

CO₂ free Power Plant Project in Vattenfall Relations to the Dynamis project

Large CCS Projects meeting
Brussels, September 5, 2006

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Vattenfall AB

Group function Strategies

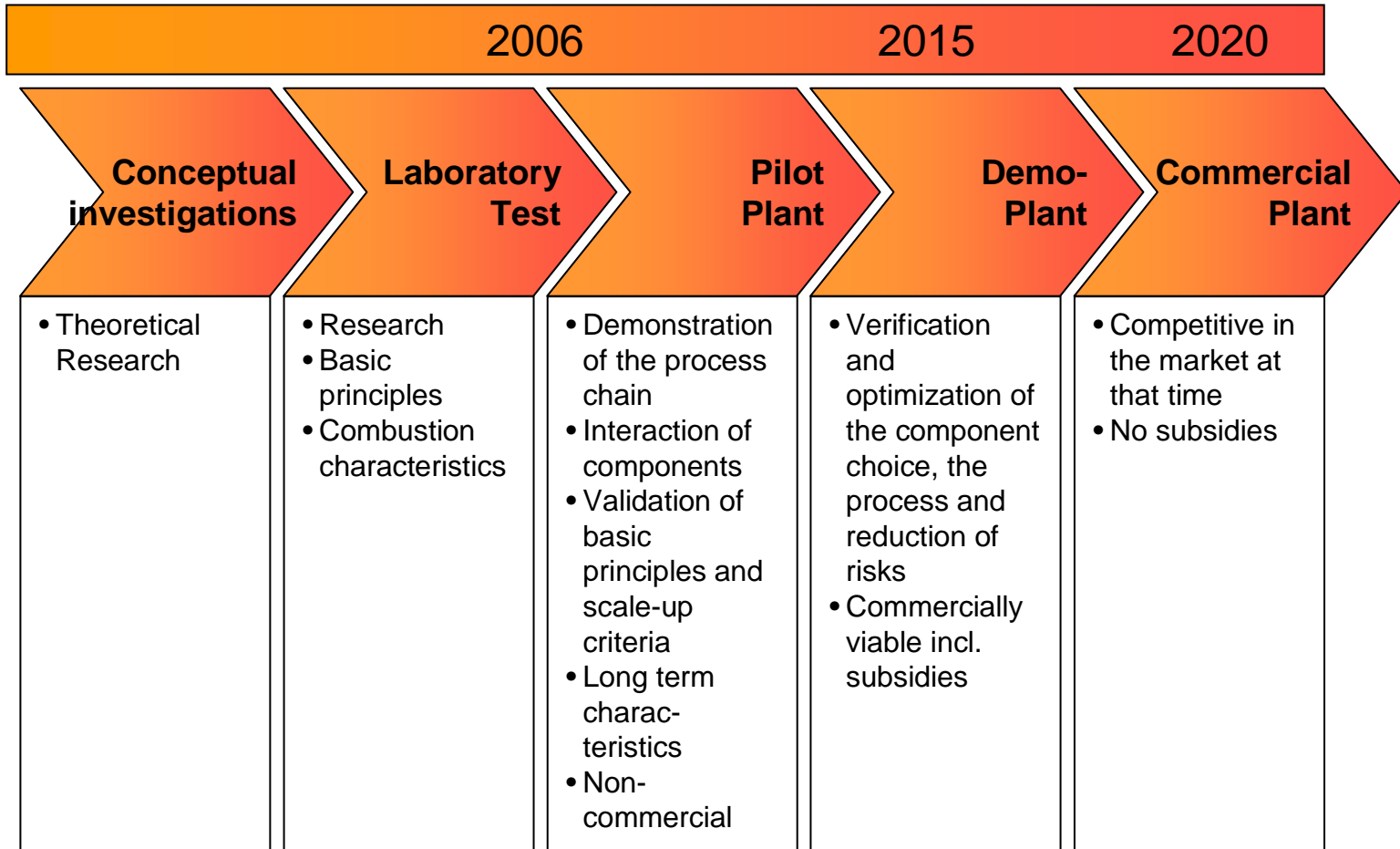
Berlin / Stockholm

The Power Sector

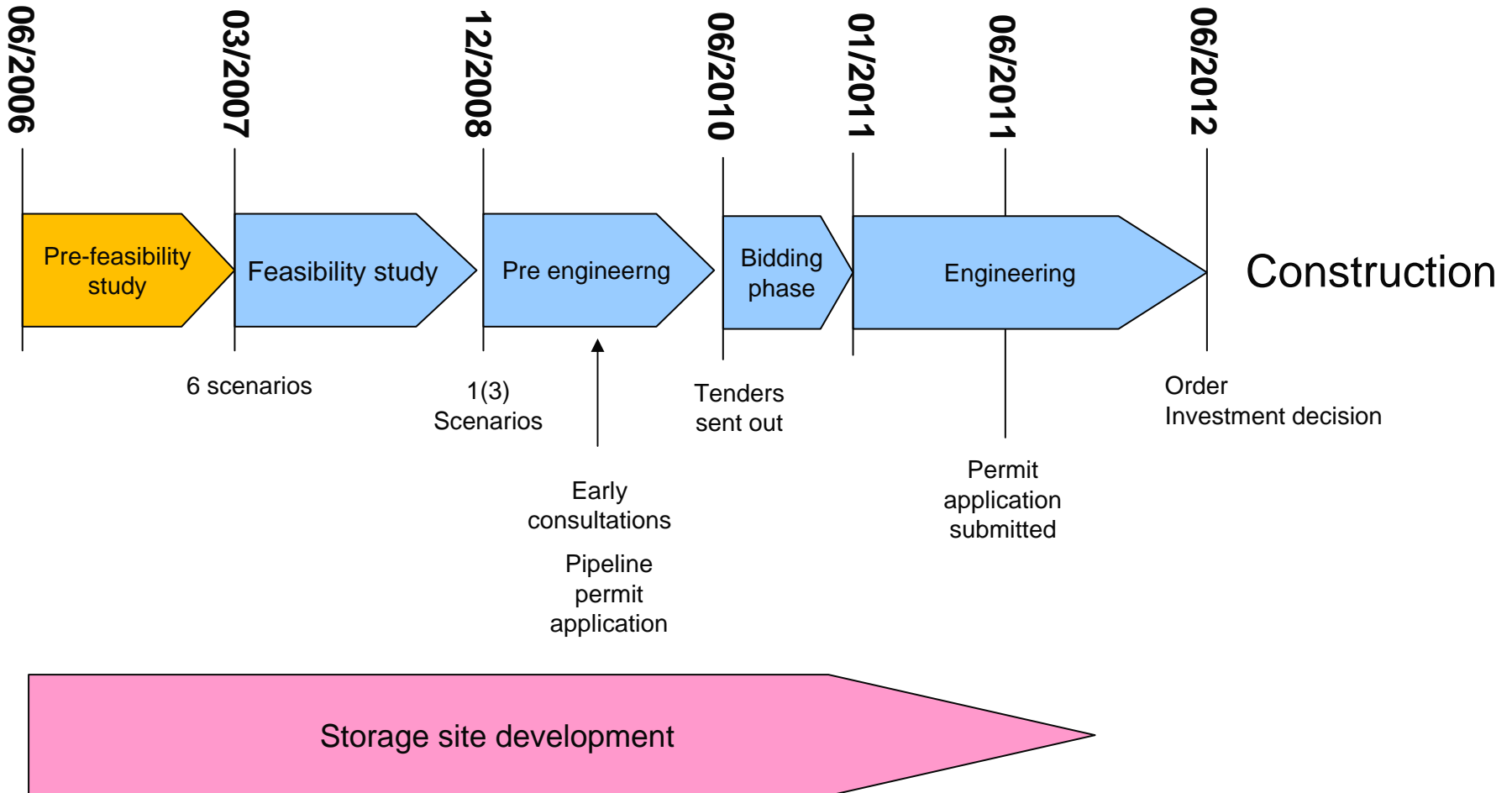
- The power sector is the major single emitter of CO₂. Vattenfall is one of the major Energy companies in Europe
- The Power industry must take responsibility and take the lead for introducing CO₂ free technology.
- To be able to make the deep cuts necessary, CCS is necessary.
- Primary target is to make technology available in 2020 at an avoidance cost of 20 EUR/ton of CO₂, but also to start development of second generation technology

