



ENCAP Integrated Project

1st International workshop on CSLF projects
29 September 2005

Prof. Lars Strömberg

Enhanced CO₂ Capture - ENCAP

A Research project for the development of
Pre-combustion technologies for
ENhanced CAPture of CO₂
in large power plants

A five year Integrated Project within the EC FP6
Total budget 22.2 MEuro
EC support 10.7 MEuro

Project period 2004 March - 2009 February

ENCAP – a powerful consortium

The ENCAP Consortium gathers:

5 large European energy companies (+Total)

11 leading European technology providers

12 high ranked research providers

<p>Energi E2 PPC RWE Power Statoil Vattenfall (+Total)</p>
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<p>Air Liquide ALSTOM Power Boiler (Fr)(GE) ALSTOM Power Centrales ALSTOM Power Ltd (UK) ALSTOM Ltd (CH)</p>	<p>BOC Linde Lurgi Mitsui Babcock Siemens</p>
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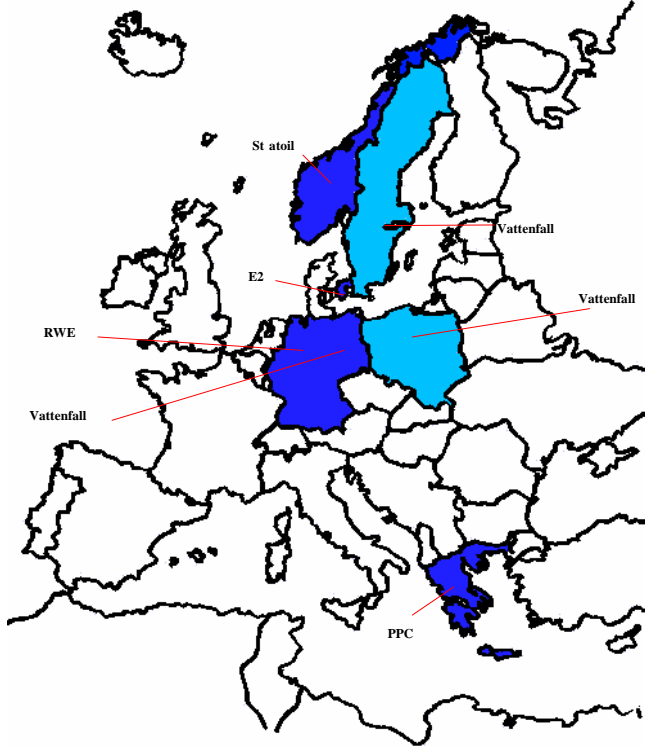
<p>DLR SINTEF IFP TNO ISFTA</p>

<p>Chalmers NTNU University of Paderborn</p>	<p>University of Twente University of Stuttgart University of Ulster</p>
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Energy providers

