

Carbon Capture & Storage (CCS)

**The Role of Subsidies to Facilitate
Transitions to Low-Carbon Technologies**

Berlin 12 november 2009

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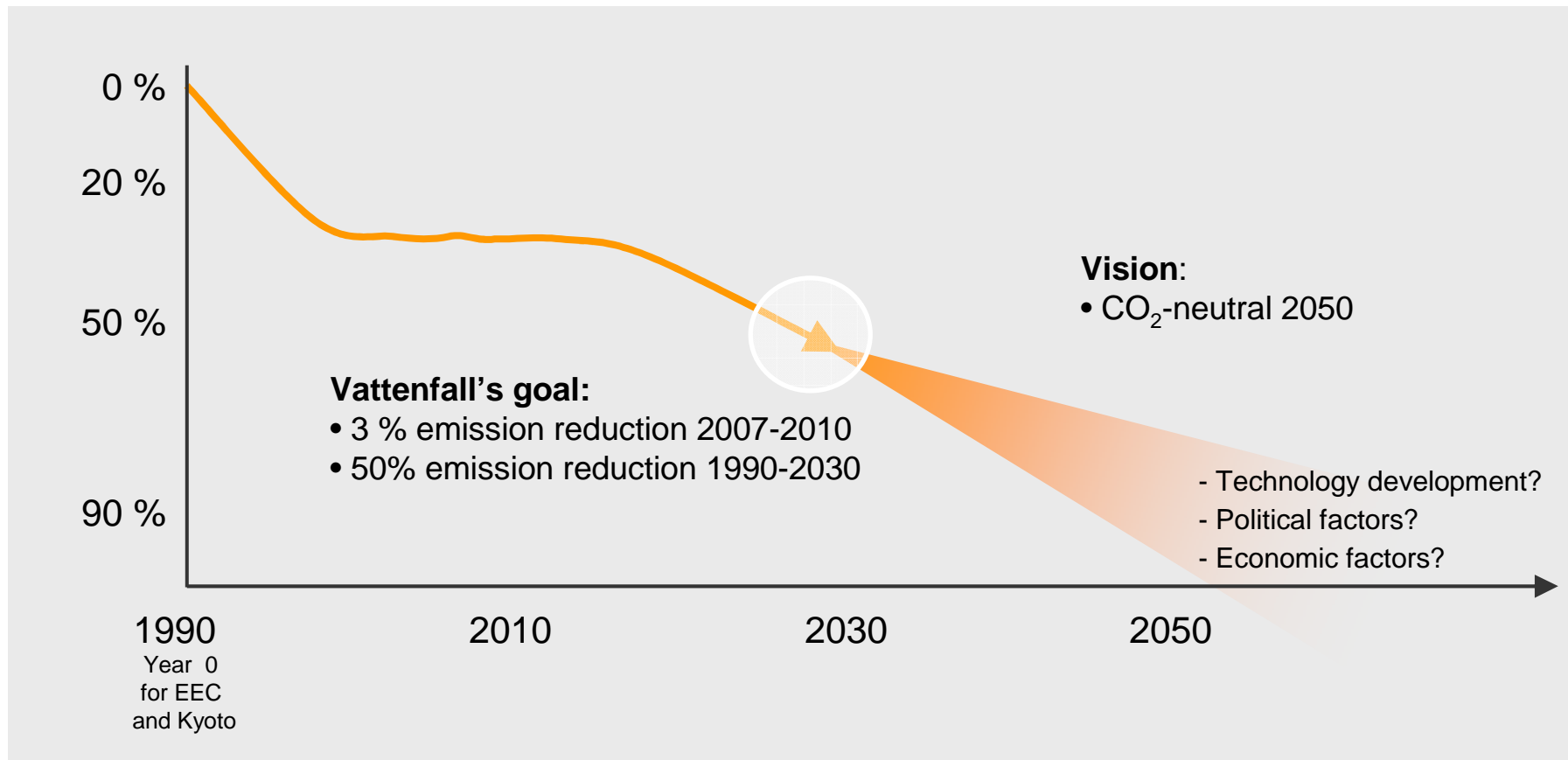
Vice President, Head of CCS

Vattenfall: A Leading European Energy Company

- Europe's fifth largest generator of electricity and the largest producer of heat
- Net sales 2008: EUR 15,041 million
- Vision: To be a leading European energy company
- Operations in Sweden, Finland, Denmark, Germany, Poland, the Netherlands, Belgium and the UK with a total of 7.4 million electricity customers and 5.6 million network customers
- Electricity: generation, transmission, distribution and sales
- Heat: production, distribution and sales
- Gas: distribution and sales
- Energy trading and lignite mining
- Consulting and contracting activities in the energy sector
- 39,000 employees
- Vattenfall AB is wholly owned by the Swedish state



Making Electricity Clean



Three Technologies – One Strategy

- Significantly increase investments in low-emitting energy generation
 - Renewables
 - Nuclear
 - Coal/Gas with CCS
- Accelerate business and technological development
- Promote incentives for investments in low-emitting technologies



