CCS in Europe - Vattenfalls activities

Workshop «Carbon Capture and Storage: Current status and future perspectives with focus to power generation»

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Content

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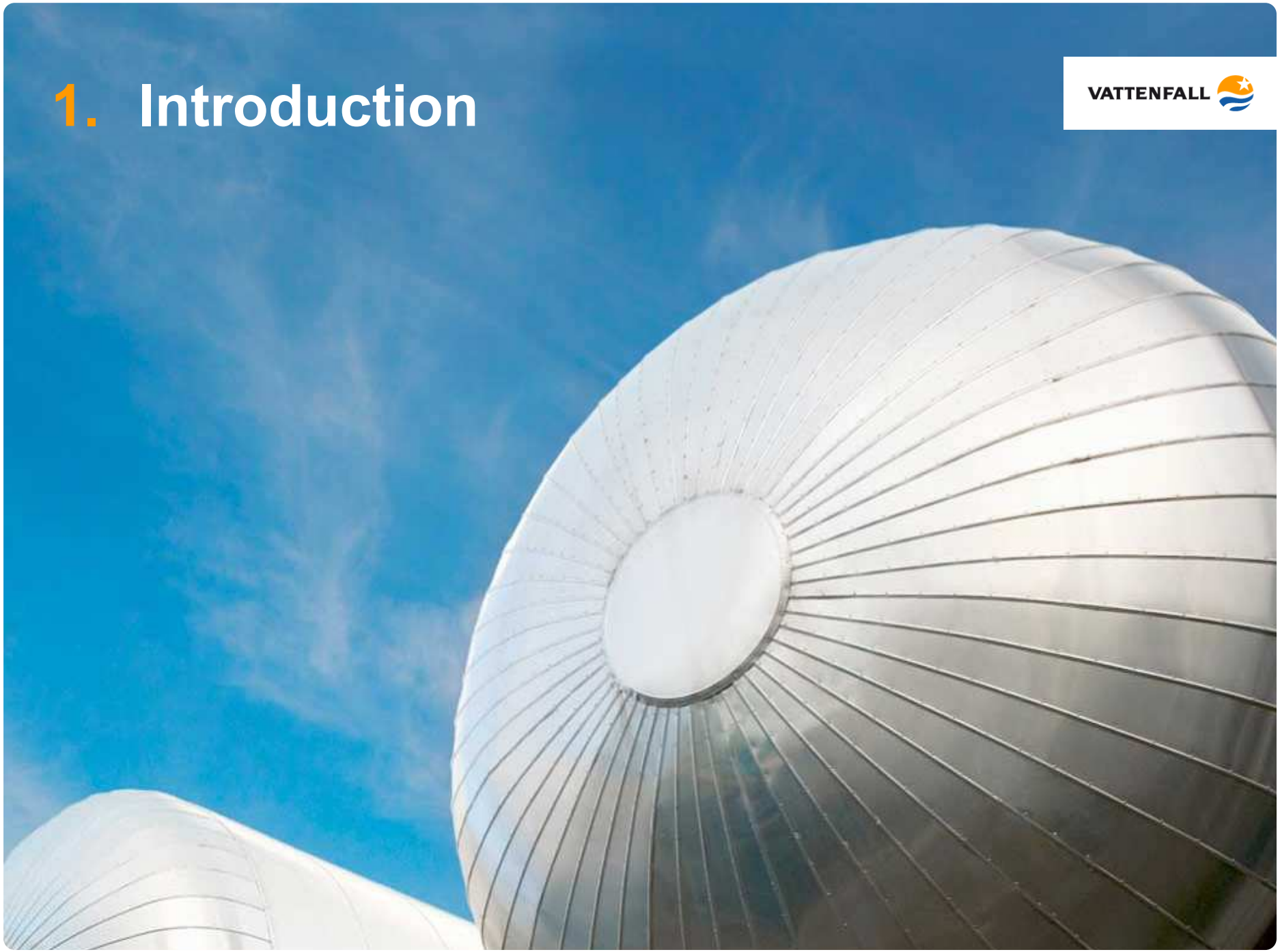
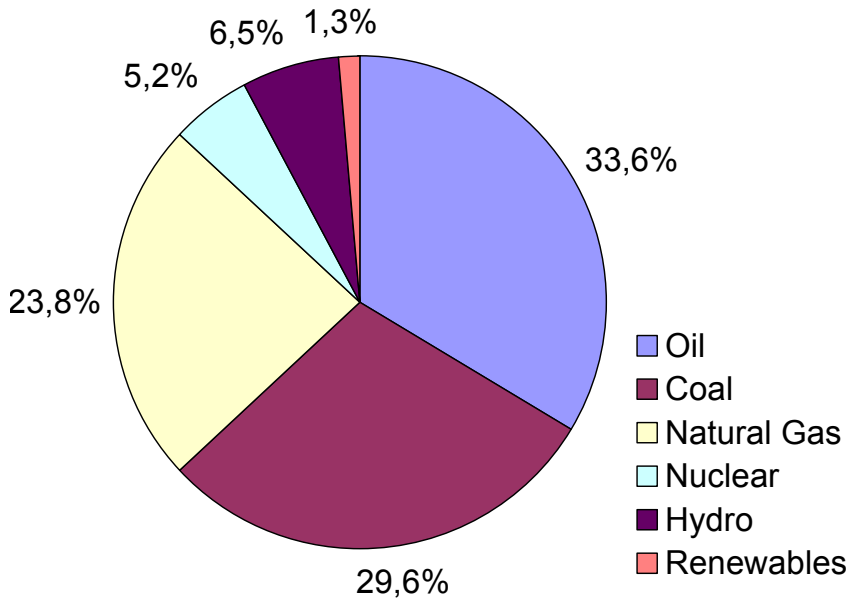
1. Introduction



Power Generation Mix World Wide 2010

Fossil fuels essential for covering energy demand!



