CO_2 free Power Plant Project in Vattenfall
Relations to the Dynamis project

Large CCS Projects meeting
Brussels, September 5, 2006

Lars Strömberg

Vattenfall AB

Group function Strategies

Berlin / Stockholm

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The Power Sector

- The power sector is the major single emitter of CO_2. Vattenfall is one of the major Energy companies in Europe
- The Power industry must take responsibility and take the lead for introducing CO_2 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 CO_2, but also to start development of second generation technology

CO_2 free power plant

The CO2 free Power Plant project

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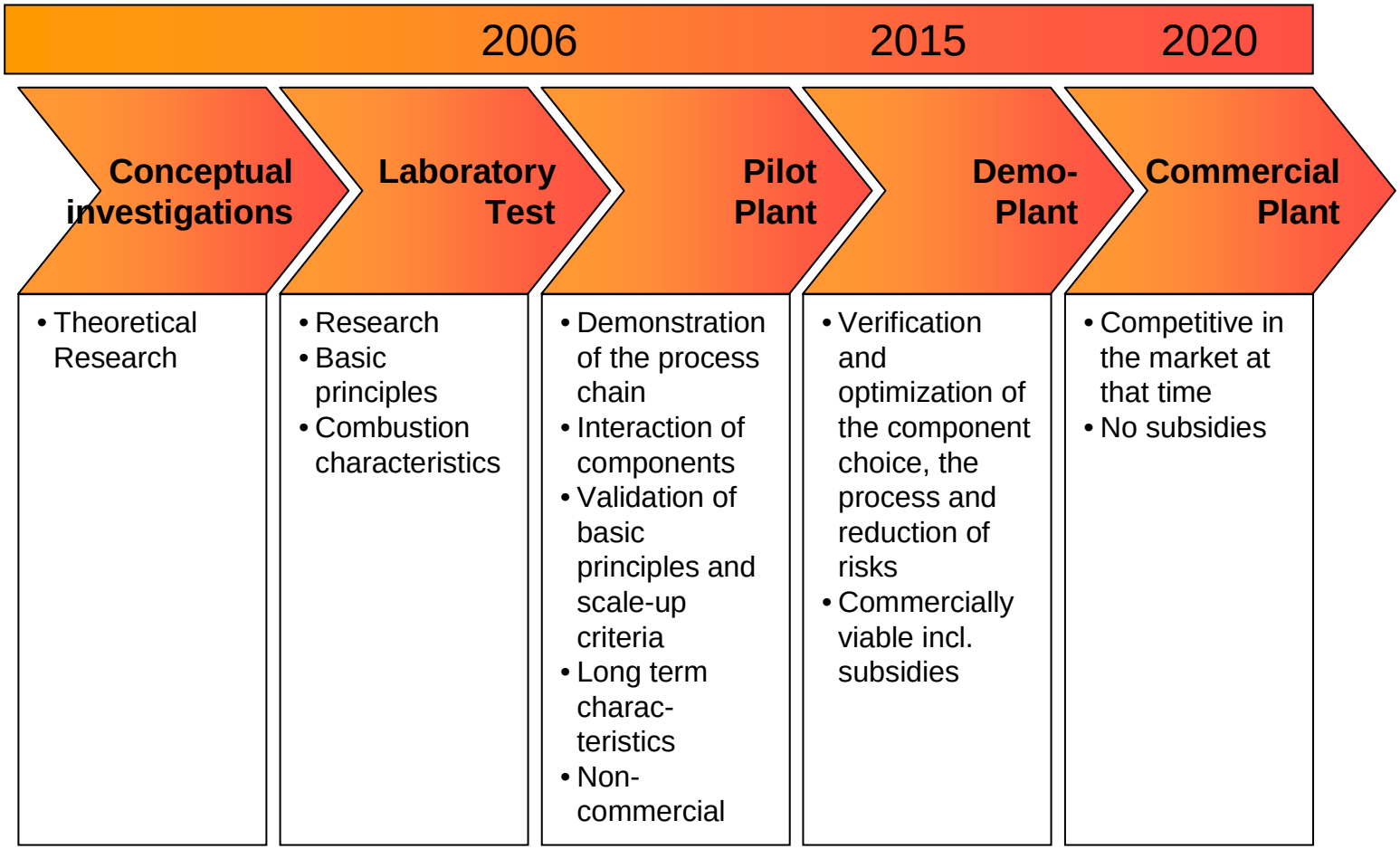
Roadmap to realization



