



PERIODIC ACTIVITY REPORT

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INSTRUMENT TYPE Integrated project	PRIORITY NAME Sustainable energy systems	
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PUBLISHABLE EXECUTIVE SUMMARY

Introduction - ENCAP objectives and structure

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.

The technological objective of ENCAP is to cut lead-time and improve cost for emerging pre-combustion carbon capture technologies¹ 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 operated by natural gas, hard coal and lignite with the objective of achieving:

- 1) at least 90% capture rate for CO₂
- 2) 50% capture cost reduction – from a current level of 50-60 € per tonne of CO₂ captured including technical validation including all steps of research of selected prospective concepts with economical assessment and HSE-conformance - with links to transportation and storage. In order to be coined *appropriate* the technology must be validated and deemed viable in regards of entire power generating efficiency, cost, versatility, and environmental impact. This requires complementary skills, large efforts and capabilities, and dedicated R&D.

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.

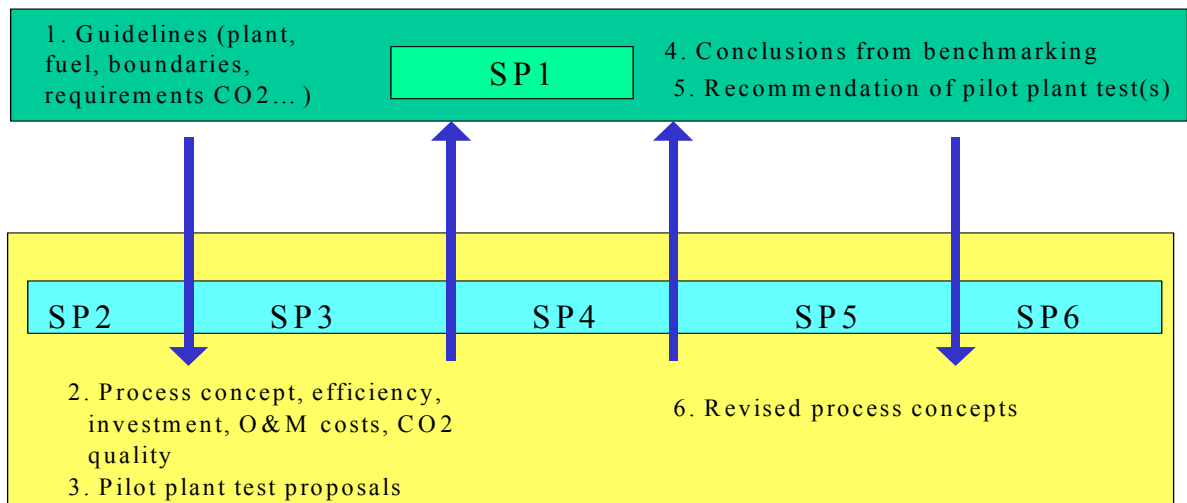
The RTD activities in ENCAP are structured in 6 sub-projects:

- 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

An overall conclusion drawn in SP1 will have a direct bearing on systems recommendations and the choice of pilot test as planned for Phase II of the project. This means that the R&D issues on ENCAP that affect processes and systems - in SP2 through SP6 - will be consistently scrutinised in SP1. The basic principle for this is illustrated in the following figure:

¹ *Pre combustion* denotes decarbonisation by appropriate measures taken prior to (or during) combustion in contrast to *post-combustion* that addresses CO₂ removal from a flue gas (after combustion)

ENCAP Integration



Partners involved

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

The ENCAP partners are:

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

Work performed and main results achieved during the first year

The main objectives and work performed in ENCAP during the first year cover

- The establishment of solid framework for process development (SP1, complemented by SP4/SP6)
- Power process design, including design of process components (SP2-SP6)
- Initiation of process cost estimation (SP2-SP5, SP6 begin with this during the second year of the project)
- Theoretical and experimental investigation of combustion, both hydrogen in air (SP2) and oxyfuel combustion of coal (SP3)
- Development and testing of materials for chemical looping (SP4) and oxygen separation (SP5)

A major achievement in ENCAP (SP1 and SP4+SP6) during the first year has been to provide a *common basis* for the studies performed in SP2-SP6. The work is the result of the agreement between major power plant equipment manufacturers, power companies, research institutions and universities about a general framework for calculating power plant performance. SP1 has provided guidelines with several reference power plants without CO₂ capture, requirements on the quality of the captured CO₂, boundaries for the economical analysis and a procedure for evaluating different CO₂ capture technologies. As a complement to the SP1 guidelines, SP4+SP6

has provided a common framework for the modeling basis, which is useful when modeling innovative power plant concepts that cannot be based directly on the reference power plants treated by the SP1 guidelines. Sometimes the use of favorable and maybe unrealistic computational assumptions is used to promote some technologies at the expense of others. The SP4+SP6 framework makes it possible to deal with this general problem of comparison of power plant performance statements from various sources. The SP4+SP6 framework provides a detailed and transparent set of computational assumptions, models and fluid properties, as well as a definition of the boundary conditions for calculating plant efficiency. It is expected that the SP1 guidelines and the SP4+SP6 computational framework will be used by others outside ENCAP, and that standards are set which can be referred to in publications.

The work in SP2 and SP3 is basically unprecedented through its detailed level of process engineering in combination with theoretical and experimental development in related combustion technologies (hydrogen combustion and oxyfuel combustion). Progress in process design has also been made in SP4, SP5 and SP6 as related to the specific objectives of these subprojects.

Chemical Looping Combustion (CLC) has been successfully demonstrated earlier for natural gas in a 10 kWth test reactor (FP5 GRACE project). Chemical Looping Combustion with solid fuels has never previously been demonstrated, but has the reporting period been successfully demonstrated in a batch process in ENCAP. An 8 kWth experimental rig for solid fuels CLC fuel conversion will be put into operation at Chalmers in April 2005 as part of the ENCAP project.

Use and dissemination of knowledge

CERTH/ISFTA as the D&T leader has undertaken the promotion and dissemination of the project's concept and its results. During the first year the main activities carried out have been targeting to enhance the publicity of the ENCAP project. The project logotype was developed and approved by the ENCAP Executive Board:



A website according to EU's specifications has been developed aiming to promote the project's idea on pre-combustion CO₂ capture technologies as well as to disseminate the knowledge generated in the project (www.encapco2.org). The website contains general information regarding the scope of ENCAP, the participants involved, links to relevant organizations & projects, and a list with relevant dissemination events & call for papers where the project's results could be presented. The website will be periodically updated and is planned to contain additional webpages concerning technology information on CO₂ capture and results, following the project's progress. The website link address was distributed by e-mail to approximately 600 recipients (Energy Centres, Manufactures, Universities, Decision-Makers, Local Authorities, EC, etc.) in the beginning of February 2005.

The first ENCAP newsletter has been produced and will be posted on the website in April 2005. The Newsletter will be distributed in electronic format to approximately 1000 recipients covering a wide target group (Energy Centres, Manufactures, Universities, Decision-Makers, Local Authorities, EC, etc.)