Options to improve climate protection

- Efficiency increase (e.g. process parameters, integrated coal drying)
- Utilisation of regenerative forms of generation
- Carbon Capture and Storage CCS

Source: bp-Statistical Review of World Energy June 2011

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Application of CCS

➔ CCS is NOT only a „fitted for coal technology“

- CCS enables capture of CO_2 from all C-containing fuels (gas, oil, wood)
- combination of CCS and biomass - negative CO_2-balance
  co-firing in conventional power plants
- CCS applicable for energy intensive industries (steel, cement, chemistry)

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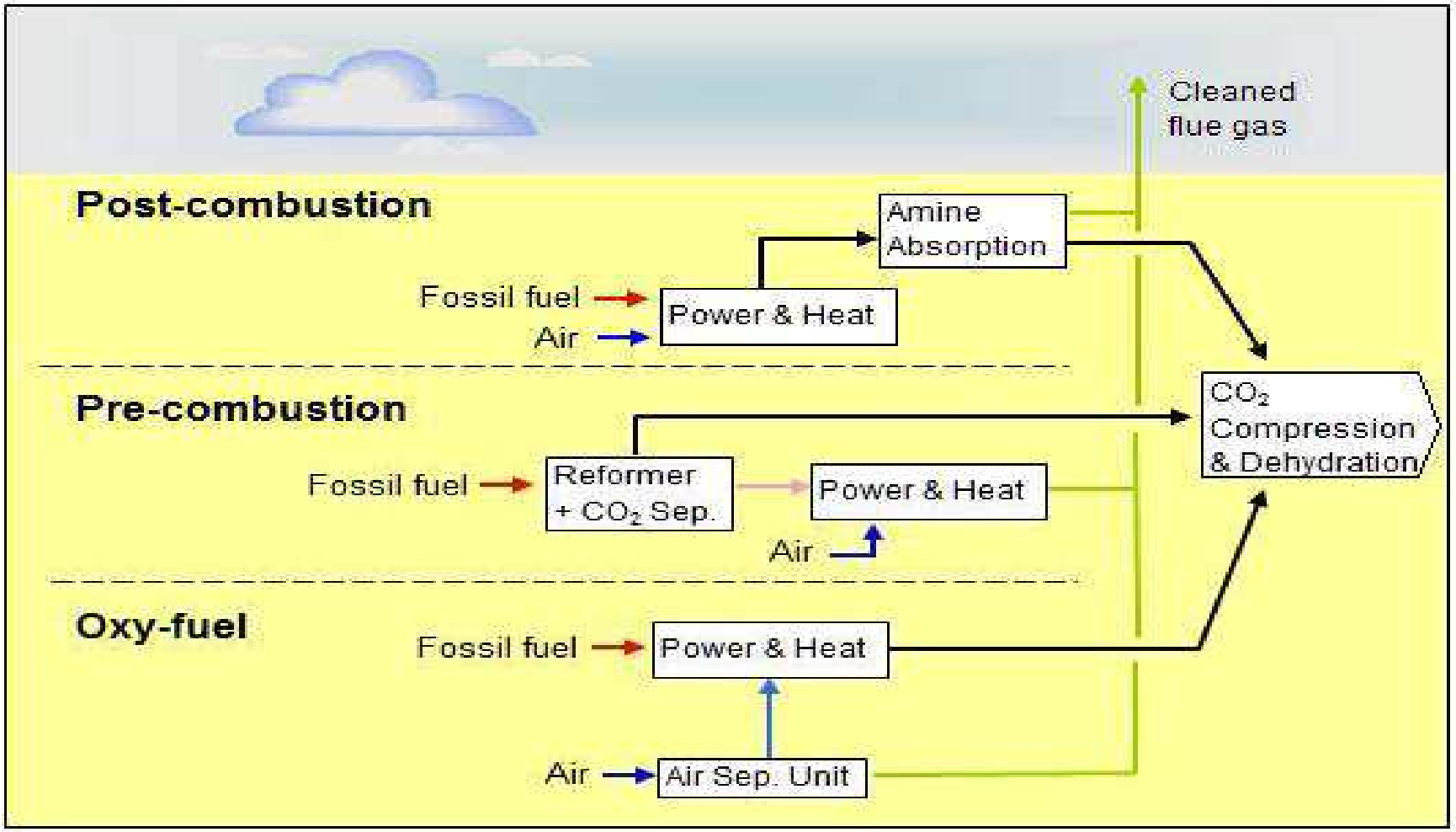
2. Vattenfalls CCS Activities