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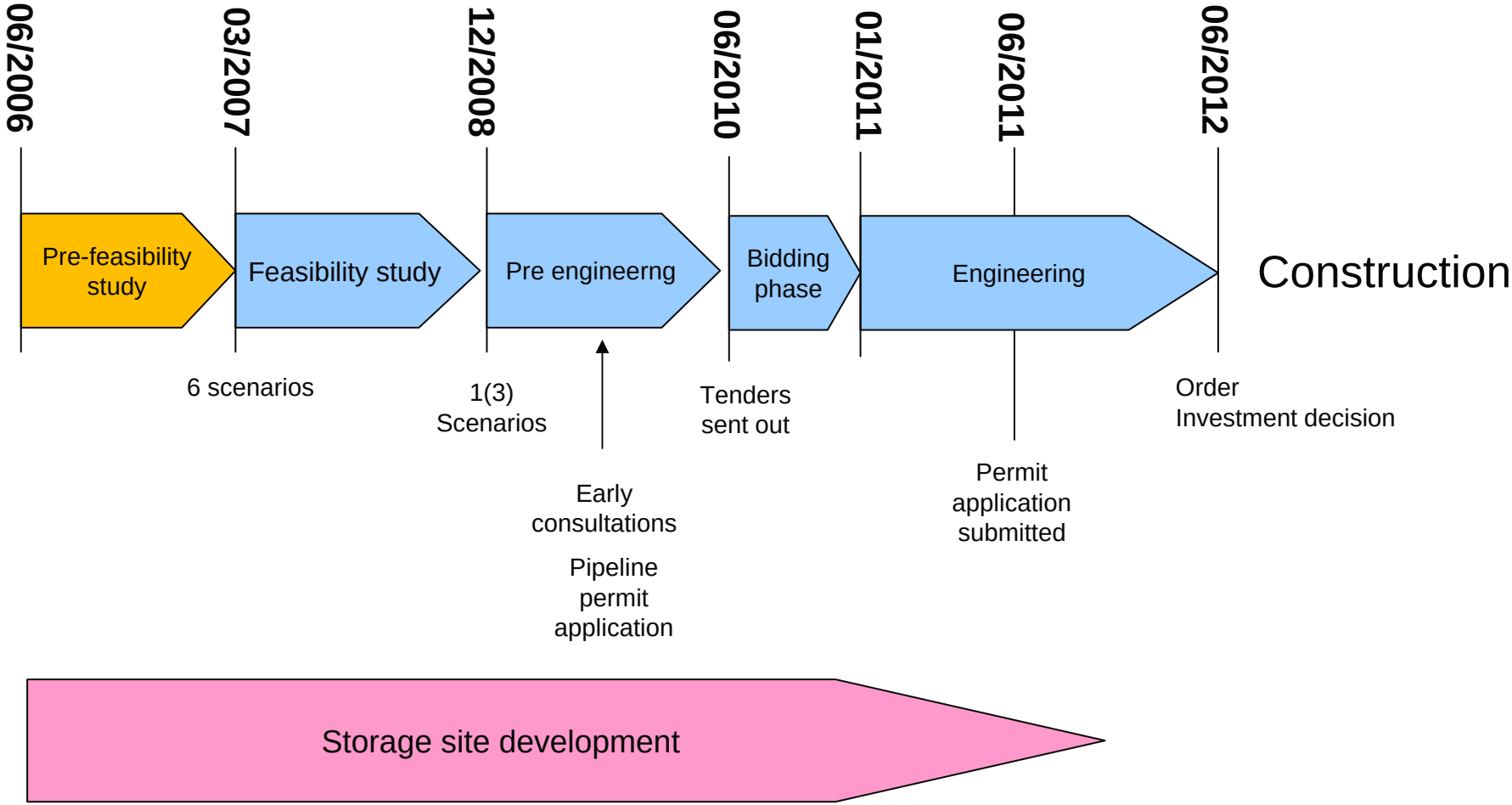
The demonstration project time line



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CO_2 free power plant

Storage and transport

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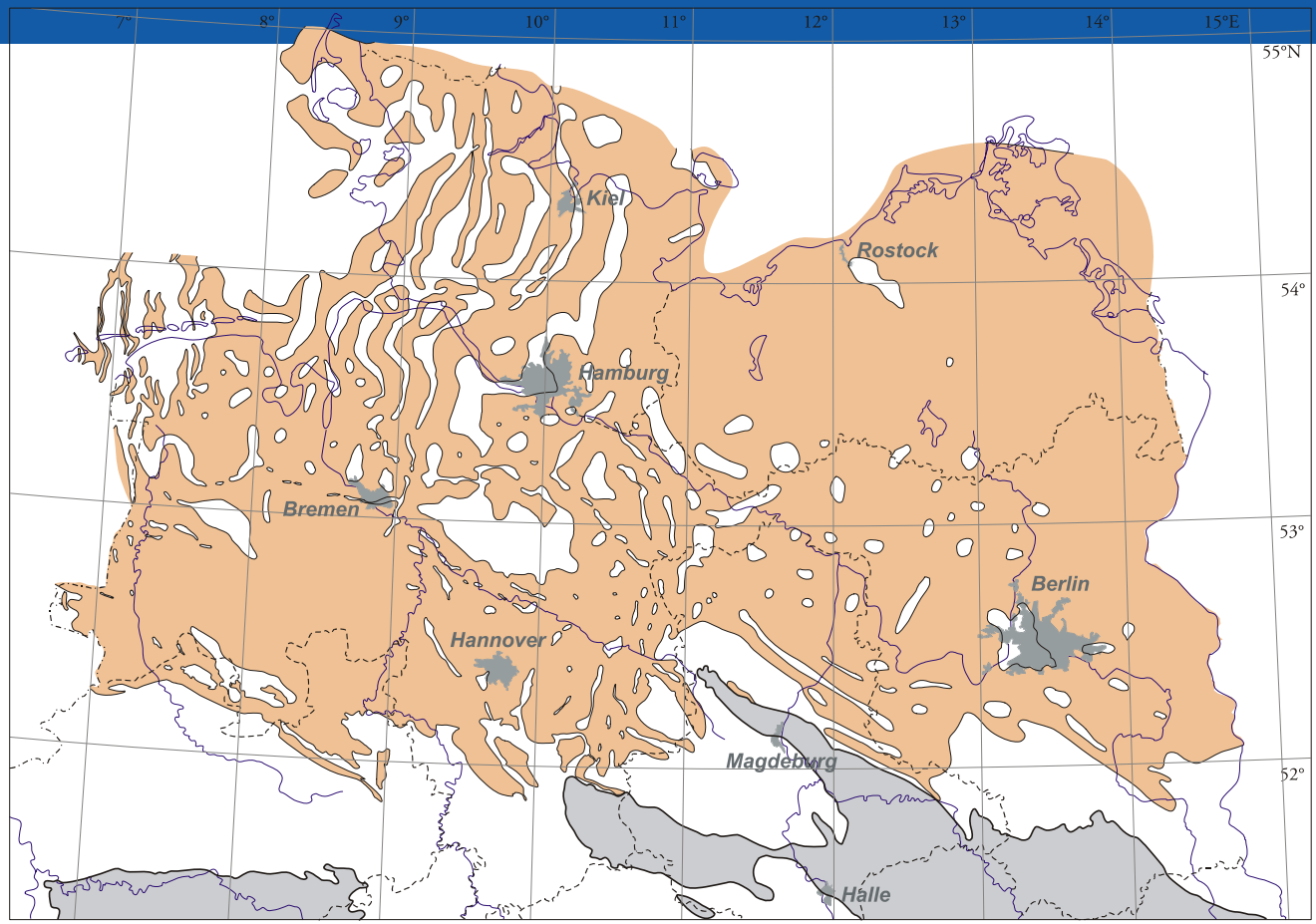
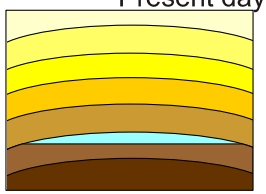
Storage Capacity, saline aquifers



