

# CO<sub>2</sub> free power plant: 15 years of R&D

Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	
Is it possible?	GAP-analysis	Concept development	Technology development/ engineering	Construction and operation of demo plant	
2000	2001	2003	2006	2008	2015 Commercial introduction

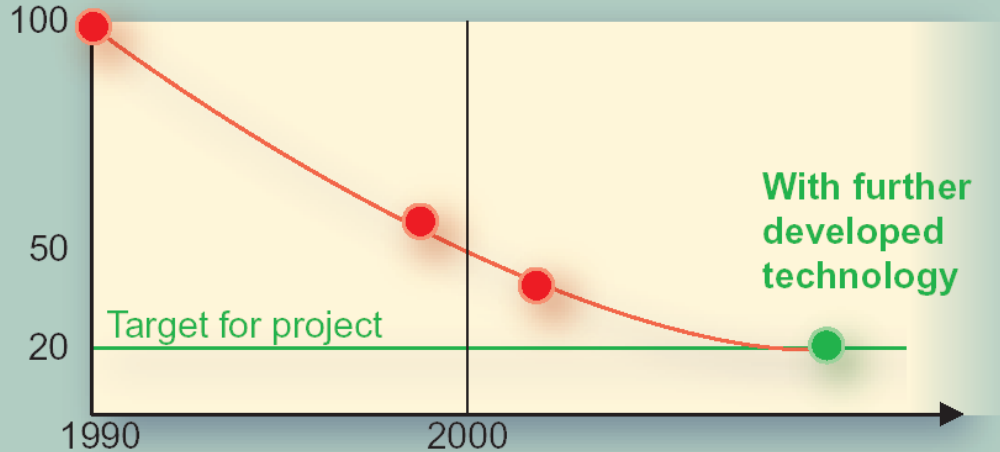
**ENCAP an important part of the effort to reach the “CO<sub>2</sub> Free power plant”**

**ENCAP – An Integrated Project within the EU-commission’s 6<sup>th</sup> Framework programme, priority “Sustainable Energy Systems”**

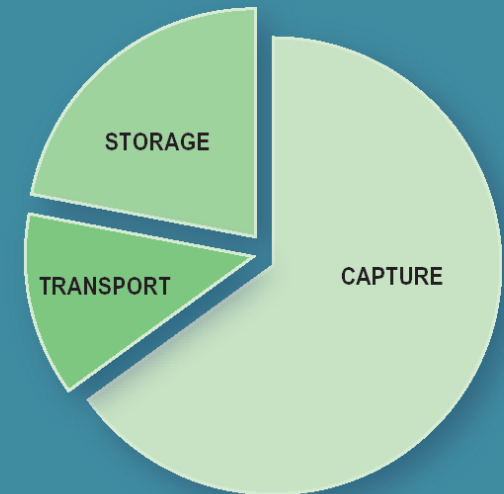
# CO<sub>2</sub> capture and storage – cost estimates

Development of total estimated cost  
(capture, transport and storage)

EUR/ton CO<sub>2</sub>



Cost relations



# The ENCAP Project goals

- Develop, optimize and verify previously known and novel "pre-combustion" capture technologies
- The technologies shall be able to reach "a total CO<sub>2</sub> avoidance cost of around 20 EUR/ton CO<sub>2</sub>, while achieving capture yields well in excess of 90%"
- Focus will be on technology for new plants
- Upgrading of existing plants will be considered
- All fuels are considered, but coal is in focus

# ENCAP project: Time plan and budget

- In total a 5 year project
- 2 phases are planned: 2003 to 2005 and 2005 to 2007
- Decision on pilot testing(s) between phases
- Total budget amounts to about 30 million €, whereof a majority is contributed from industry, the rest from the European Commission