The CO₂ free Power Plant project

Roadmap to realization

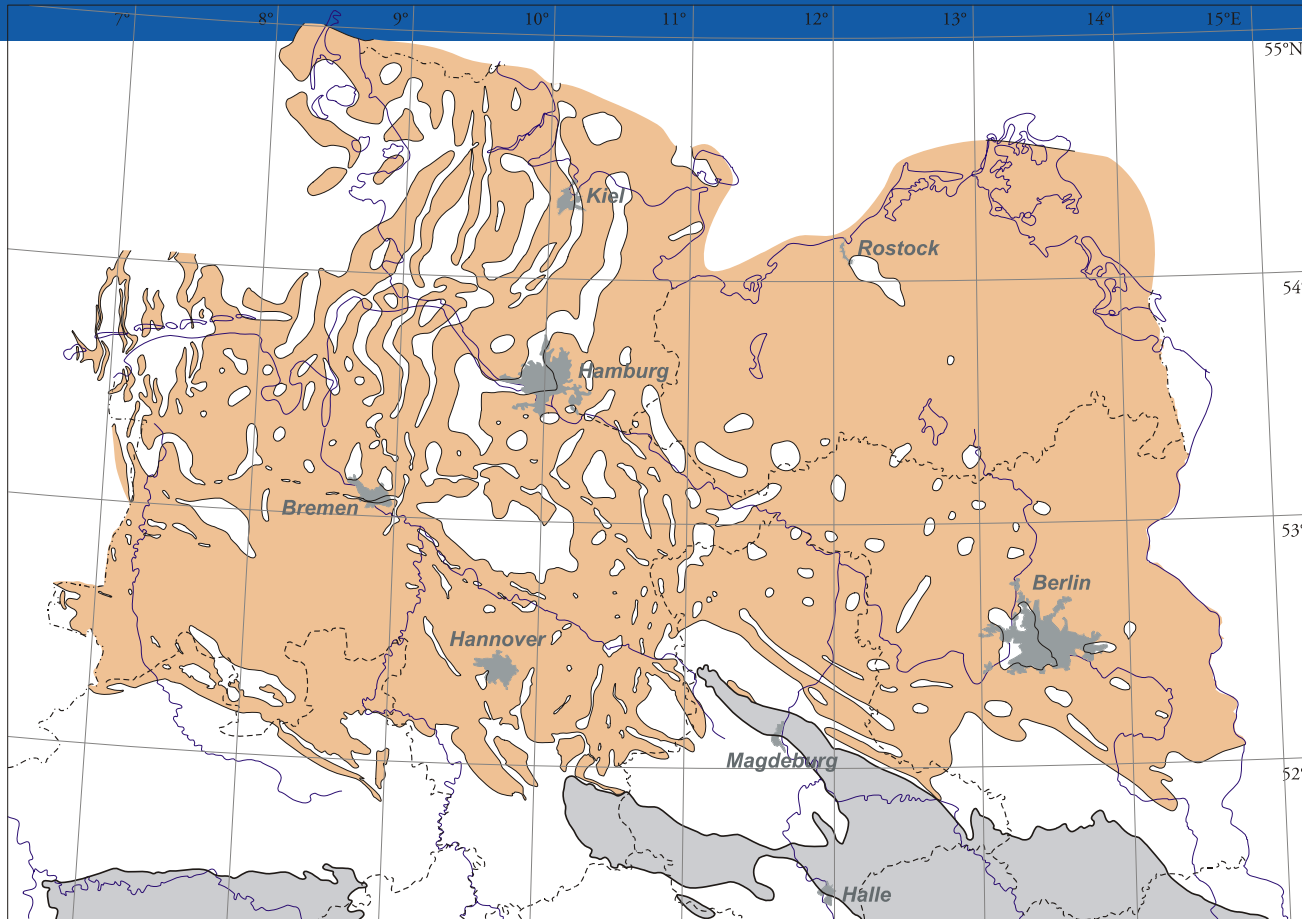


The demonstration project time line



Storage and transport

Storage Capacity, saline aquifers



Distribution of Rhetian Basement below Cenozoic cover

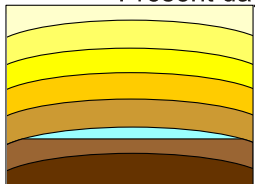
Present day distribution of the Rhetian - aquifers (a. DIENER et al. 1984, FRISCH & KOCKEL 1998)

There exists more storage capacity within Europe (and in the world) than the remaining fossil fuels

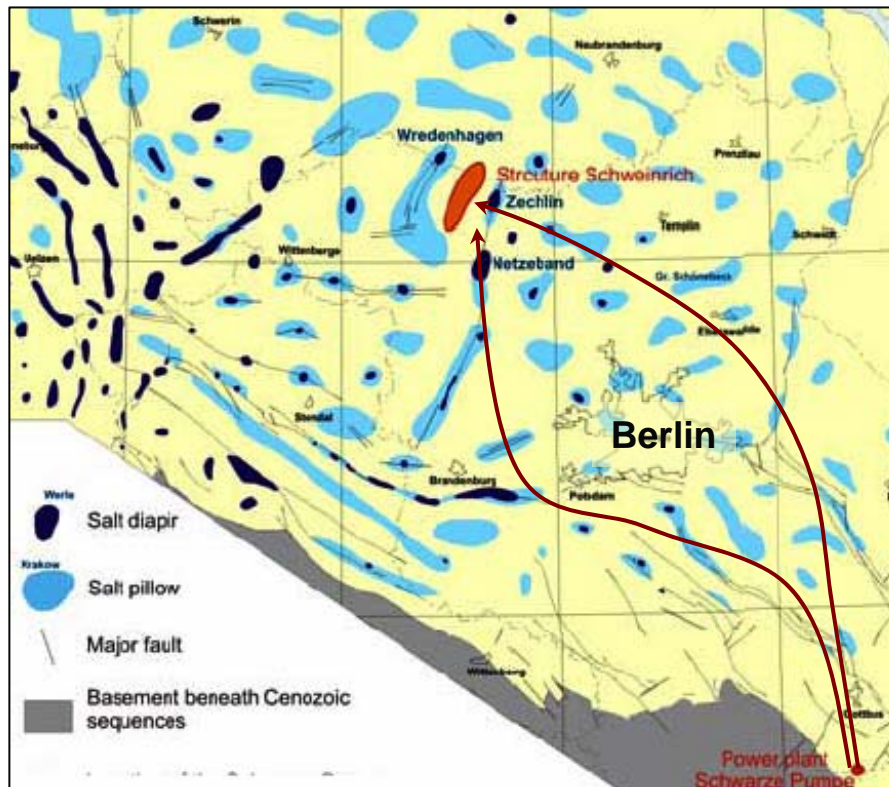
Source:

Franz May,
Peter Gerling,
Paul Krull

Bundesanstalt für
Geowissenschaften und
Rohstoffe, Hannover



CO₂ Transport and storage Schweinrich structure



- Two pipeline transport routes are possible
- Both routes can be designed to follow existing pipeline corridors >90%
- Structure can contain 1,4 billion ton of CO₂, equivalent to about emissions from 6000 MW their whole lifetime

