

PUBLISHABLE EXECUTIVE SUMMARY

The ENCAP project

ENCAP is a five-year integrated project (IP) within the EU sixth framework research programme. The project will run for five years and has a total budget of 22 MEUR. ENCAP started in March 2004. This report summarizes the activities and results from the second year of the project (2005-04-01—2006-02-28).

The technological objective of ENCAP is to cut lead-time and reduce costs for emerging pre-combustion¹ carbon capture technologies attributed to power generation for continued use of fossil fuels in Europe - and the world - in a resource-efficient and environmentally benign manner. The stated target of ENCAP is to provide pre-combustion capture technologies in power cycles fueled by natural gas, hard coal and lignite with the objective of achieving: 1) at least 90 % capture rate for CO₂ and, 2) 50 % capture cost reduction (from a current level of 50-60 € per tonne of CO₂ captured).

The scientific objective is to generate new knowledge and comprehension of systems, processes, materials and matter by characteristics of potentiality, constraints and governing mechanisms pertaining to pre-combustion capture from fossil fuels, with a bearing on solutions that (might) facilitate sequestering of CO₂. This objective requires targeted fundamental and applied research and topical involvement by leading European R&D institutions.

ENCAP will deliver results that have the potential for commercial exploitation beyond year 2015 and will generate knowledge and results that enable power companies to launch design projects by 2008-2010 aimed at large-scale demonstration plants (250-300 MWe).

The RTD activities in ENCAP are structured in 6 sub-projects:

- SP1: Process and Power Systems
- SP2: Pre-Combustion Decarbonisation Technologies
- SP3: OxyFuel Boiler Technologies
- SP4: Chemical Looping Combustion
- SP5: High-Temperature Oxygen Generation for Power Cycles
- SP6: Novel Pre-Combustion Capture Concepts

ENCAP will be executed in two phases. Validation in large scale is planned for some of the technologies in phase two. A selection of a candidate or candidates among the OxyFuel Boiler Technologies, Chemical Looping Combustion, High-Temperature Oxygen Generation for Power Cycles and Novel Pre-Combustion Capture Concepts will be made in mid term of the project period (2006).

Partners involved

The ENCAP project gathers 28 European entities. The consortium that consists of highly ranked RTD providers, leading European manufactures and large energy providers creates an important European Research Area of CO₂ capture technologies.

¹ Here pre-combustion capture denotes measures taken prior to combustion and includes pre-combustion decarbonisation and pre-combustion denitrogenation (the latter is often referred to as oxyfuel).

The ENCAP partners are:

ENERGI E2	ALSTOM	DLR	Chalmers
RWE Power	Siemens	CERTH/ISFTA	NTNU
PPC	Mitsui Babcock	TNO	Universität Paderborn
Statoil	Linde	IFP	University of Stuttgart
Vattenfall	Lurgi	SINTEF	University of Twente
Air Liquide	BOC		University of Ulster

Work performed and main results achieved during the second year

RTD activities

Year two of ENCAP has been a productive year. The research and dissemination activities have been performed according to the first part of the Implementation Plan for Month 13-Month 30 with only a few delays. The development and the validation of the pre-combustion technologies in ENCAP have been reported in 48 Deliverables. There are smaller delays in the final reporting of some deliverables. The work performed in the six sub-projects is shortly described below.

Specific efforts have during the second year been dedicated to the process of the selection of candidates for large scale testing. A decision by the Executive Board on the technology for large-scale test was need in December 2005 in order to make it possible to submit the Implementation Plan for Month 25-Month 42 to the Commission in March 2006. Preparations of applications of large-scale testing candidates have been a part of the work in SP 3, SP4, SP5 and SP6. Six applications were submitted and the Executive Board decided in December that further work should be planned for the two applications of the OxyFuel Boiler Technologies: 1 MWth CFB pilot, Chercher, France and PF Oxyfuel 30 MWth Vattenfall Pilot, Cottbus, Germany. A final decision on the large scale candidate is schedule for March 2006 in connection with the ENCAP General Assembly meeting.

The ENCAP Technical Advisory Committee has been establish in 2005 in order to give advice to the Executive Board. ETAC consists of external experts and will act as a scientific support to the Executive Board (EB) in its management duty to meet the over all ENCAP objectives.

SP1 Process and Power Systems

The industrial partners and SINTEF have during the first year, with updates during the second year, defined a set of reference power plants and guidelines for evaluation and benchmarking of capture technologies developed in ENCAP (SP2-SP6).

The power companies, Statoil, ALSTOM, Siemens and SINTEF have during the second year performed a first evaluation and benchmarking of these technologies.

Chalmers and ISFTA, with input from power companies, Statoil, ALSTOM, Siemens, are developing a simulating model and scenarios to investigate how large-scale introduction of CO₂ capture and storage may influence the European energy system.

SP2 Pre-Combustion Decarbonisation Technologies

Technical and economic key figures of IGCC/IRCC processes based on lignite, hard coal and natural gas have been elaborated and process/block flow diagrams have been provided for each process.

A reduced code for H₂-rich combustion has been produced, validated against lab scale combustion experiments, and implemented in commercial CFD programs. Siemens and ALSTOM have tested an optimised version of their current burner; designing of new burner has been started.