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



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

Source:

Franz May,

Peter Gerling,

Paul Krull

Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover

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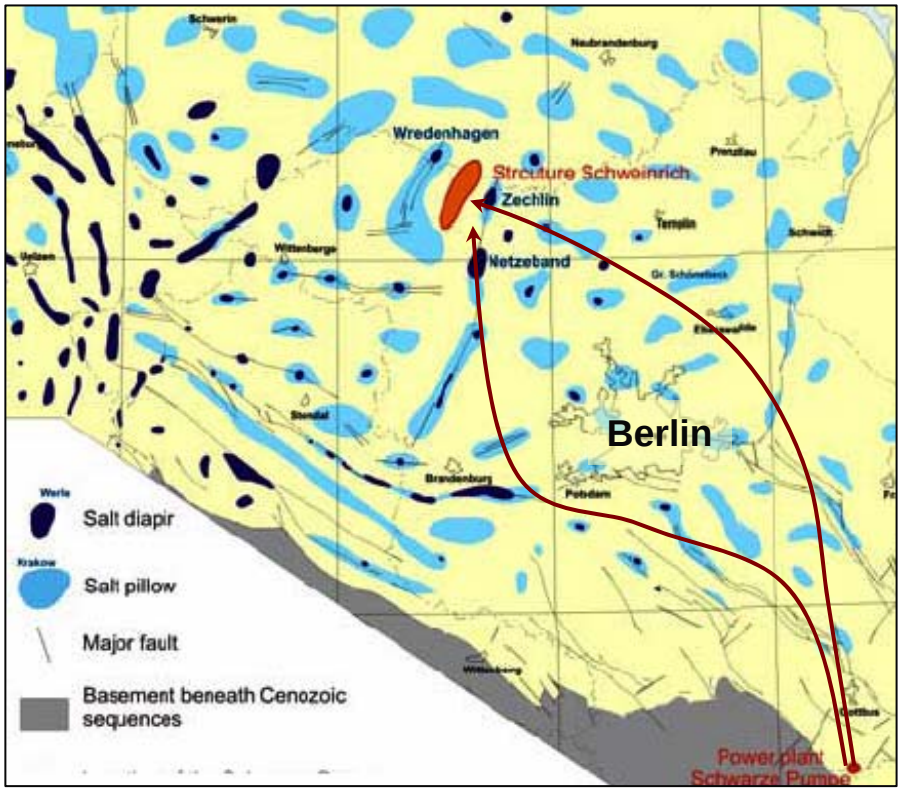
CO_2 Transport and storage Schweinrich structure



- 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

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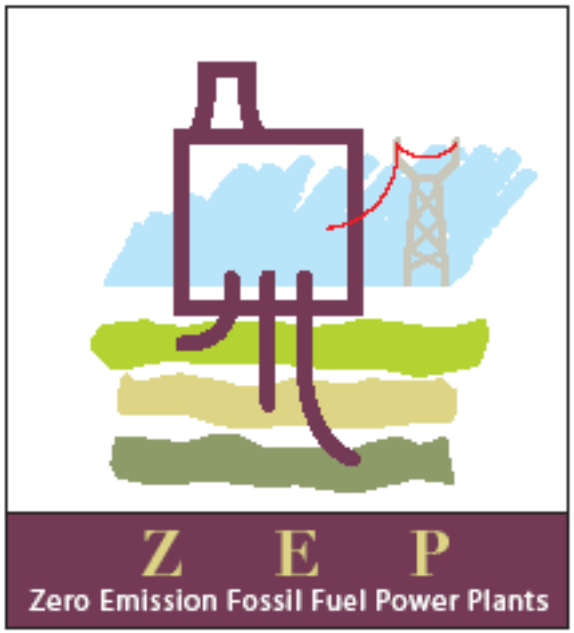
The technology options

