The overall goal of the CASTOR project was to develop and validate, in public / private partnerships, a substantial part innovative technologies needed to capture CO2 at the post-combustion stage and to store CO2. The CASTOR R&D target was to enable the capture and geological storage of 10 % of the CO2 emissions of Europe, which corresponds to about 30 % of CO2 emitted by European power and industrial plants. To reach this goal, CASTOR planned to improve current techniques and develop, validate and generalise previously nonexistent methodologies and technologies for the capture of CO2 and its subsequent secure underground storage.

Key targets of CASTOR were the following:
- a major reduction in post-combustion capture costs, from EUR 50-60 down to EUR 20-30 per ton of CO2 (large volumes of flue gases need to be treated with low CO2 content and low pressure);
- to advance general acceptance of the overall concept in terms of storage performance (capacity, CO2 residence time), storage security and environmental acceptability;
- to start the development of an integrated strategy connecting capture, transport and storage options for Europe.

Strategy for CO2 reduction (10 % of the budget)

This activity aimed to define the overall strategies required to effect a 10 % reduction of EU CO2 emissions and to regularly monitor the effectiveness of the strategies (from capture to storage) from a techno-economical point of view. Research work was also focused on obtaining data on CO2 sources and potential geological storage capacities from Eastern Europe (an extension of the GESTCO European project). At the same time, solutions were identified for legal and public acceptance of the concept of CO2 sequestration as a viable option for CO2 mitigation, by developing and applying a template for exploring the public perceptions toward carbon storage. The following results have been obtained during the project:
- development of an economic tool for CCS;
- establishment of scenarios for large-scale implementation of CCS in Europe (30 % CO2 emission reduction in European power generation);
- study of CO2 geological storage in eight European countries.

Post-combustion capture (65 % of the budget)

The objectives of work on post-combustion capture were:
- development of absorption liquids, with a thermal energy consumption of 2.0 GJ/tonne CO2 at 90 % recovery rates;
- resulting costs per tonne CO2 avoided not higher than 20 to 30 EUR/tonne CO2, depending on the type of fuel;
- pilot plant tests showing the reliability and efficiency of the post-combustion capture process.

This action delivered the following:
- 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.

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

The objective was 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. Items for improvements included: the prediction of seal efficacy prior to injection, the effects of CO2 on the seal integrity and on mechanical site stability, the leakage potential of wells and methods to improve well safety, the improvement of reaction-transport simulation models, and development of cost-effective monitoring strategy and site completion criteria. The large majority of work was related to four sites for CO2 storage, with a large variety of situations and characteristics:
- storage in a depleted oil reservoir in Mediterranean Sea: Casablanca oil field, Spain (operated by Repsol);
- storage in a depleted gas field: Atzbach-Schwanenstadt, Austria (operated by Rohoel);
- storage in a depleted gas field: K12B, North Sea, the Netherlands (operated by Gaz de France);
- storage in a deep aquifer: Snøhvit, Norwegian Sea (operated by StatoilHydro).

In summary, CASTOR produced the following achievements:
- geological characterisation with varied datasets;
- consolidating geochemistry: experiments and numerical modelling (including reaction-transport);
- fluid flow in caprocks: long-term versus transient laboratory methods for gas permeability;
- flow simulations: exact history-matching; far-field containment risks;
- geomechanics: integrated fluid flow and geomechanical simulators;
- monitoring strategies: tracers; focussing on site-specific requirements;
- well integrity / remediation;
- risk analysis methodologies.

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