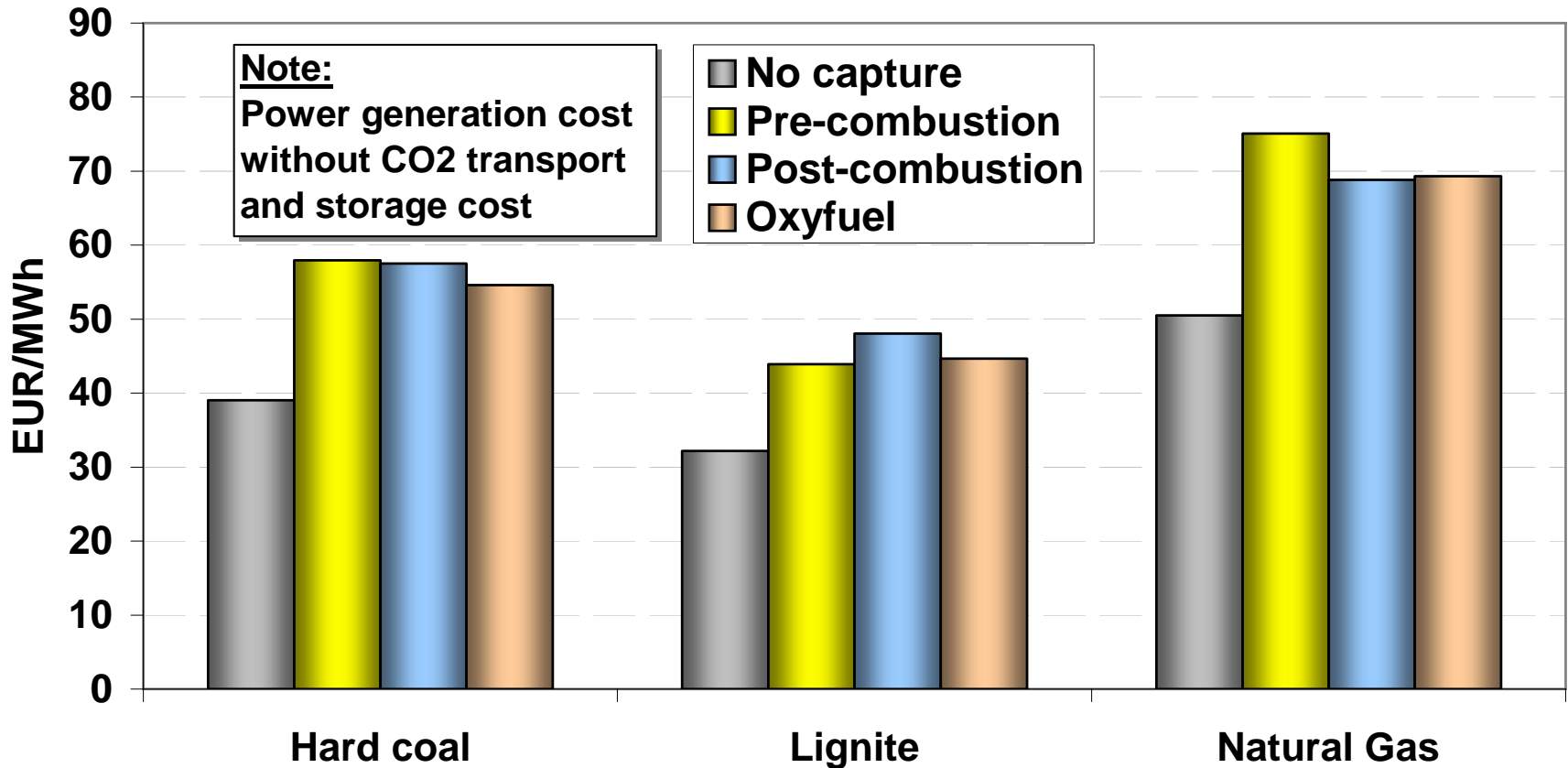
The technology options

Technology Platform

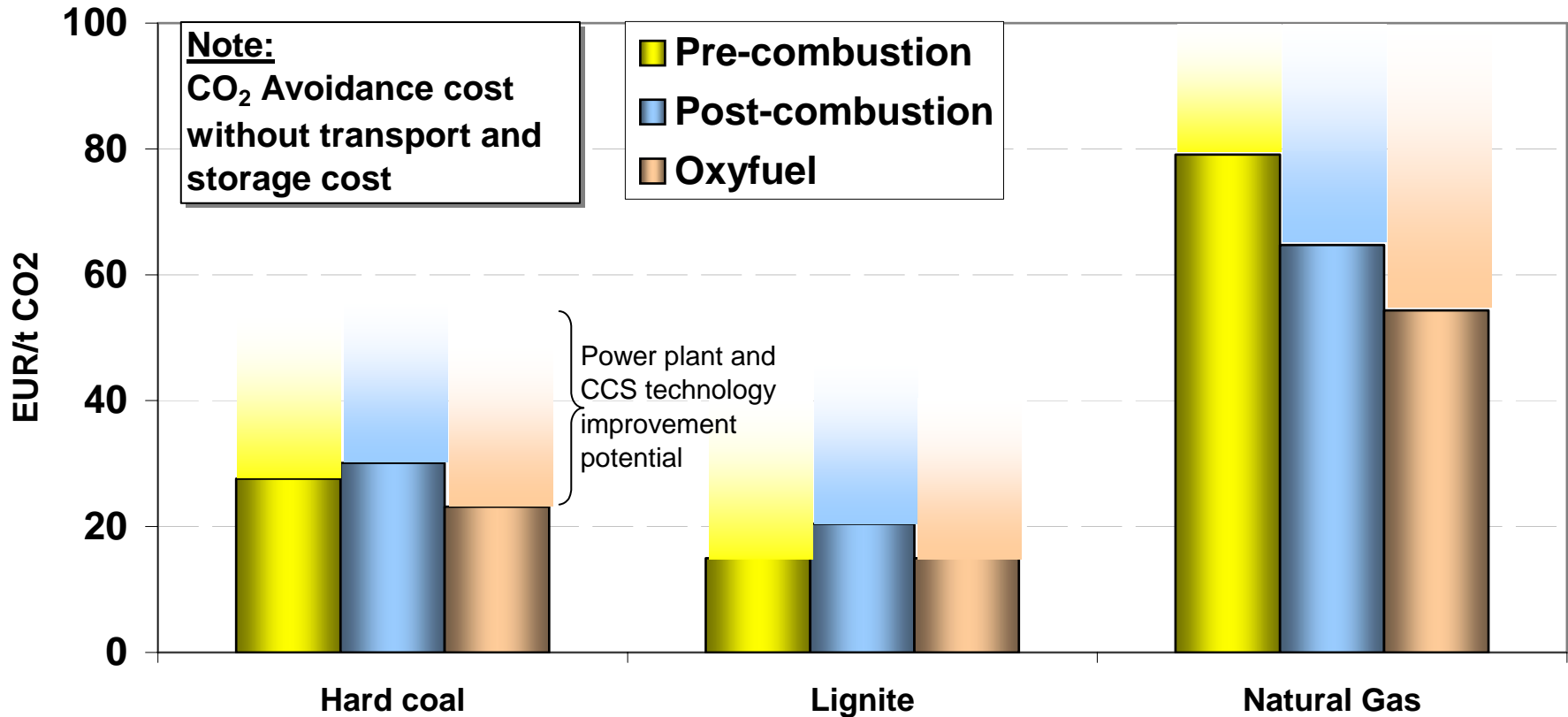


The European Technology Platform for
Zero Emission Fossil Fuel Power Plants (ZEP)