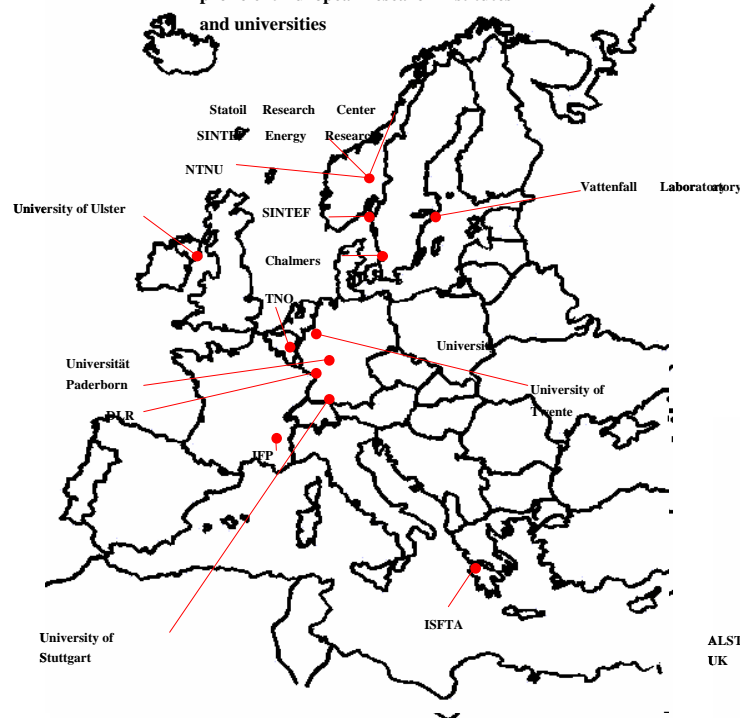
Main operating areas

Power & fossil fuel suppliers



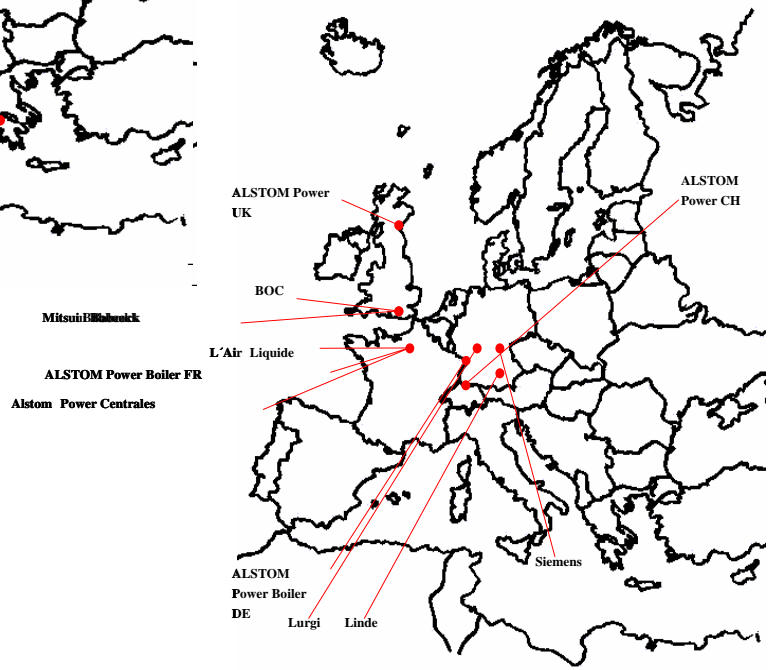
RTD Providers

proficient European research institutes and universities



Technology providers

leading European manufacturers

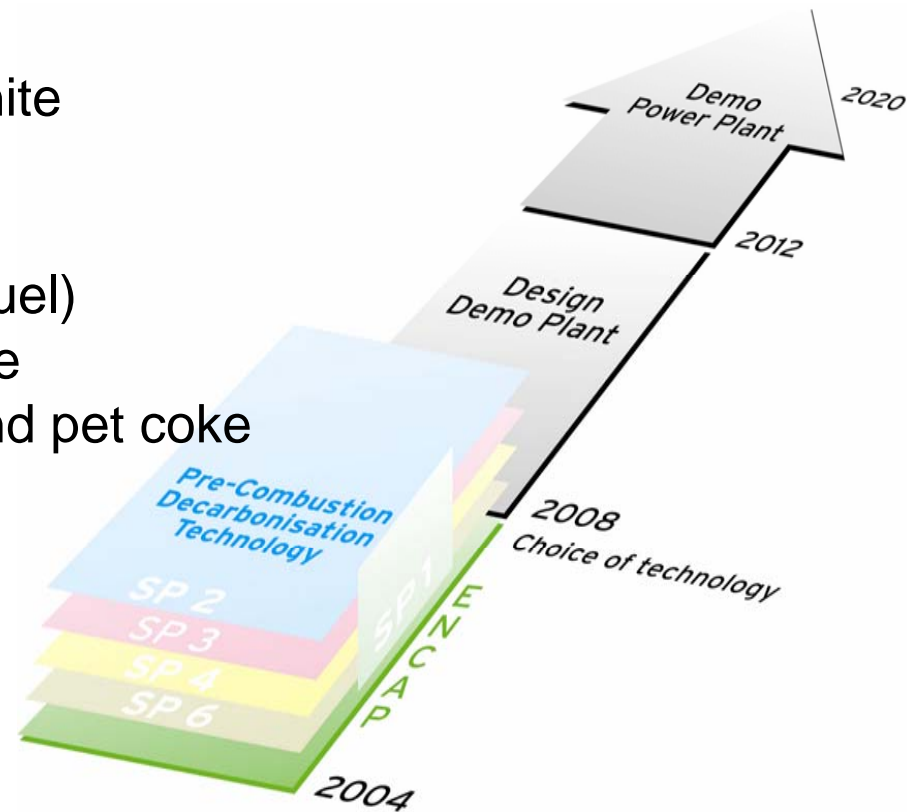


ENCAP target

Development and verification of technologies to reach a capture rate higher than 90% at a cost lower than 20 €/ton CO₂

- Pre-combustion decarbonisation
 - IGCC for hard coal and lignite
 - IRCC for natural gas
- CO₂/O₂ combustion technologies (oxyfuel)
 - PFC for hard coal and lignite
 - CFB for hard coal, lignite and pet coke
- Chemical Looping Combustion

In 2008 - Recommend technology for a Demo Plant



ENCAP Update

The project has been running for 18 months

Important results for the CCS strategy:

