequences for monitoring)
  - storage site types: depleted oil field, depleted gas field, enhanced gas recovery, aquifer
  - some cases with good sample access, others with chance for monitoring
    (→ covers many methods, focus different from field to field)
  - cases in different countries to give many countries their "own case" (good for public acceptance)
- Two cross-disciplinary activities
  - Preventive and corrective actions
  - Criteria for site selection & site mgmt

CASTOR CO_2 storage initiatives

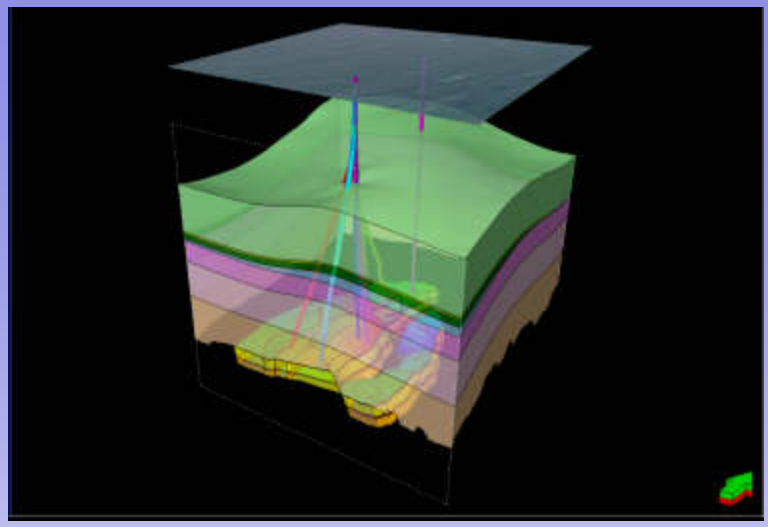
- Spain: offshore oil reservoir (Casablanca, REPSOL)
- Norway: offshore aquifer (Snohvit)
- Austria: offshore gas field (Atzbach, Rohoel)
- The Netherlands: offshore gas field (K12b Gaz de France)

Ketzin (Germany) – CO2Sink EU project
In-Salah (Algeria)





Casablanca reservoir model



K12-B geological model

Rock samples from Atzbach

Field cases research topics

- Data gathering, geomodel building
- Analysis of fluid flow properties
- Reservoir simulation
- Geochemical, geomechanical experiments and simulations
- Well integrity analysis
- Long term modelling and simulation
- Monitoring of stored (and escaping!) CO_2
- Integrated risk assessment analysis

CASTOR the way forward

- CASTOR is a large integrated effort aiming at:
  - Developing technologies for cost-effective post-combustion capture (pilot plant launching beginning of 2006, official launching 15th March 2006)
  - Building confidence in CO_2 geological storage by adding 4 more cases to the portfolio of existing sites:
    - K12-B in the Netherlands: industrial scale in 2006-2007?, not decided yet
    - Start CO_2 injection on Snohvit in 2007

Build-up upon acquired experience