CCS Technologies for Medium-term Application



Source: European Platform for: Zero Emission Power Plants - SRA

➔ Vattenfall follows up all three capture technologies

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Vattenfall's Roadmap for Oxyfuel

Concept-studies

Test rigs:
0.1 – 0.5 MW_{th}

Pilot plant:
30 MW_{th}

Demonstration plant:
≈ 300 MW

Commercial plant:
≈ 1000 MW

2001	2004	2008	2015	>2020
• Theoretical Investigations	• Research • Basic principles • Combustion characteristics	• Demonstration of complete process chain • Interaction of components • Validation of results • Scale up criteria	• Verification & optimisation of components • Reduction of risks • Verification of commercial availability	• Economic and competitive power plant concept

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3. CO_2 Catch- up Pilot Plant

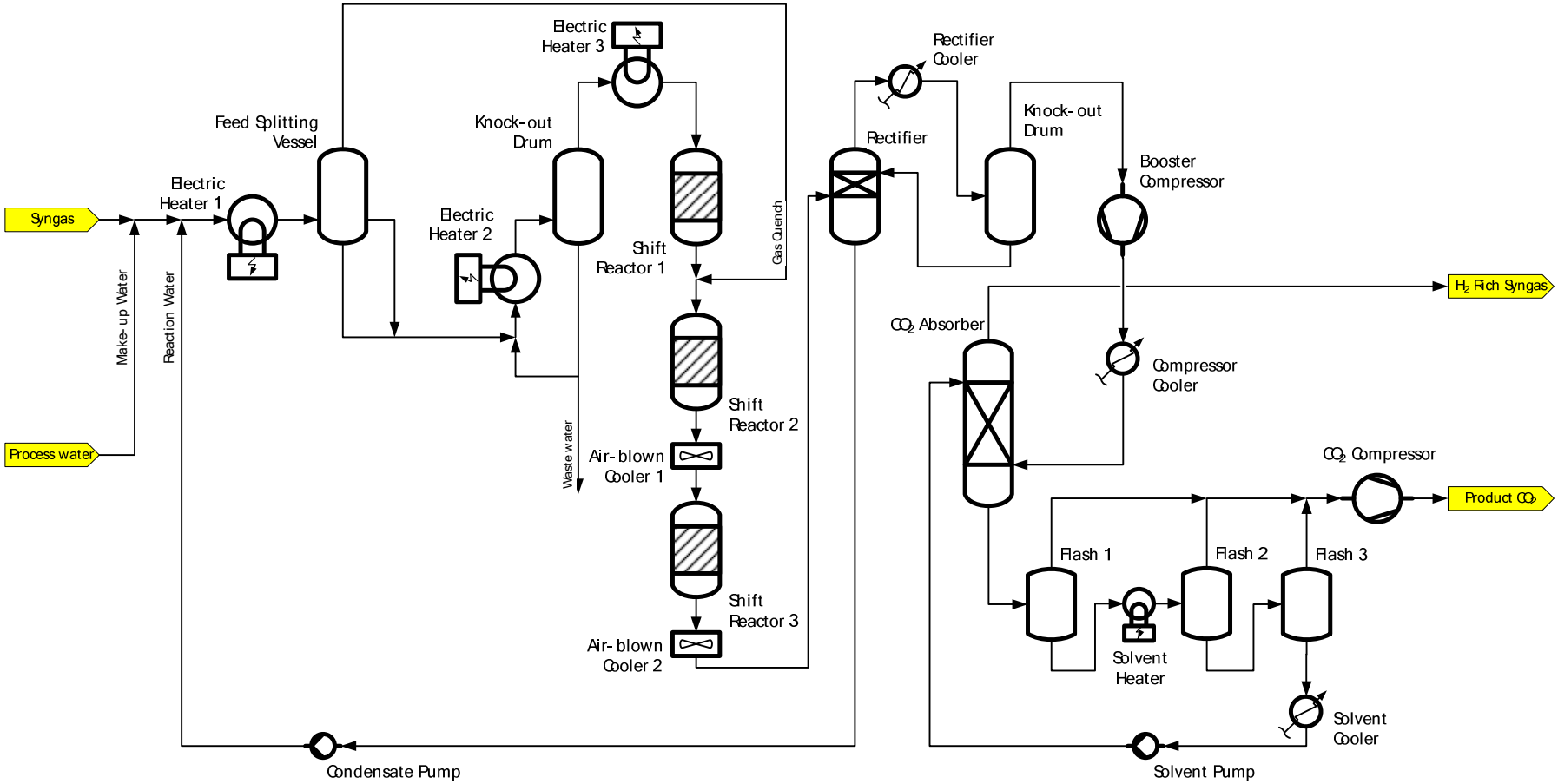
CO_2 Catch-up Project

Pilot testing of pre-combustion CO_2 capture at IGCC

In bypass of existing IGCC process test of CO_2 removal

- Development new technology application
- Validation of parameters representative for the Magnum IGCC to verify the technology performance and operation window
- Identify and mitigate potential risks associated with the novel application of the selected technology
- Optimise design and technology performance
- Gather operating experience