SP3 OxyFuel Boiler Technologies

The planned experiments in for the verifications of oxyfuel fundamentals have been finished. The conceptual design of the oxyfuel PF plants have been finished, including process integration and design of the boiler system. The investment and O&M costs have been estimated and supplied to SP1. Work on safety and operability, economic assessment, and RAM analysis has been performed but remains to be reported. A conceptual design of the OxyCFB has been completed and a proposal for large scale testing in a 1 MWth pilot plant has been presented. The subcontracted tests in a small-scale CFB lab rig have been delayed due to technical difficulties but are now about to be finished. The construction of the 500 kW oxyfuel test rig has been finished and commissioning is ongoing. A proposal for large scale testing has been developed in order to be included in the ENCAP project based on the 30 MWth pilot plant to be built by Vattenfall in Germany.

SP4 Chemical Looping Combustion

In SP4, solid fuel conversion with oxygen carrier has been successfully demonstrated at lab-scale with pet coke and different bituminous coals. The suitability of low cost materials, e.g. natural ores, has been confirmed for this reaction. Chalmers' fluidised bed reactor system (10 kWth) for solid fuels has been constructed and is now ready for operation. A design concept of Chemical Looping Combustion for solid fuels and a size of 445 MWe based on CFB boiler technology has been performed. The Chemical Looping concept looks very promising when it shows a low cycle efficiency penalty and a CO₂ mitigation cost lower than 10 €/ton CO₂. Further work has been done on the two new concepts

SP5 High-Temperature Oxygen Generation for Power Cycles

The overall goal of SP5 is to identify and develop promising low cost oxygen generation option, which can be effectively integrated in power plant process scenarios with CO₂ capture. Reducing the cost of oxygen generation and use in the power plant cycle is in fact an important requirement to make the economics of carbon dioxide capture more favourable than currently possible. Three different high temperature technologies have been further develop during the period. The CAR process was selected for a further validation of the alternative high temperature oxygen generation systems investigated in ENCAP mainly due to the high technical maturity and limited risk associated with this technology.

SP6 Novel Pre-Combustion Capture Concepts

In SP6, 17 novel cycles has been modelled, evaluated and compared to the SP1 Power Plant reference cases. All cycles data are now available in for the ENCAP partners. All cycles were classified into a specific structure based on the classification of the cycles in two families: oxy-fuel combustion ones (natural gas fired) and pre-combustion ones (natural gas and coal fired). A component book has been elaborated giving expert opinions considering available technology, best design practices, state of the art in materials, existing experience and other relevant issues for each studied novel cycle and for each component. University of Ulster started the economic calculations using their ECLIPSE toolbox in the second part of the reporting period.

Use and dissemination of knowledge

During the reporting period (12-24 month) CERTH/ISFTA as the D&T leader has supported the widespread dissemination of the knowledge obtained through the implementation of ENCAP activities. Aimed at an extensive promotion of the project's objectives the following training and dissemination actions have been carried out:

Web-based Training Activities Continuous Web-site Development

The ENCAP Website (www.encapco2.org) has been continuously updated with project's results and unrestricted reports concerning the conclusions drawn from the Work Programme. Potential upcoming events, training courses and calls for paper are also reported in order to enforce the disseminating knowledge. As part of the running training and dissemination activities, a "Technology Information" web page has been developed from February 2006 containing information pertaining to the engineering status of the candidate pre-combustion capture technologies. Major R&D topics are also addressed, targeted to the general public, researchers, industrial market players etc.

Web – "traffic" results of www.encapco2.org

Visits	
Total number since the starting date :	10419
Peak of monthly visits (Feb 2006) :	1211
Second peak of monthly visits (July 2005) :	980
Total number for previous month :	1211
Hits	
Total number since the starting date :	348066
Peak of monthly hits (Feb 2005)	42636
Second peak of monthly hits (Feb 2006) :	34210
Total number for previous month :	34210

Dissemination material

The ENCAP Newsletter Issue No2, containing information about the Training Seminar-Workshop as well as project's highlights, was electronically distributed to a wide target group (Energy Centers, Manufactures, Universities, Decision-Makers, Local Authorities, EC, etc). The distribution of dissemination material (Newsletters, pens) in various International events facilitated the promotion of ENCAP's scope and activities. Furthermore, a third ENCAP Newsletter will be published (both in electronic and hard copy format), containing the results presented in the ENCAP-CASTOR Workshop, related to CO₂ pre-and post-combustion capture and CO₂ storage.

Preparation of the Training Seminar-Workshop

The arrangements concerning the Workshop, planned to be held in Denmark on March 2006, were managed by CERTH/ISFTA. Part of the management activities such as, proceedings preparation, poster and badges printing has been subcontracted to a professional event organizer company "Crone & Co" | event communication. Further to the programme definition, possible speakers and attendees have been identified and Invitations and Registration Forms have been sent out to a wide target group of possible attendees. Around 100 participants from Universities, Research Community, Industry, Governmental Offices, is anticipated to attend the Workshop

Allocation of Dissemination Events & Paths

Considerable efforts on gathering information linked to potential dissemination events (call for papers in conferences) were carried out by CERTH/ISFTA in order to achieve a wider dissemination target group of the project results.