- A common framework is established in ENCAP to define and compare the different technologies (Benchmarking and base for recommendation)
- Verifications in test rigs and constructions of larger test facilities according to plan
- Development and test results so promising that preparation for “large scale” test has started
- Coordinated with CASTOR (post-combustion capture)
- Planned coordination with proposed projects Dynamis and Cachet

Reference cases and guidelines for ENCAP technology concepts

A common framework is established to define:

- State of the art reference power plants without CO₂ capture
 - Natural gas-fired 400 MWe Combined Cycle Gas Turbine (Statoil / Siemens)
 - Hard coal / pet coke-fired 445 MWe Circulating Fluidised Bed (Alstom)
 - Hard coal-fired 600 MWe PF (Mitsui Babcock)
 - Lignite-fired 1000 MWe PF (RWE / Vattenfall)
 - Lignite fired 380 MWe PF (PPC).
- Boundaries for economic analysis
- Procedure to evaluate power plants with CO₂ capture
- Design scenarios for CO₂ purity

■ This will enable consistency in the benchmarking of CO₂ capture alternatives

Experimental work and pilot testing

Pre-combustion decarbonisation (for hard coal, lignite and natural gas)

- H₂-rich combustion in gas turbines (Siemens, Alstom)

Pre-combustion denitrogenation, Oxyfuel

- Experimental investigation of combustion fundamentals in 10-500 kW_{th} test rigs
- Pilot testing in PF oxyfuel plant 10-30 MW_{th} and CFB 1 MW_{th}