Electricity generation cost for large power plants in operation by 2020 (ZEP WG1)



Avoidance cost for large power plants in operation by 2020 (ZEP WG1)



Cost for hydrogen in a CO₂ free coal co-gen plant

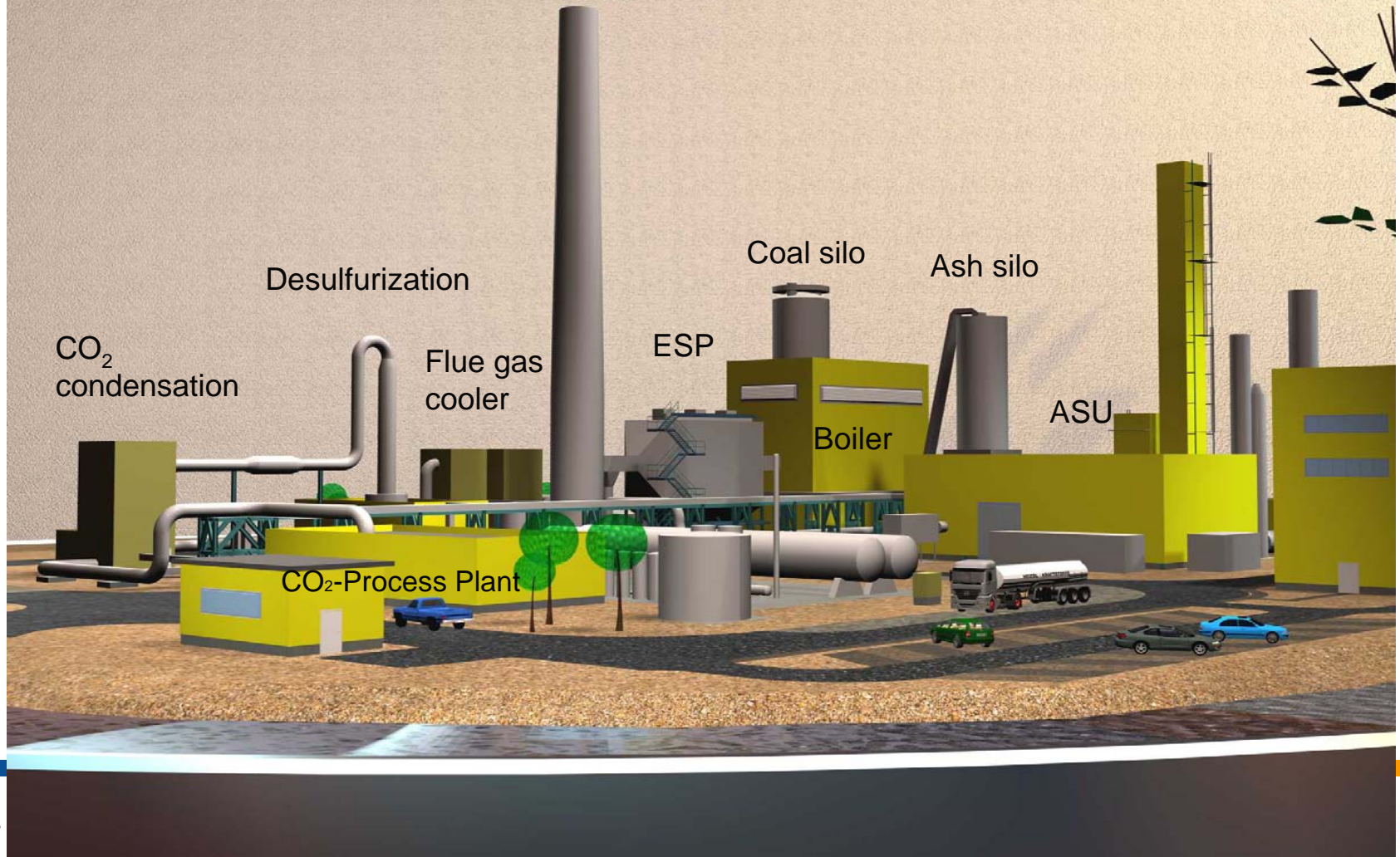
- Assume the conditions for the economy calculations are as above.
 - The investment is probably too low for a plant with co-generation of hydrogen.
 - The hydrogen contains 10 –15 % non-condensable gases, but is rather clean
- Accept that the electricity generation cost lies at about 45 €/MWh if 7500 hours of operation is assumed.
- The electricity generation part of the plant has an efficiency of 57 %.
- This gives a hydrogen cost of about 28 €/MWh
- Hydrogen cost of 30 €/MWh might be achievable at site, comparing with natural gas at about 20 – 24 €/MWh for LNG

