The "CASTOR" – Project and the CO$_2$ Sequestration Activities of RAG

Torsten Clemens
Introduction
RAG’s activities in Upper Austria
EU Project: CO₂, from Capture to Storage (CASTOR)
RAG’s participation in CASTOR
Conclusions
- Austrian target for CO₂ emission reduction: 13 % compared with CO₂ emissions in 1990
- However, until 2000 CO₂ emissions increased by 3.5 %
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However, until 2000 CO\textsubscript{2} emissions increased by 3.5 %

Greenhouse gas emission reduction can be achieved by:
(1) Increasing energy efficiency
(2) Switching to fuels emitting less CO\textsubscript{2}
(3) Increasing use of renewable energy
(4) CO\textsubscript{2} capture and storage
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- RAG is operating an Underground Gas Storage field in Upper Austria
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Outline

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- RAG’s participation in CASTOR
- Conclusions
CASTOR

$\text{CO}_2$, from Capture to Storage
an European Initiative
CASTOR Objectives / targets

- Reduce the cost of CO₂ post-combustion capture
- Contribute to the feasibility & acceptance of the geological storage concept
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- Reduce the cost of CO₂ post-combustion capture
- Contribute to the feasibility & acceptance of the geological storage concept
- Validate the concept on real site(s)
  - Pilot testing for capture (25 t CO₂ / day)
  - Detailed studies of future storage projects
Consortium participants

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)
GDF (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

Participant outside Europe: Petrobras (Brazil)
CASTOR main components

- **Strategy for CO₂ Reduction**: Budget: 0.9 M€
- **CO₂ Post-Combustion Capture**: Budget: 10.3 M€
- **CO₂ storage performance & risk assessment studies**: Budget: 3.8 M€
- **Management Dissemination**: Budget: 0.75 M€
CASTOR main components

Strategy for CO₂ Reduction

WP1.1 Development of CO₂ reduction strategies

WP1.2 Geological storage options for CO₂ reduction strategy

Budget: 0.9 M€

CO₂ Post-Combustion Capture

CO₂ storage performance & risk assessment studies

Budget: 10.3 M€

Management Dissemination

Budget: 0.75 M€

Budget: 3.8 M€
CASTOR main components

**Strategy for CO₂ Reduction**

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**CO₂ Post-Combustion Capture**

- WP2.1 Evaluation, optimisation & integration of post-combustion capture processes
- WP2.2 Identification of most promising liquids
- WP3.3 Designed of membrane based processes
- WP3.4 Advanced processes
- WP3.5 Process validation in pilot plant

**Budget**: 10,3 M€

**CO₂ storage performance & risk assessment studies**

**Budget**: 3,8 M€

**Management & Dissemination**

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CASTOR main components

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**CO₂ storage performance & risk assessment studies**

WP3.1 Field case "Casablanca"

WP3.2 Field case “Atz-Sch"

WP3.3 Field case "K13b"

WP3.4 Field case "Snohvit"

WP3.5 Preventive & corrective actions

WP3.6 Criteria for site selection and site management

**Budget: 3,8 M€**

**Management Dissemination**

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CASTOR main components

**Strategy for CO₂ Reduction**
- WP1.1 Development of CO₂ reduction strategies
- WP1.2 Geological storage options for CO₂ reduction strategy

**Budget:** 0,9 M€

**Management Dissemination**
- WP0.1 Project Management
- WP0.2 Dissemination & Training

**Budget:** 0,75 M€

**CO₂ Post-Combustion Capture**
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**Budget:** 3,8 M€
Objectives

- Define the overall strategies required to effect a 10% reduction of EU CO$_2$ emissions and to monitoring the effectiveness of the strategies (from capture to storage) from a techno-economical point of view.
  - input from other sub-projects and on ongoing research in this field
  - Existing economic tools will be adapted such that they are applicable to the purpose of strategy development
Objectives

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- Obtaining data on capture and geological storage capacities from Southern and Eastern Europe (extension of GESTCO European project). The impact of the overall strategies on EU countries, including Candidate Countries, will be taken into account.
Overall 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
- Pilot plant tests showing the reliability and efficiency of the post-combustion capture process
Elsam Esbjerg Power unit

- Boiler house
- Turbine hall
- De-SOx plant
Overall 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-focused, cost-effective site monitoring.
- Improve the "Best Practice Manual" by adding 4 more real-site cases.
Four field cases

- Casablanca case (oilfield, Repsol, Spain)
- Atzbach-Schwanenstadt case (gasfield, Rohöl-Aufsuchung AG, Austria)
- K12B case (gasfield, Gaz de France, Netherlands)
- Snøhvit case (aquifer, Statoil, Norway)

Two cross-disciplinary work packages

- Preventive and corrective actions
- Criteria for site selection & site mgmt
Casablanca oilfield (Repsol, Spain)

- Carbonate oil-field, offshore
- Depth: 2500 m
- Injection of 0.5 Mt CO$_2$ / year from the Tarragona Refinery
Atzbach-Schwanenstadt Gas Field (Rohöl-Aufsuchungs AG, Austria)

- Sandstone gasfield, onshore
- Depth: 1600 m
- Possible injection of 200,000 t CO₂/year
Snohvit Aquifer (Statoil, Norway)

- Sandstone aquifer, offshore
- Depth: 2500 m
- 0.75 Mt CO₂ per year; Start in Oct 2006 and last for 20 + years
- CO₂ source is removal from natural gas before cooling to LNG; limit 50 ppmvol.

Tubåen Formation storing CO₂ under the Snohvit Field
K12b Gas Field (Gaz de France, The Netherlands)

- Gasfield in Rotliengen clastics, offshore
- Depth: 3500-4000 m
- Small-scale injection test: 30,000 t/year in mid-2004
- 400,000 t/year in 2006

![Map of K12b Gas Field](image)
CASTOR Summary

- Budget: 15.8 M€
- EU funding: 8.5 M€
- Industrial funding: 2.2 M€
- Duration: 4 years
- 30 partners from 11 European countries
Austrian part of CASTOR project – RAG involvement

- BGS – reservoir geochemistry-geomechanics
- BGR – monitoring
- IMPERIAL – long-term effects, geomechanics
- OGS – monitoring (seismic)
- RWTH – cap-rock diffusion/leakage
- SINTEF – reservoir simulation, long-term effects, geological model
- SINTEF – reservoir geochemistry-geomechanics
- BGS – cap-rock geochemistry-geomechanics
Potential implementation in Upper Austria

- Industrial products
- Electricity
- Hydrogen
- CO₂ Separation
- Hydrocarbon production
- CO₂ transport
- CO₂ Injection

Innviertel Formation
Hall Formation
Basal Sands Gas Reservoir
Conclusions

- CO₂ separation and geological storage is a viable option in Upper Austria to reduce greenhouse gas emissions
- First results from CASTOR indicate that gas fields in Upper Austria are suitable for CO₂ geological storage
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CO\textsubscript{2} geological storage offers the opportunity to install zero emission infrastructure in Upper Austria.

However, it should be noted that at current trading prices of CO\textsubscript{2} such projects are economically not attractive.
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