Flow-Sheet CO_2 Catch-up



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Facts and Figures

Main Inputs

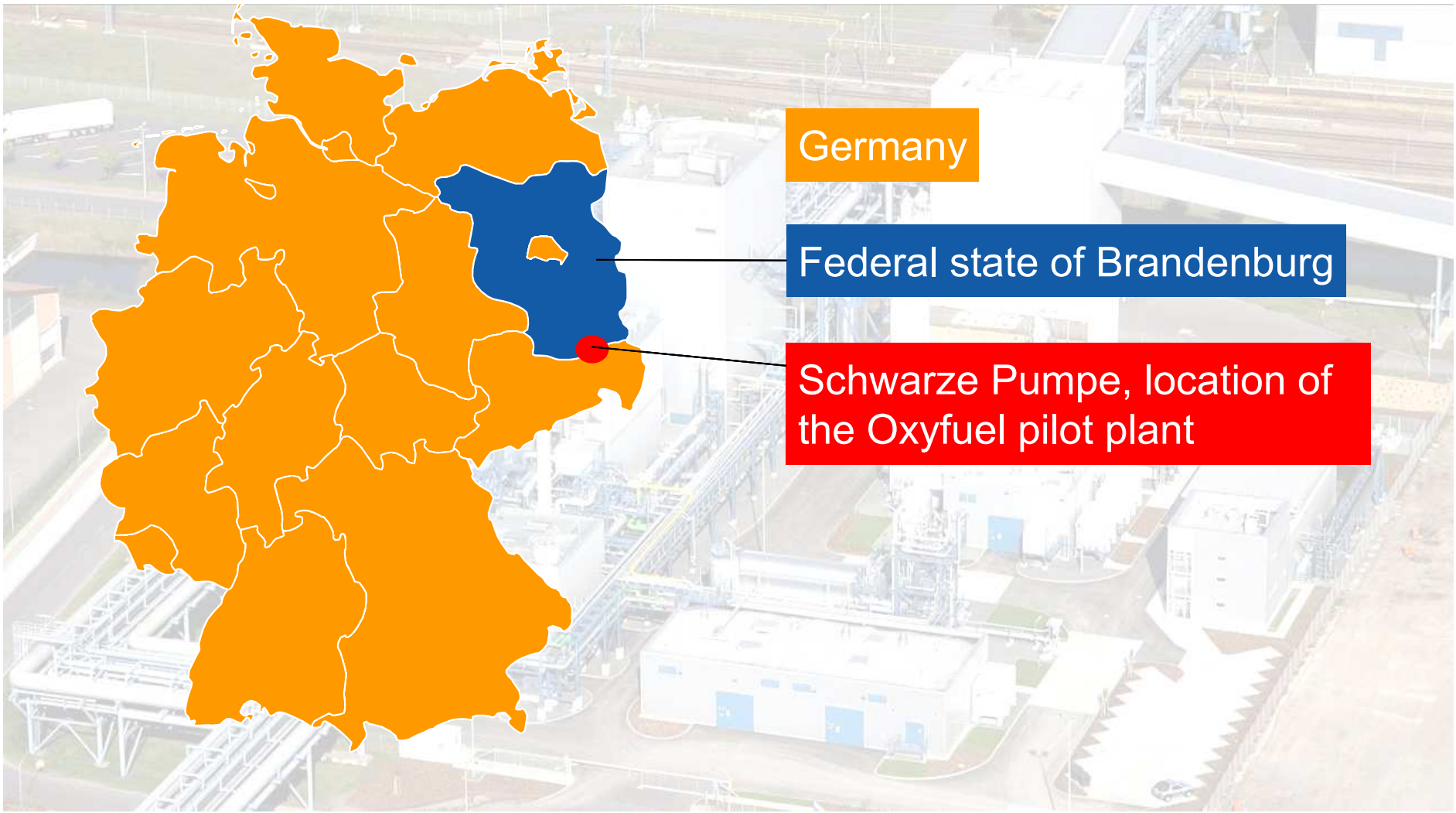
Syngas	1224 kg/h
Demi-Water	644 kg/h

Main Outputs

H_2 rich gas	435 kg/h
	83 vol.%
CO_2 gas	1386 kg/h
	97 vol.%
Capture efficiency	
	80-85 %
Sweet CO-shift	
	Fe-Cr catalyst