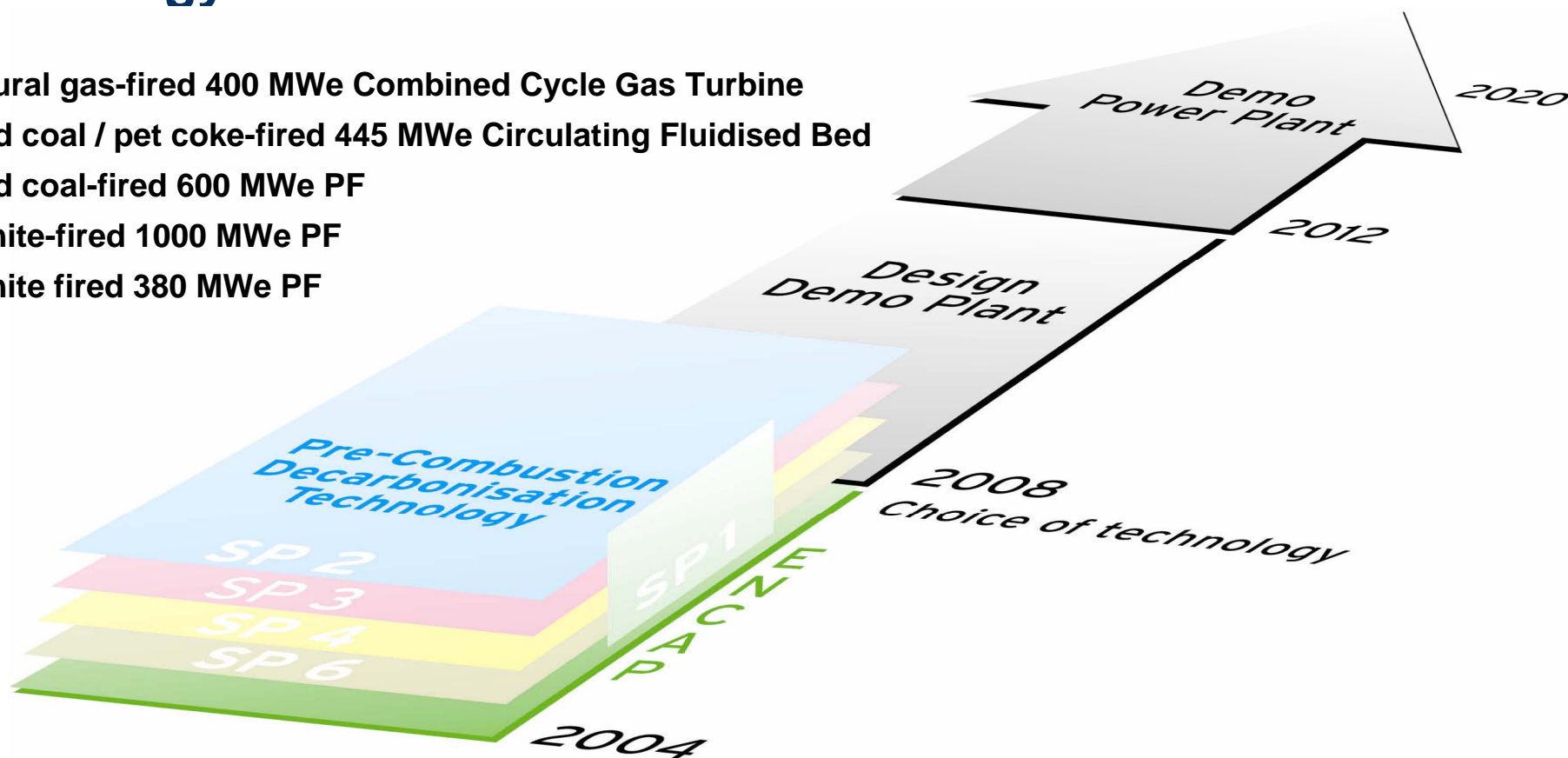
Chemical Looping Combustion

- Experiments in test rigs (IFP/Chalmers) and pilot testing 1 MW

Expected Results

Recomendation, in 2008-2009, of a pre-combustion technology for a Demo Power Plant:

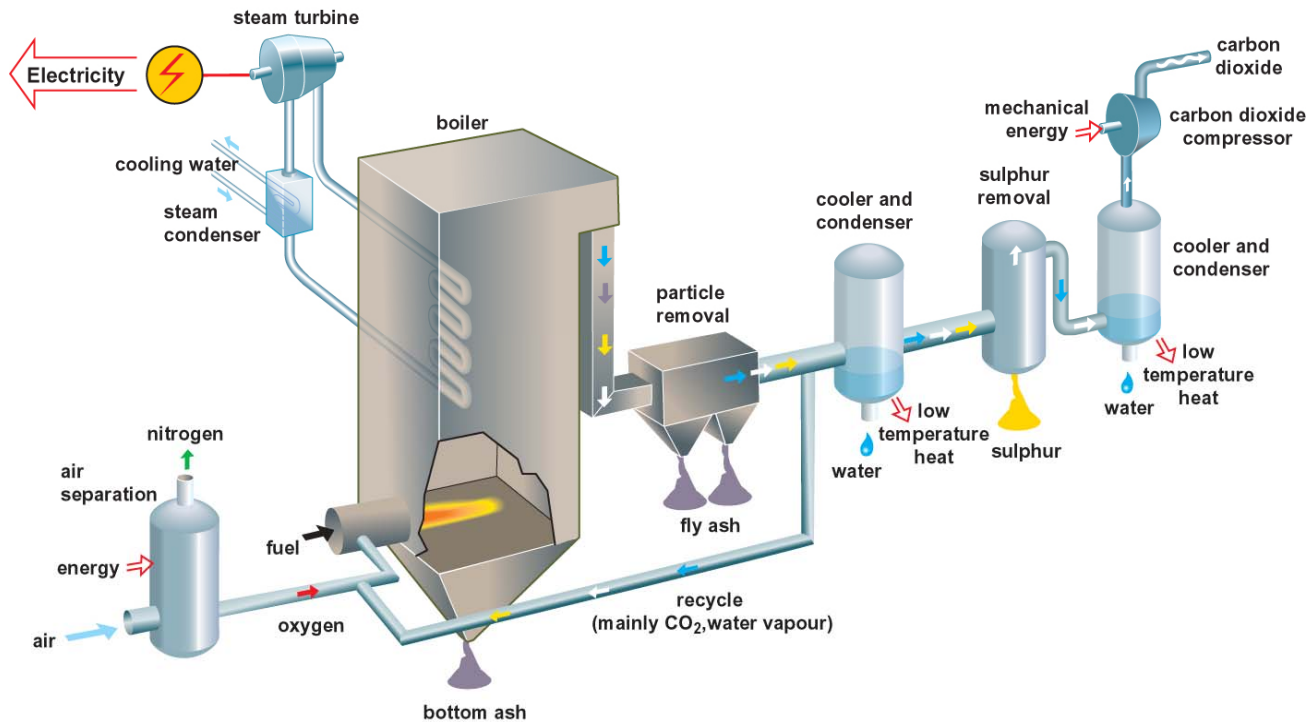
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- Lignite fired 380 MWe PF



The Vattenfall Pilot Plant supporting ENCAP

The size of the plant is 30 MWth and the energy will be utilized.

O₂/CO₂ recycle (oxyfuel) combustion capture



- The technology used is the CO₂/O₂ combustion also called “Oxyfuel technology”
- The plant will be built adjacent to the Schwarze Pumpe Power plant and will utilize all necessary infrastructure there.
- Fuel will primarily be lignite, but also hard coal
- Budget including test program is Mio €57