**The project started the 1<sup>st</sup> of March 2004**

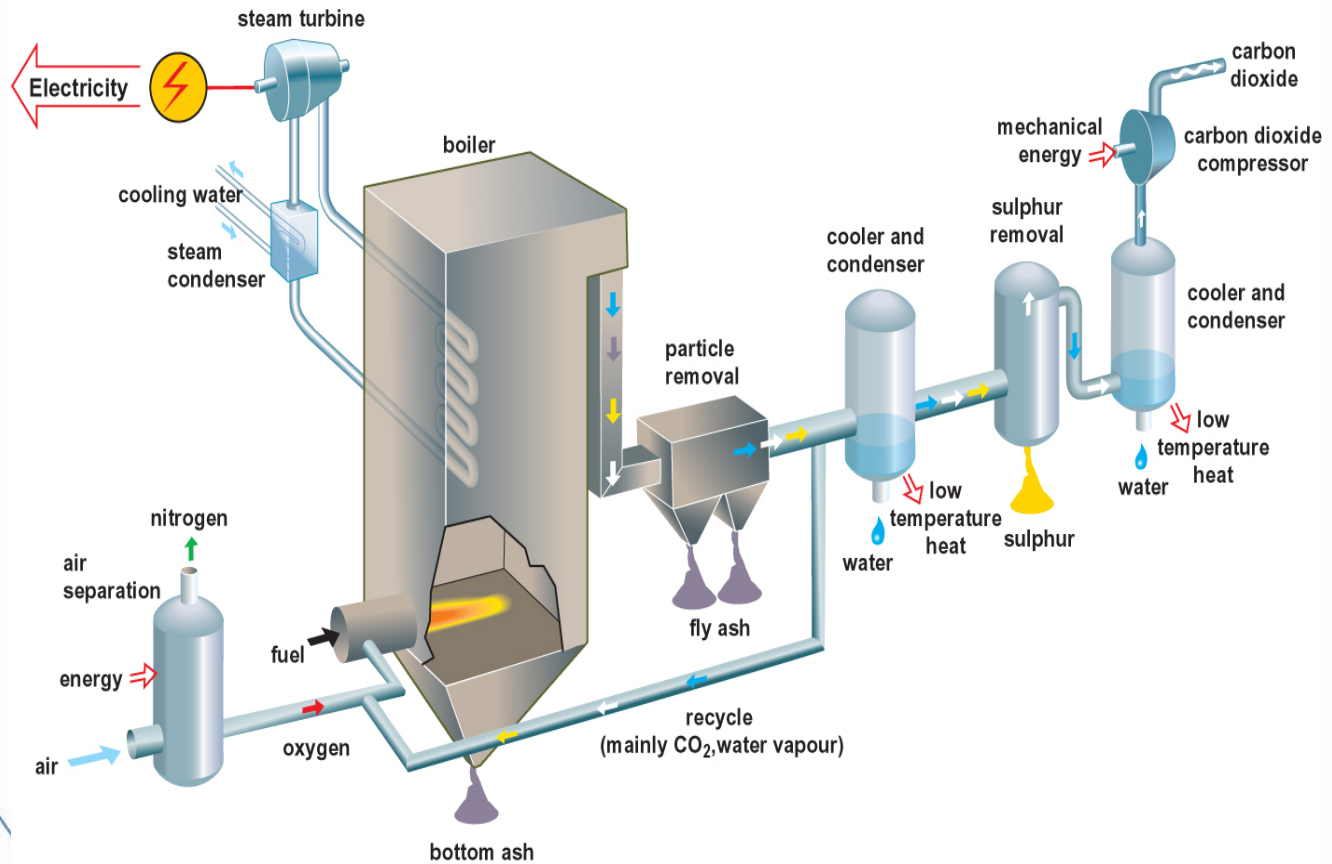
# ENCAP project: Scope of work

- Plant, Process and System evaluation
- Pre-combustion decarbonisation validation (IGCC)
- Oxyfuel ( $O_2/CO_2$ ) combustion validation
- Chemical looping combustion
- Advanced oxygen production and gas turbine cycles
- Novel  $CO_2$  capture concepts