4. Oxyfuel Pilot Plant OxPP

Location of OxPP



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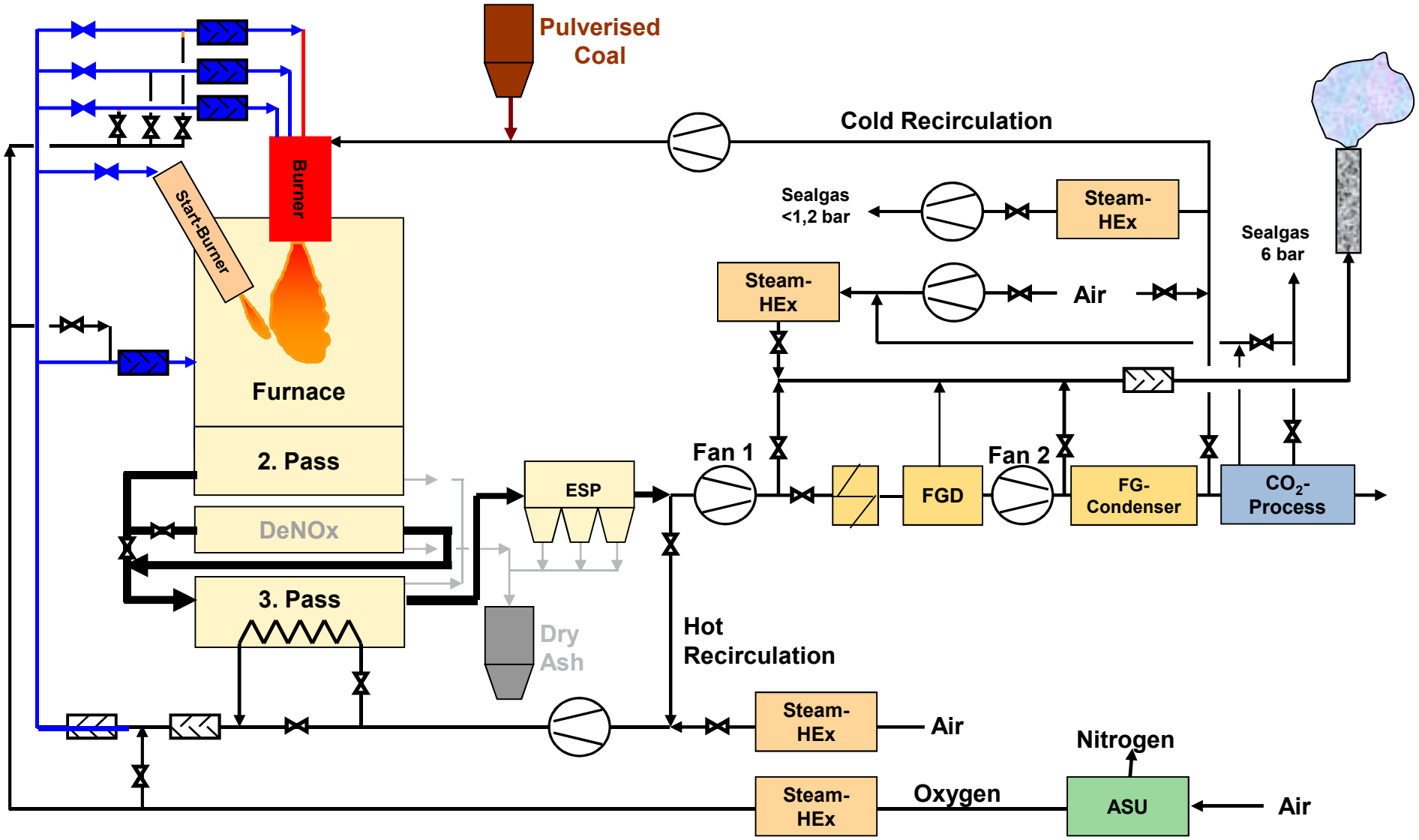
System Overview of Oxyfuel Pilot Plant



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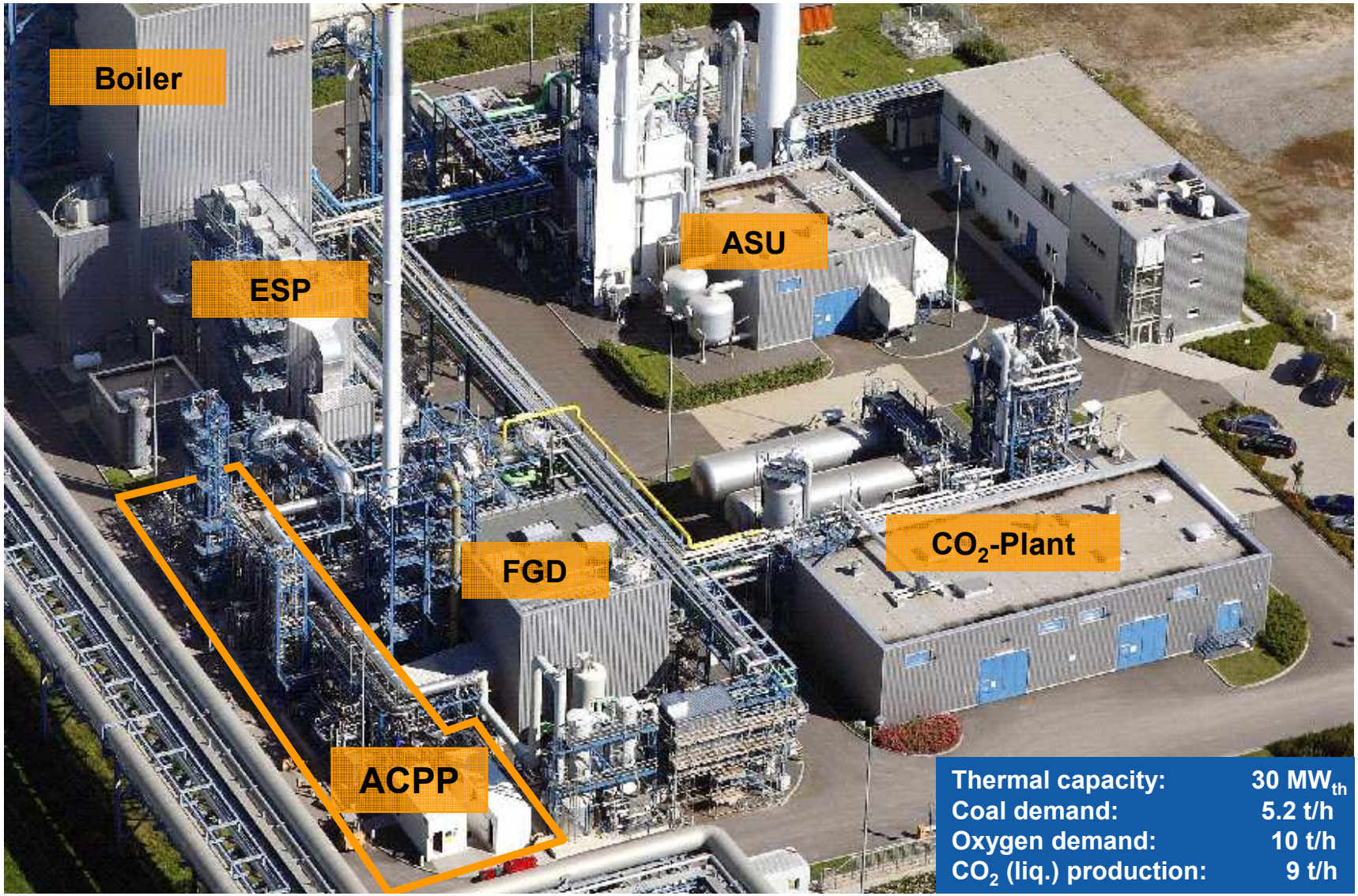
Oxyfuel Pilot Plant Schwarze Pumpe