Technology Platform



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

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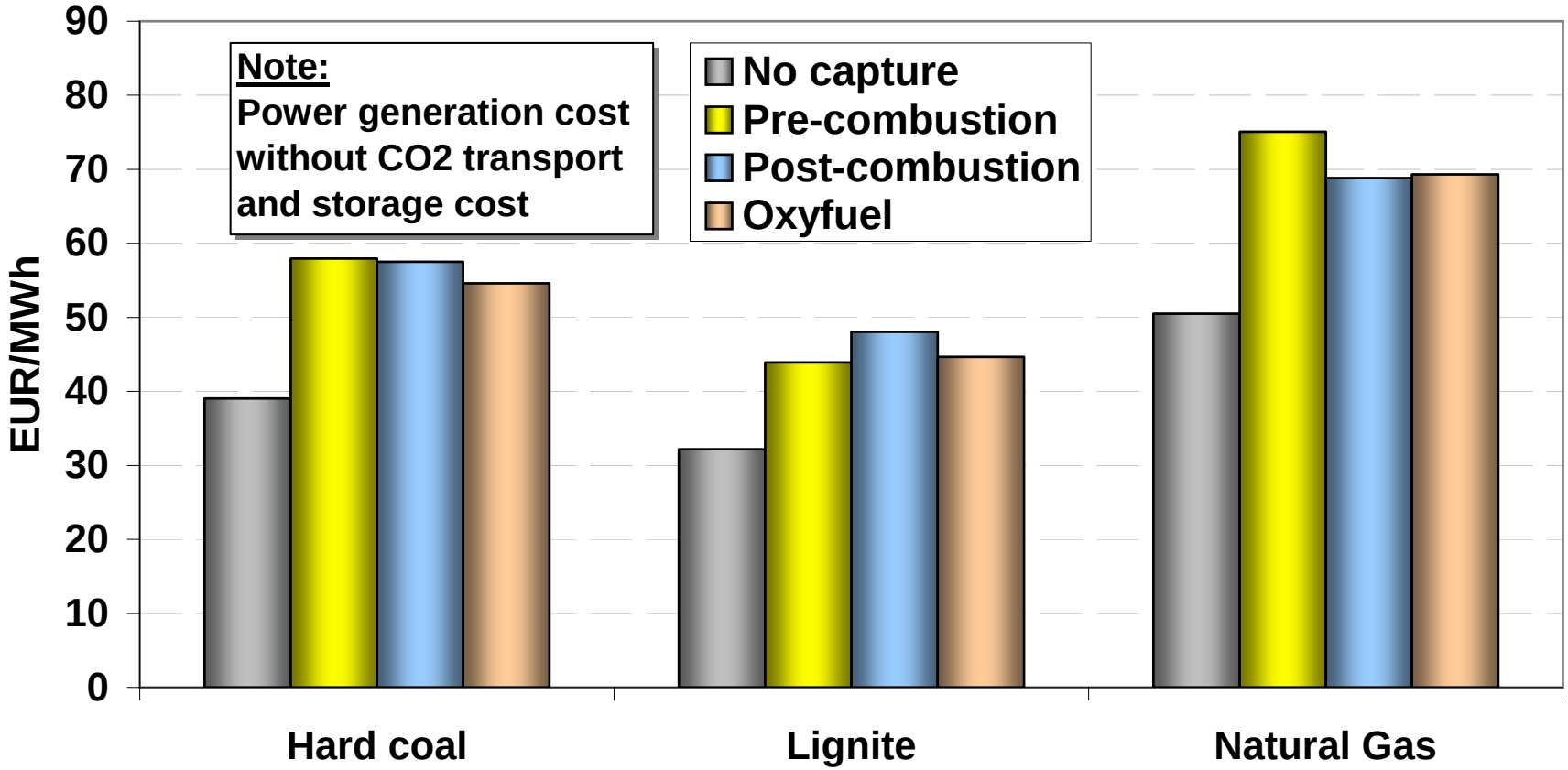
Electricity generation cost for large power plants in operation by 2020 (ZEP WG1)



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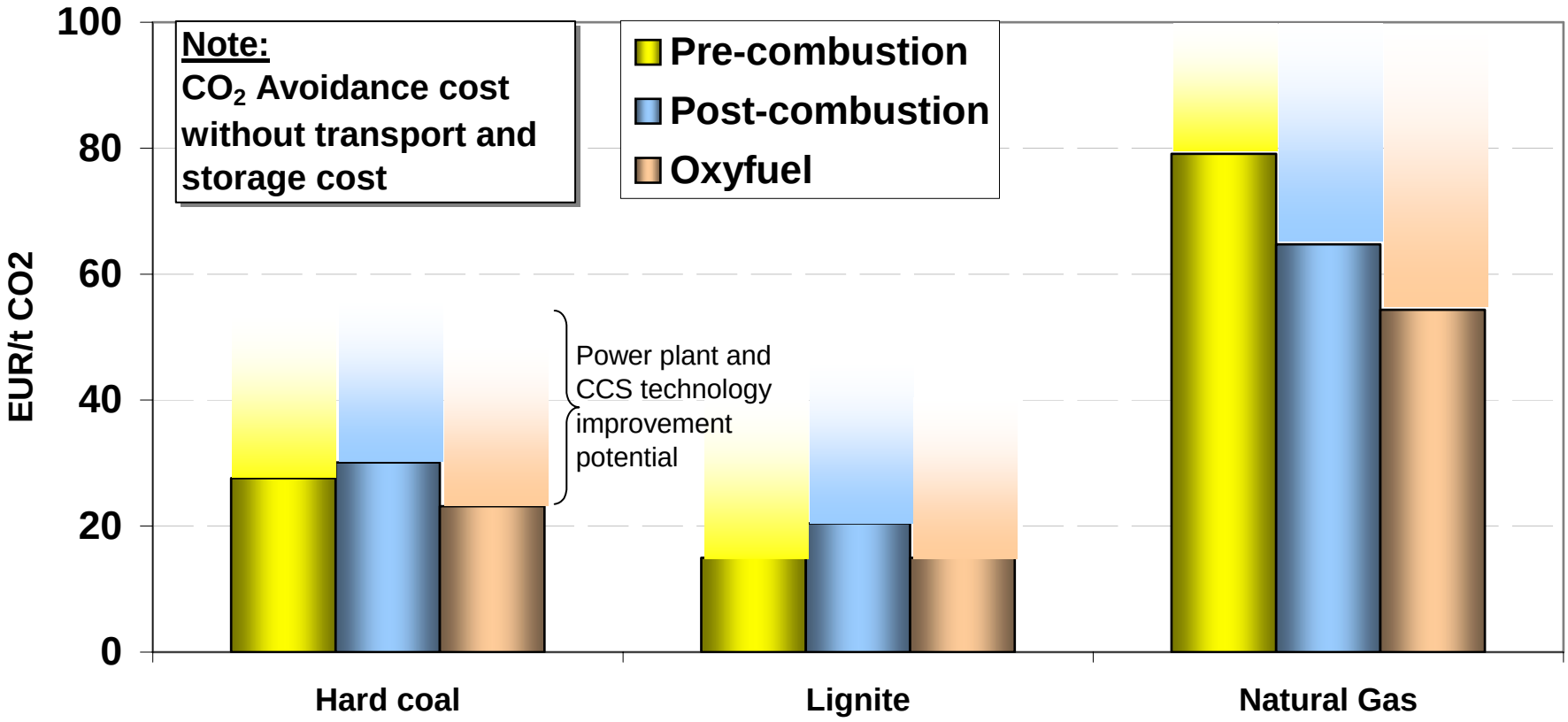
Avoidance cost for large power plants in operation by 2020 (ZEP WG1)