Pilot Plant

Preliminary Lay out

VATTENFALL EUROPE
POWERCONSULT GMBH

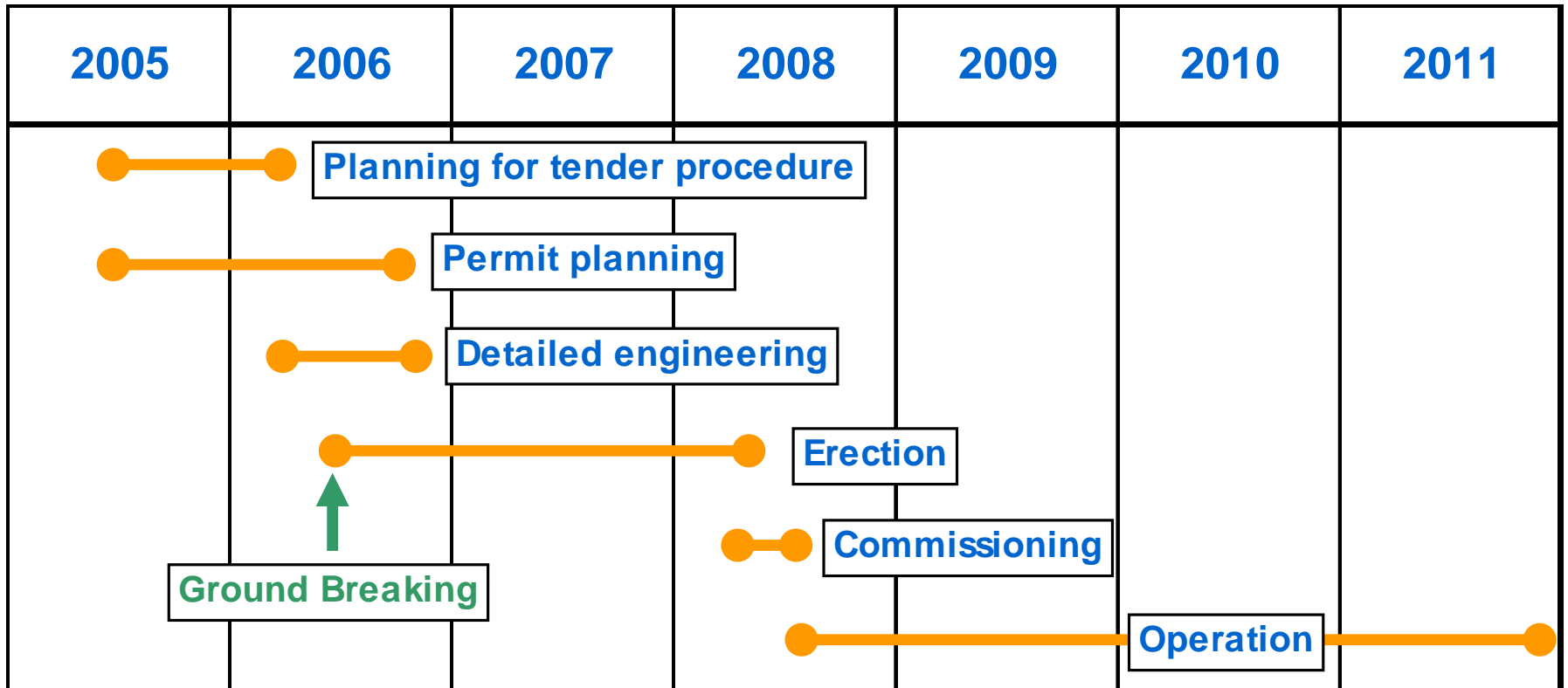
VATTENFALL



Plant Status

- The pilot plant will comprise a full chain including boiler, gas cleaning, CO₂ processing and an air separation unit
- The CO₂ will not be permanently stored initially. It will be released into atmosphere.
 - It will produce liquid CO₂ of very high quality (food grade) to a tank storage
 - It is prepared for later connection to a storage project
- The contracts for the main components are awarded and construction started in June 2006.
- The permitting process is running very smoothly. Permit is expected in October 2006
- The estimated cost of the plant itself is 67 mio € and a three year test program will have running costs of about 27 mio €. All costs covered by Vattenfall and industrial partners. No public funding.