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Vattenfall‘s Oxyfuel Pilot Plant

Great international interest

2009:

4.500 visitors (54 countries)

2010:

2.500 visitors (40 countries)

- Commissioned in Sep 2008
- Up to now approx. 14.100 operating hours
- Sequestration of more than 10.200 t CO_2
- CO_2-removal rate 90 %
- Management system for high product quality
- Demonstration of functionality

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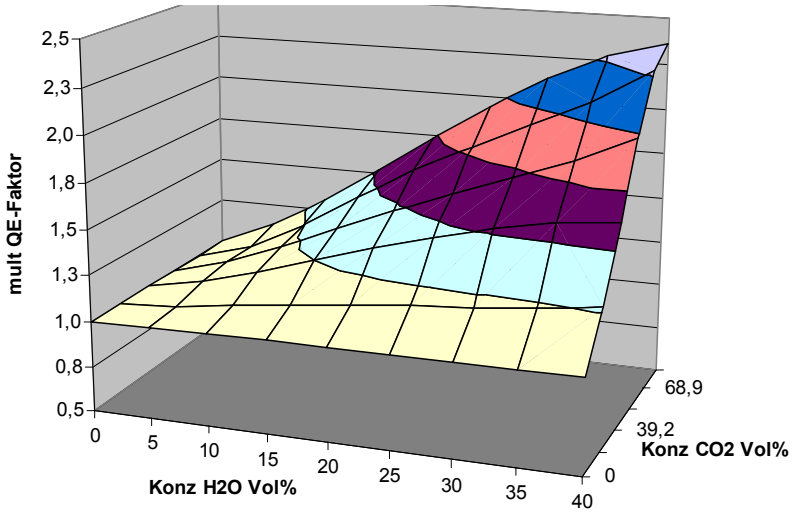
Research Aspects



- Realisation of oxyfuel process, emission limits kept
- Successful testing of individual components (burner, filter, FGD, CPU, membrane)
- Operation experiences (process behaviour, integration of ASU, CPU, maintenance)
- High CO_2-quality obtained – industrial utilisation
- Variation of coal quality (Moisture, S-content, size), materials, corrosion
- Closing of C-chain
- Adjustment of analytical equipment for Oxyfuel-flue gas composition and CO_2-monitoring
- Advanced technologies (ACPP)