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Cost for hydrogen in a CO_2 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

CO_2 free power plant

Pilot Plant

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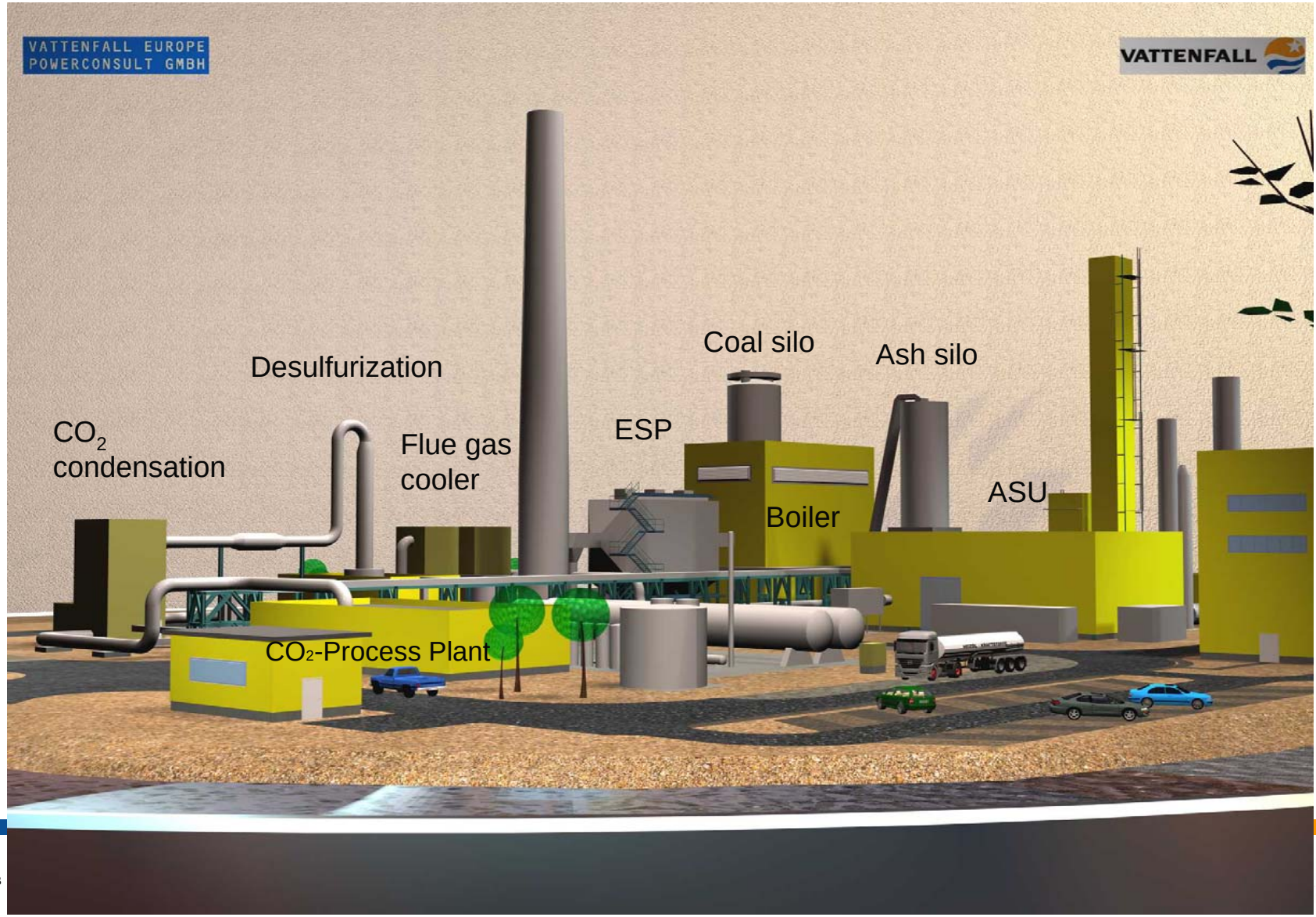
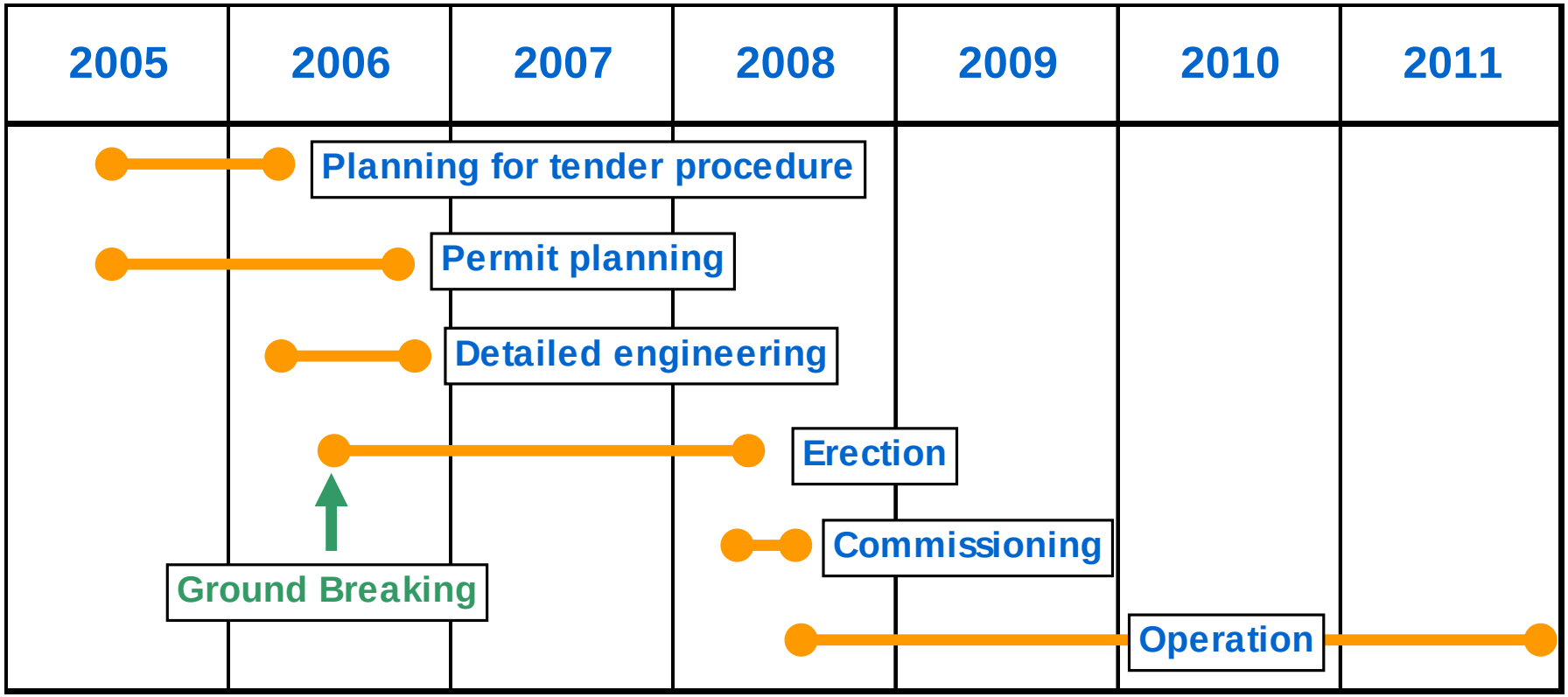
Preliminary Lay out