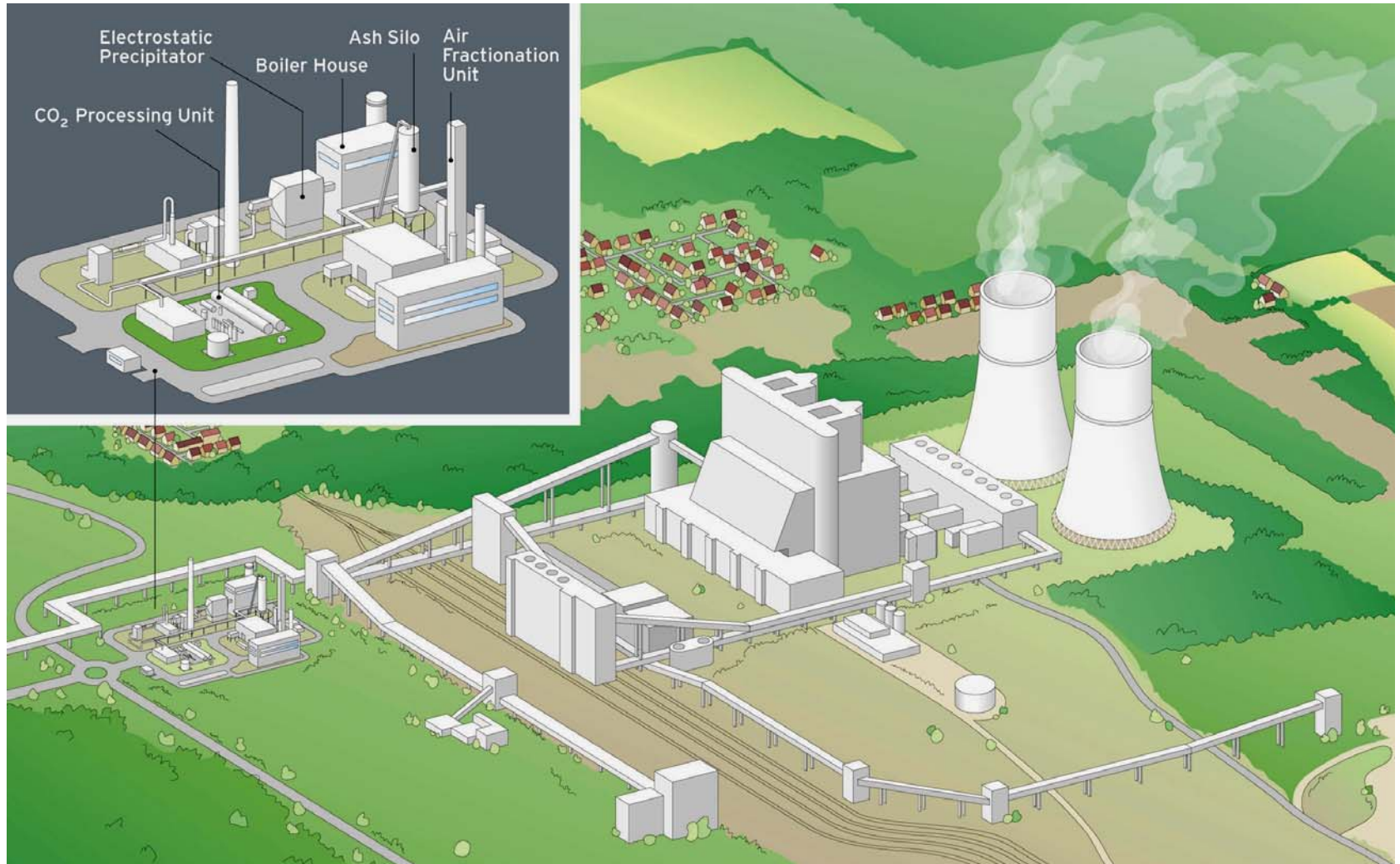
Time Schedule



Schwarze Pumpe power plant



Location of the pilot plant at Schwarze Pumpe Power station



Klimaschutz durch Innovation DAS CO₂-FREIE KRAFTWERK VON VATTENFALL



Conclusions

Conclusions CO₂ Capture and Storage project

- All three technologies are probably available at a commercial stage in 2020.
- At present the oxyfuel technology is the preferred option due to adaptability to present generation technology and best economy.
- Only pre combustion capture produces an intermediary product in the form of hydrogen.
- Other ways of production is by electrolysis, at a significantly higher cost, but already distributed.
- We do not believe that hydrogen in pure form will be an important energy carrier
- One 1000 MW power plant, matching the system variation produces enough methanol for about half a million cars.

Relation Dynamis and Vattenfall's Pilot plant

- There are very few synergies to be seen between Vattenfall's Pilot Plant and Dynamis.
- IGCC with pre combustion capture will be the preferred option if hydrogen is wanted by a market
- Technology choice is not yet made. Oxyfuel is preferred technology in Vattenfall at present for power production
- The pilot plant might contribute to the spread of knowledge about CCS and general issues concerning gas processing, permission process and storage