➔ Ready to scale up …

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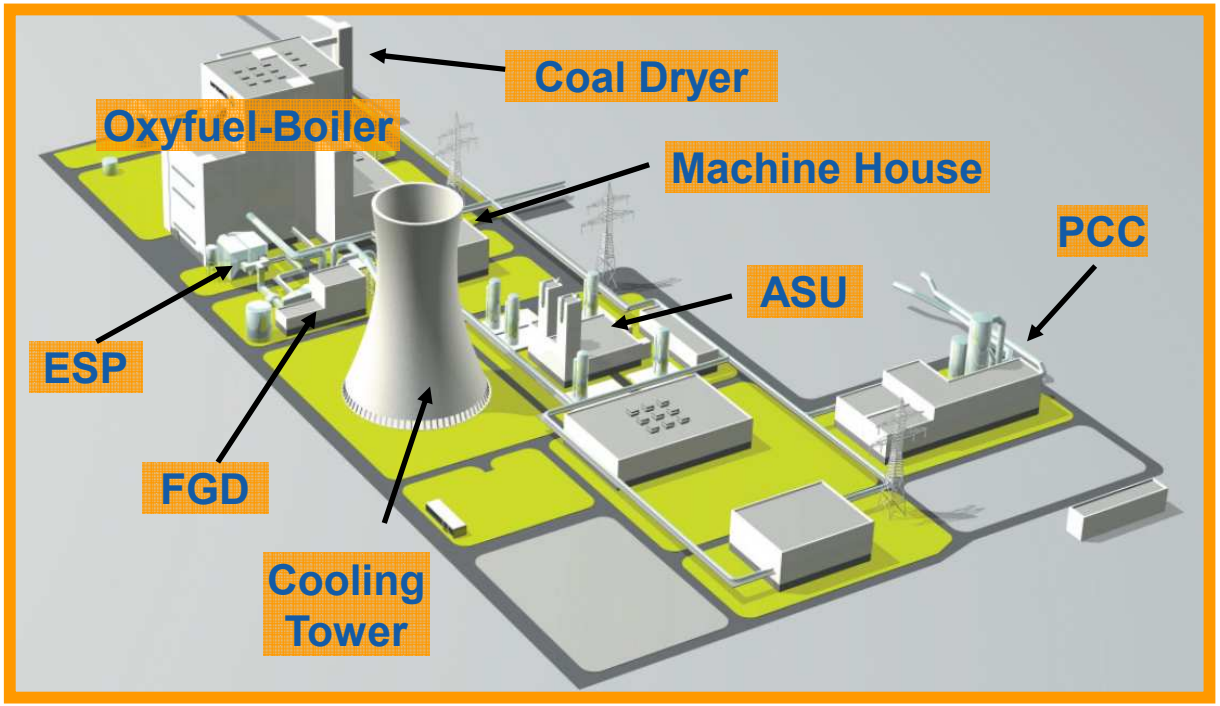
5. CCS Demonstration Plant Jänschwalde

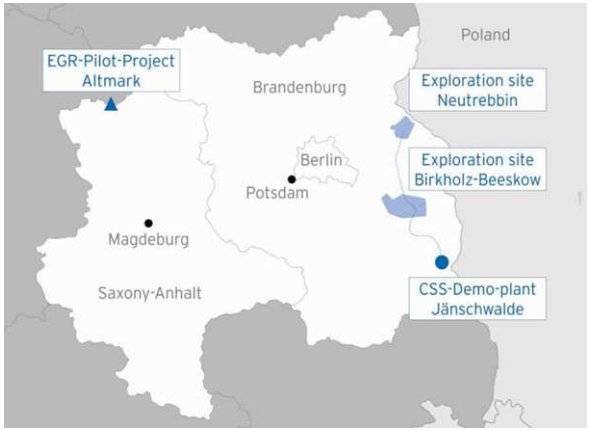
Strategic Targets of the Demonstration Project

- First time large scale demonstration of the complete CCS chain including Capture → Transport → Storage
- Demonstrate economical efficiency of the Oxyfuel and Post-Combustion-Capture technology
- Significantly reduce Vattenfall's carbon footprint



Vattenfall‘s CCS Demonstration Projekt Jänschwalde

- Installation of two CCS Technologies:
  - Oxyfuel (separate block 250 MW_{el} ,η=36%)
  - Post Combustion Capture (retrofit 50 MW_{el})
- Sequestration of 1.7 Mio. t CO_2/year
- Integration of PFB-Drying technology
- Base load with load flexibility 50-103 %
- Availability ~97%
- Investment of 1.5 bn. €
- Rated as best project within the European Union’s EEPR program



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European Energy Programme for Recovery