Plant Status

- The pilot plant will comprise a full chain including boiler, gas cleaning, CO_2 processing and an air separation unit
- The CO_2 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 industrialpartners. No public funding.

Time Schedule



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Schwarze Pumpe power plant

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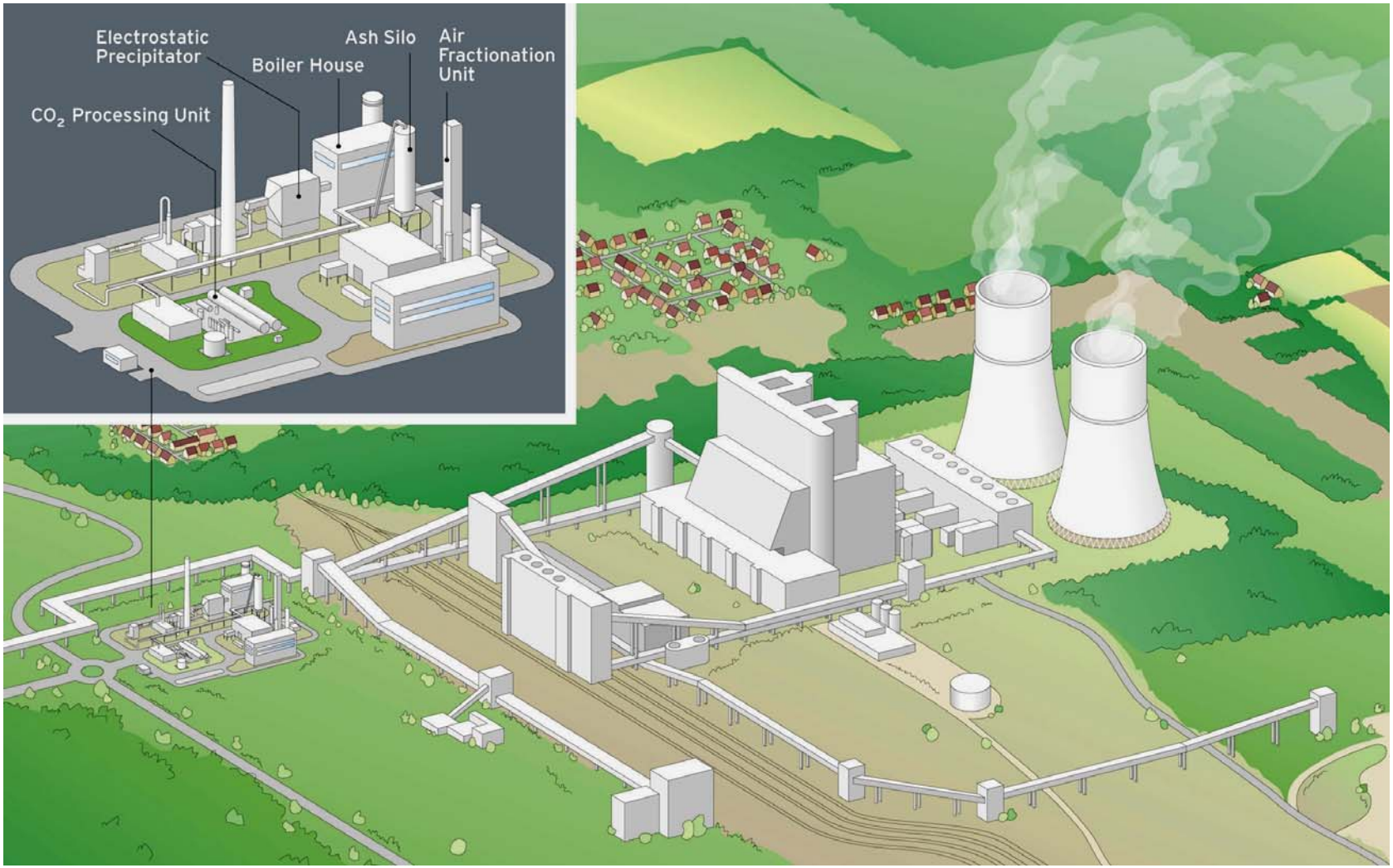
Location of the pilot plant at Schwarze Pumpe Power station



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Klimaschutz durch Innovation
DAS CO_2-FREIE KRAFTWERK VON VATTENFALL
CO_2-Verflüssigung und -Reinigung
E-Filter
Kesselhaus
Aschesilo
Luft-zerlegungs-anlage
Leistung: 30 MW (thermisch)
Dampfmenge: 40 t/h