# ENCAP's 28 project partners

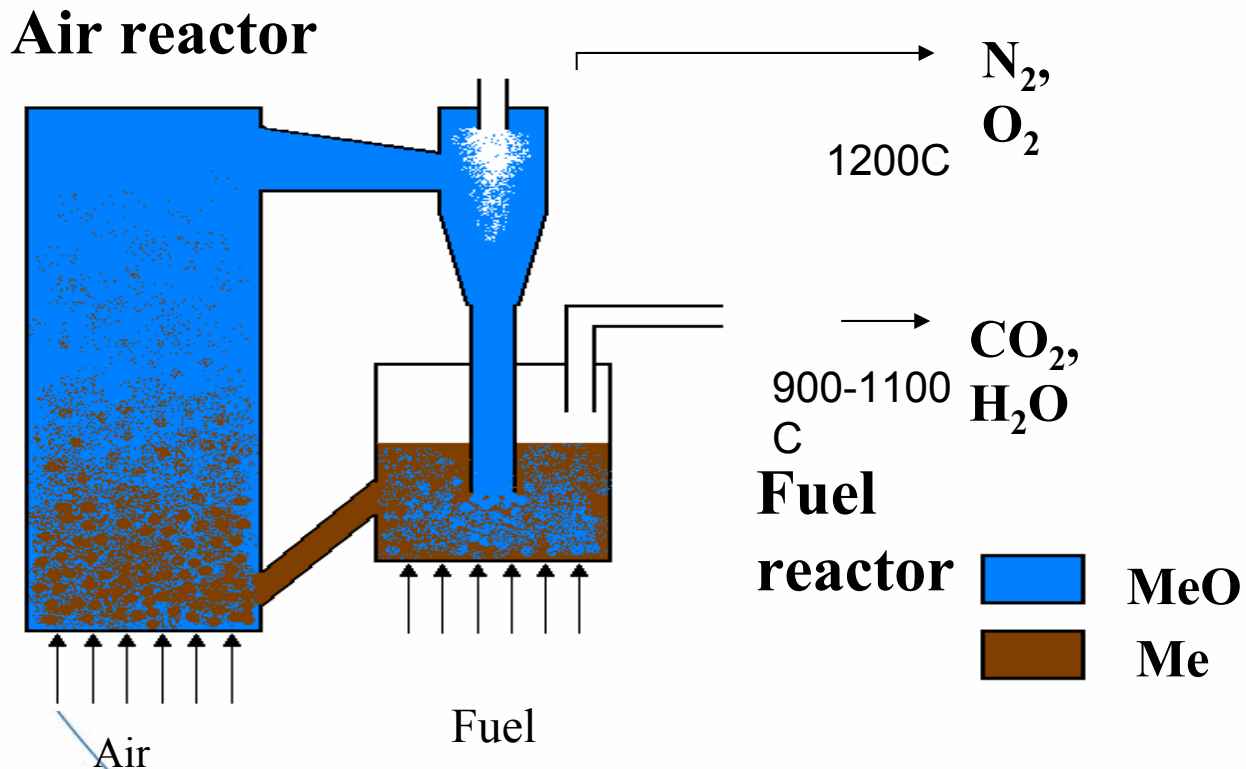
- Power companies
  - Energi E2, Public Power Corporation, RWE Rheinbraun, RWE Power, Vattenfall (project leader)
- Manufacturers
  - ALSTOM Boilers, Power and Turbines, Mitsui Babcock, Siemens
- Technical gas companies
  - Air Liquide, BOC, Linde
- Gas and oil companies
  - Statoil
- Engineering companies
  - Lurgi, Uhde
- Research institutes
  - IFP, Sintef, DLR, ISFTA, TNO
- Universities
  - Chalmers UT, Imperial College, NTNU, U Ulster, U Paderton, U Stuttgart, U Twente

# O<sub>2</sub>/CO<sub>2</sub> combustion is the preferred option at present



# CO<sub>2</sub> free power plant

## Chemical looping combustion





# The ENCAP project

The ENCAP project is important:

- The ENCAP demonstrates the ability of European industry to cooperate around a common problem – the global warming
- It will bring knowledge of CO<sub>2</sub> capture and storage up to a point, where decision for commercial development and introduction of the technology can be made.
- In ENCAP European industry, with the support of the European Union, utilize the best research facilities in form of leading universities and institutes to create a European knowledge base to be used by manufacturers and energy industry.