Computer simulation of the new units in Hamburg (Moorburg) 2 x 865 MW hard coal

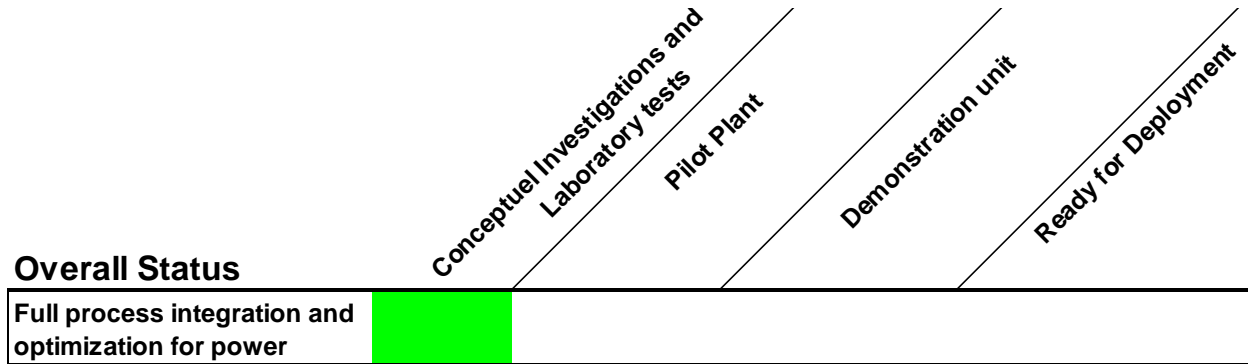


Computer simulation of the new Boxberg R unit 675 MW- lignite

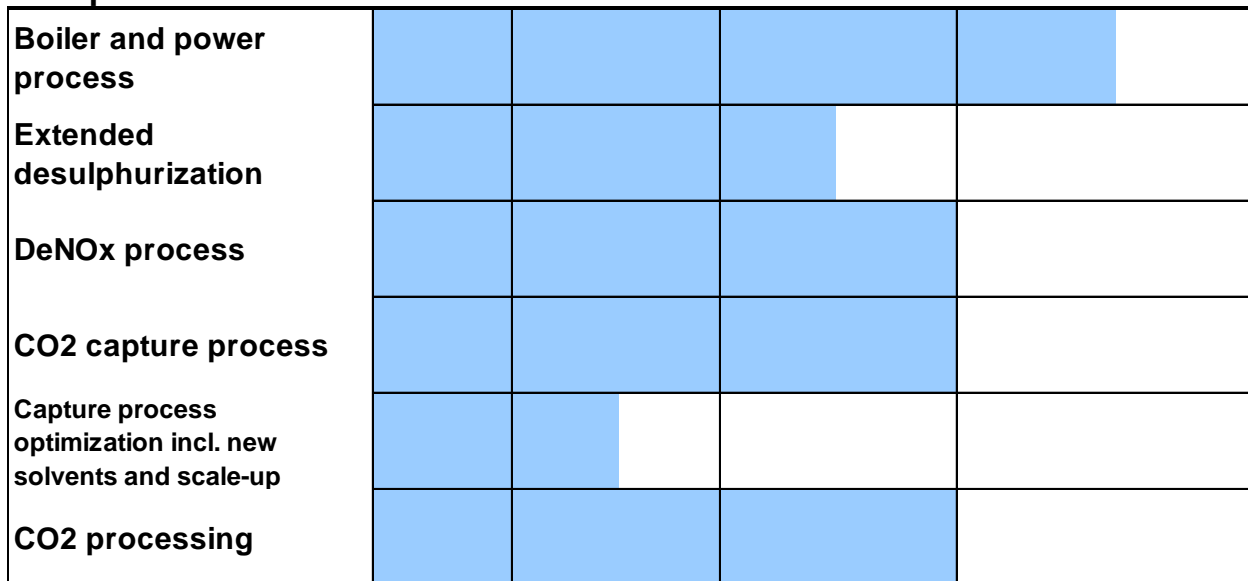


Back up

Maturity of Capture Technologies Post Combustion Capture



Component Status



Maturity of Capture Technologies

Pre Combustion Capture

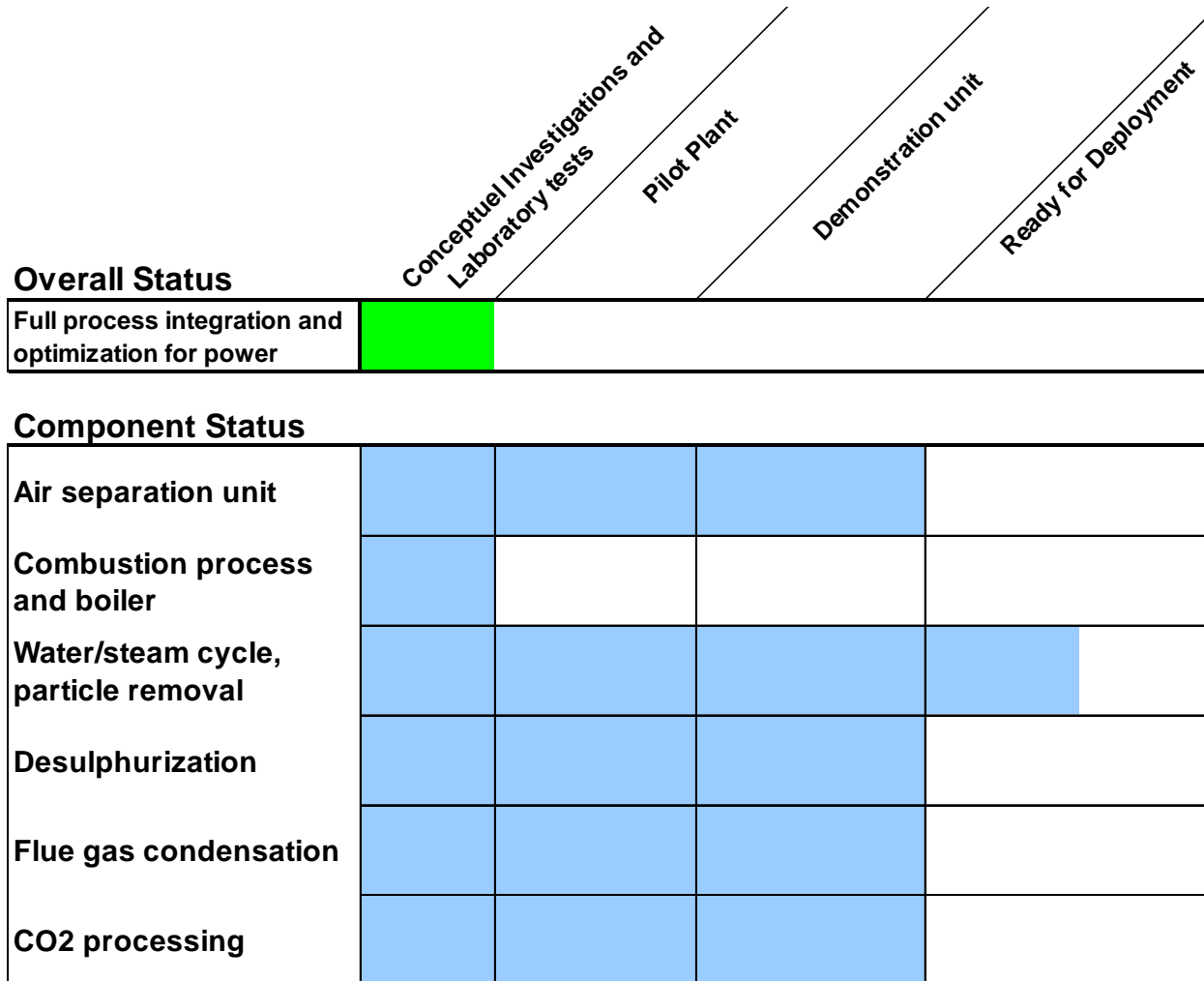
Overall Status	Conceptual Investigations and Laboratory tests	Pilot Plant	Demonstration unit	Ready for Deployment
Full process integration and optimization for power				

Component Status

Air separation unit					
Coal Gasification					
Natural gas reforming					
Syngas processing					
CO2 capture process					
CO2 processing					
High efficiency, low emission H2 Gas Turbine					

Maturity of Capture Technologies

Oxyfuel



Cost and Potential of options to reduce CO₂ emissions

Principal example

Cost for carbon dioxide avoidance
[EUR/ton CO₂]

New Picture 2005 including recent knowledge