Exchange of plants reduction of CO_2

Conclusions

Conclusions CO_2 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 Vatenfall'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

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

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CO_2 free power plant

Back up

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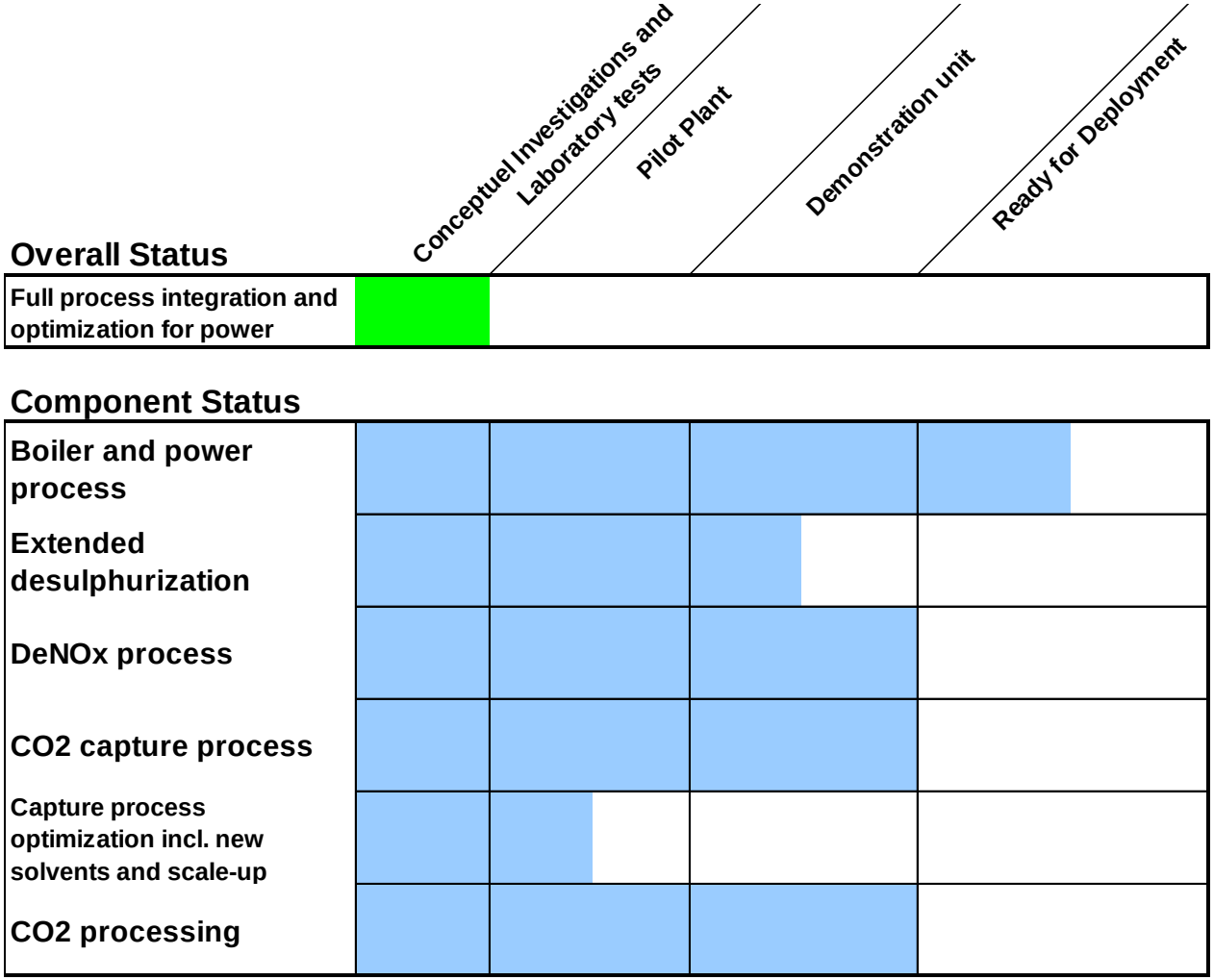
Maturity of Capture Technologies
Post Combustion Capture