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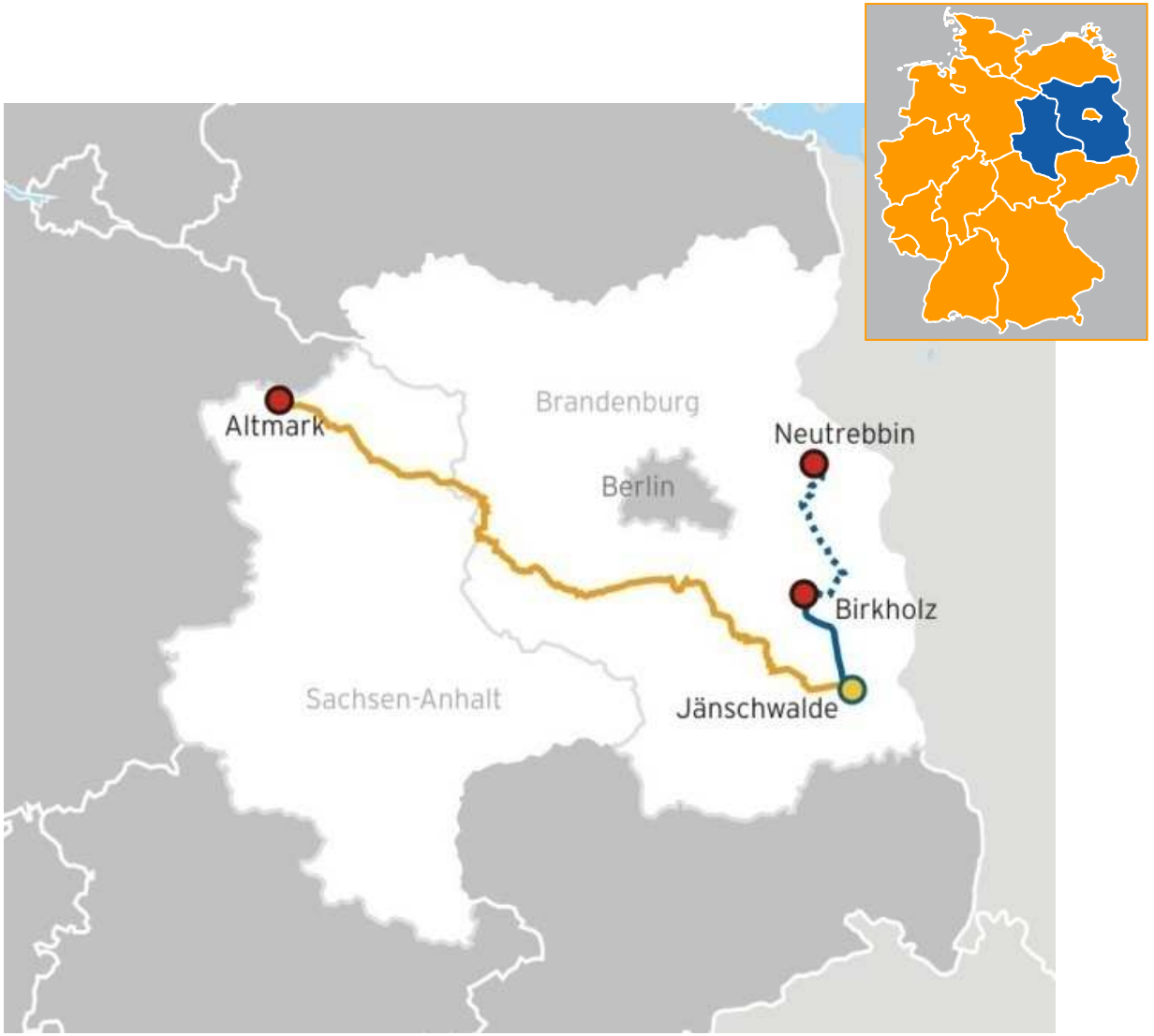
Demonstration Plant Jänschwalde – Potential Storage Sites

I. Brandenburg

Storage in deep saline aquifers (pipeline 50/140 km)

II. Altmark

EGR pilot project in cooperation with Gaz de France (pipeline 300 km)



6. Conclusions

Summary

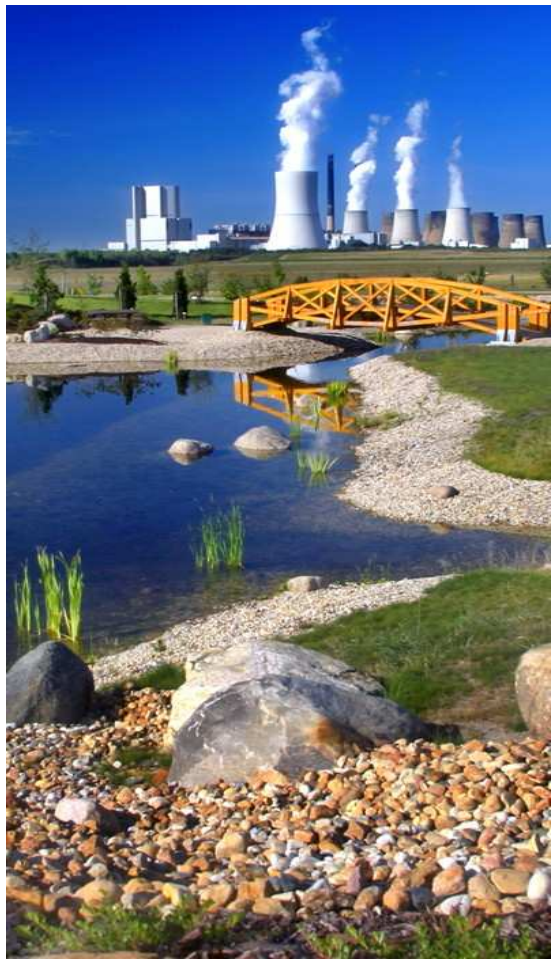
- Coal is fuel with long time perspectives (availability, costs),
  World won't do without the use of fossil sources of energy
- CCS is central climate measure (IPCC, IEA, Stern-Review)
- CCS is not only a "coal technology"
- Biomass CCS results in negative CO_2 balance
- New market for material use of CO_2 - further development necessary
- Vattenfall makes endeavors to develop CCS for industrial scale

  Oxyfuel technology ready for scale up

  Potentials: Efficiency, process optimisation, membranes, ACPP

Development Perspectives

- **Future generation structure:**
  - **Safety of supply**
  - **Profitability**
  - **Climate protection**
- **That means that all forms of generation should be utilized reasonably:**
  - **Coal (with or without CCS)**
  - **Nuclear**
  - **Wind power**
  - **Biomass**
- **Additional massive expansion of the grids**
- **Development and implementation of storage technologies**



Thank you!