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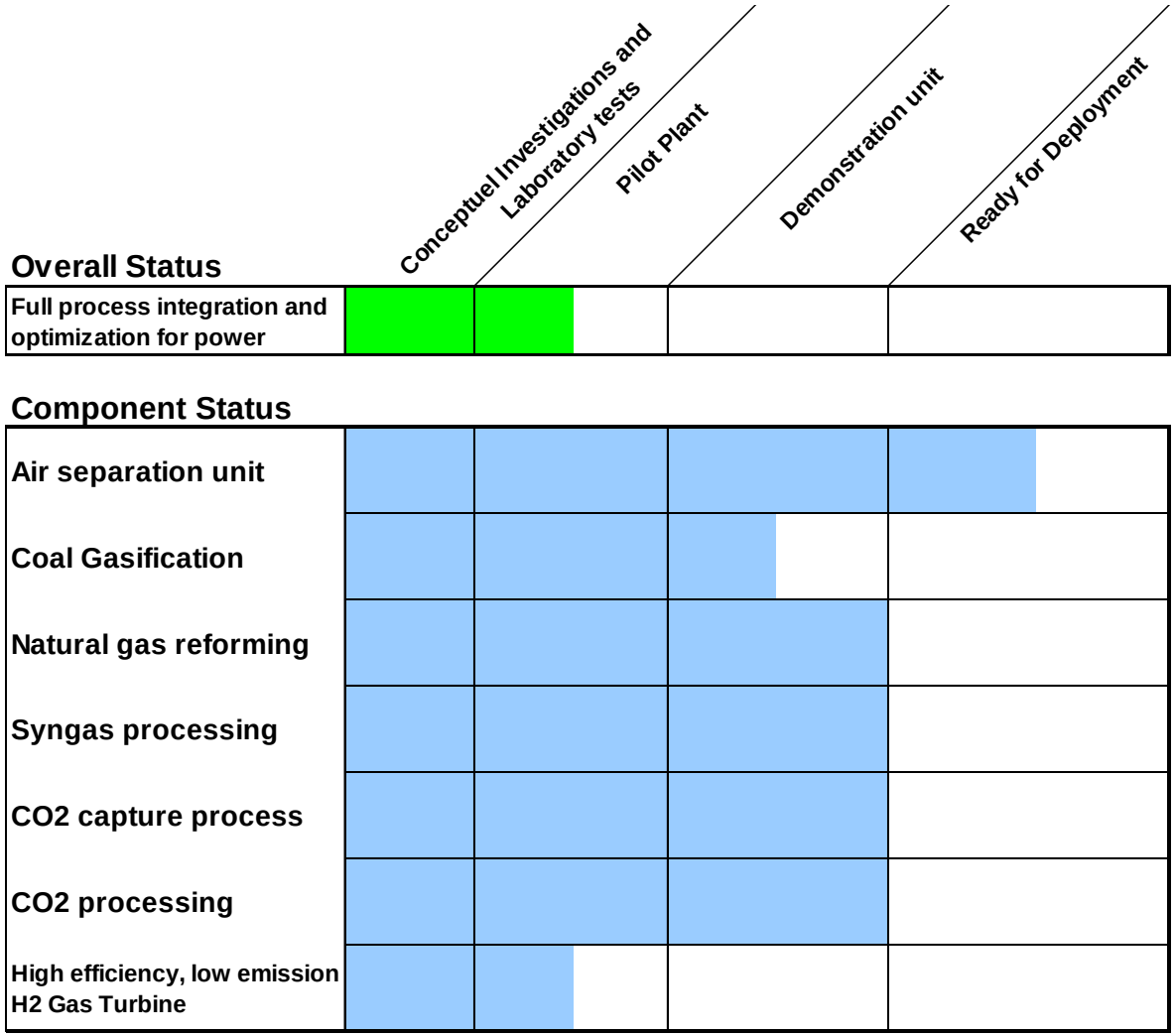
Maturity of Capture Technologies
Pre Combustion Capture



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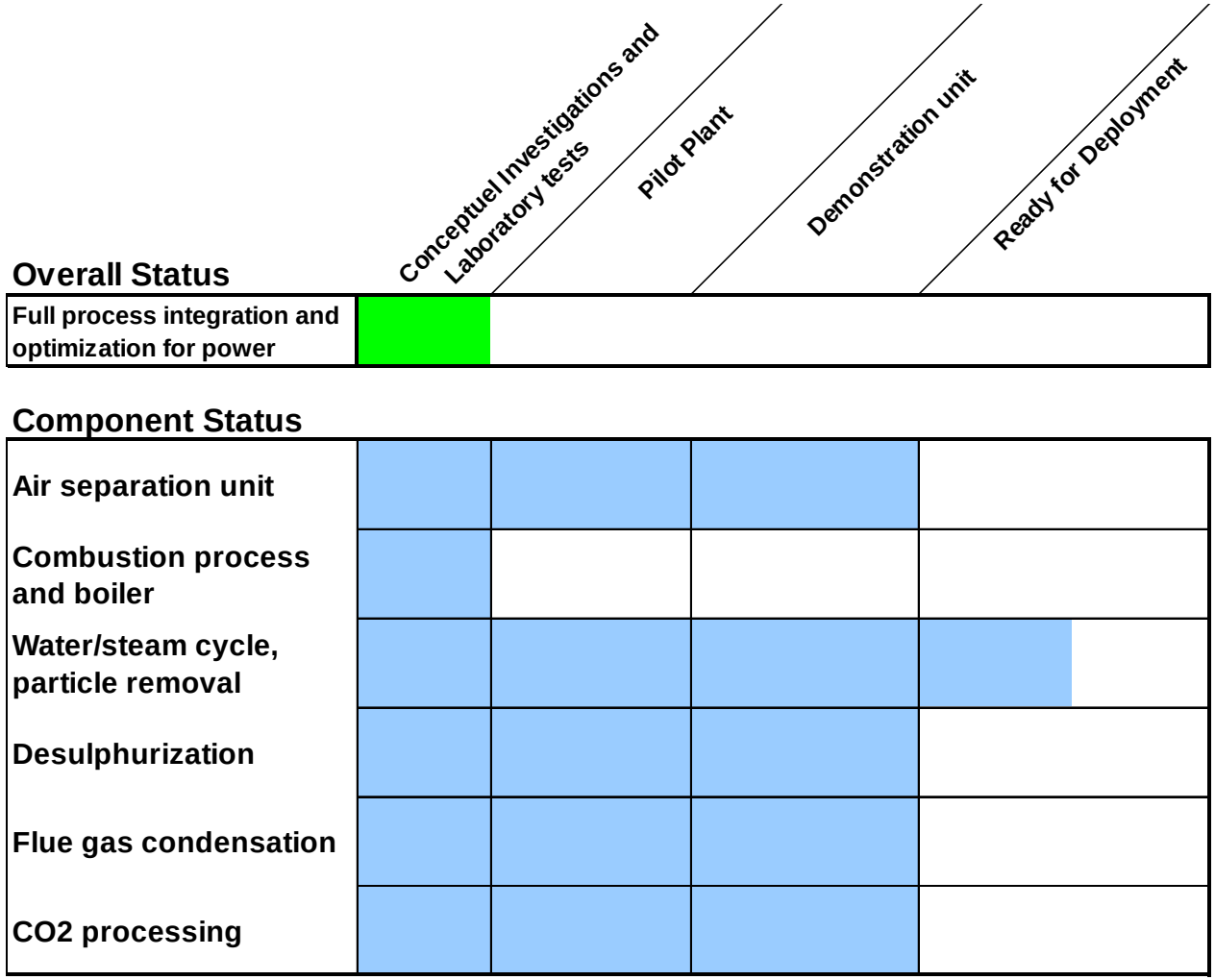
Maturity of Capture Technologies
Oxyfuel



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Cost and Potential of options to reduce CO_2 emissions
Principal example