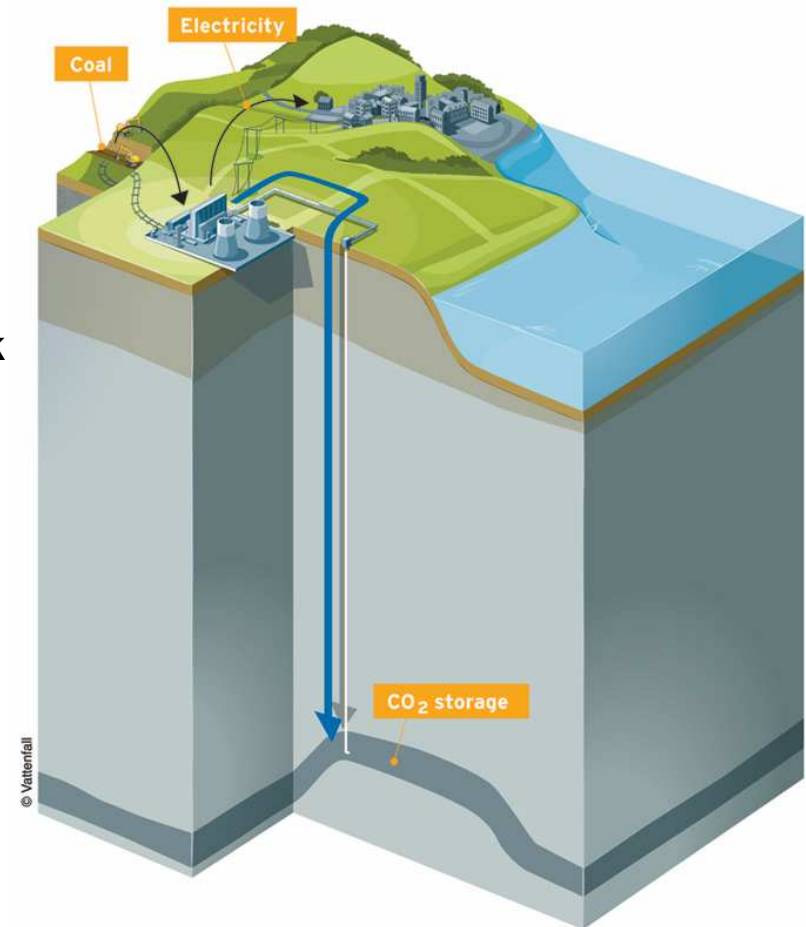
The Concept of CCS

The idea is to capture carbon dioxide from a coal-fired power plant, compress it and permanently store it deep underground

The storages are of the same kind of structures that oil and gas are extracted from - a porous rock with a sealing cap on top

CCS is needed to reach the target of 50 percent reduction and CO₂ neutrality

The targets can't be met with CCS alone



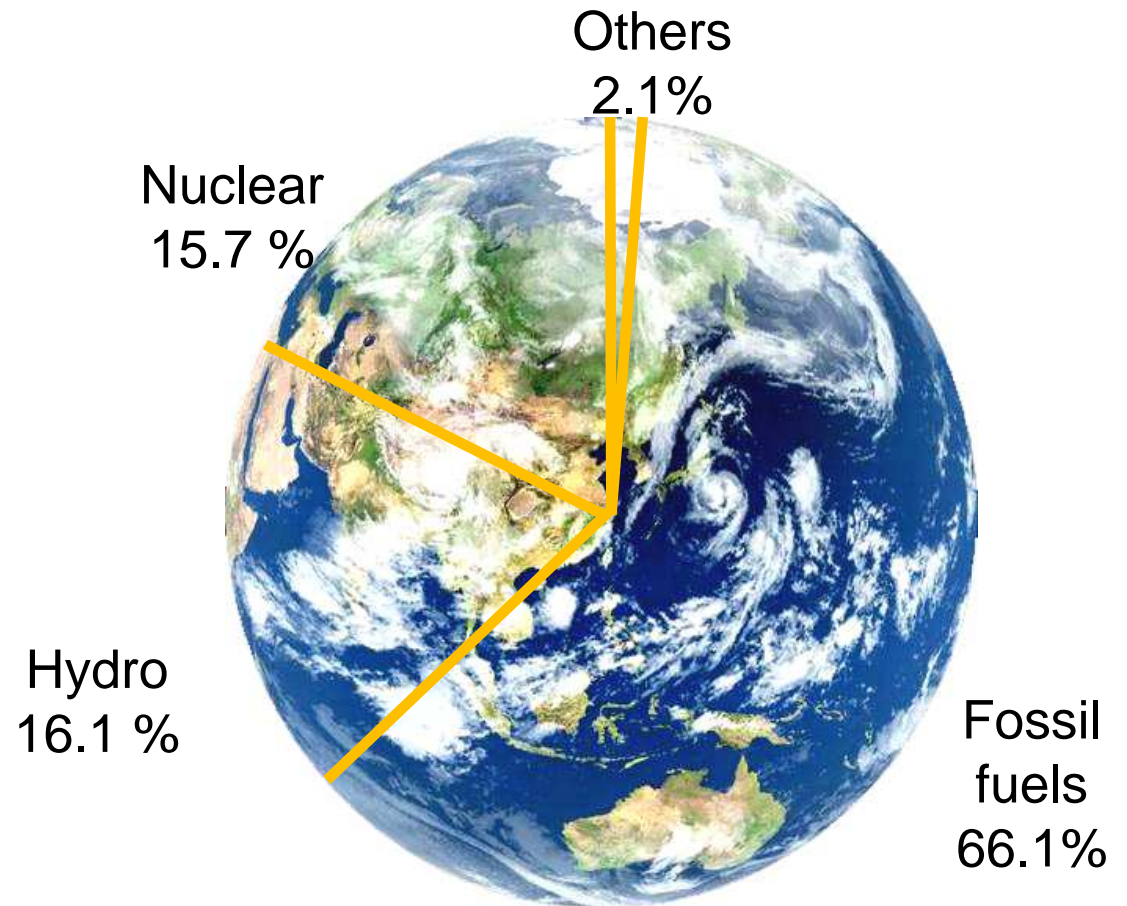
CCS – A Global Perspective

global electricity supply - 2008

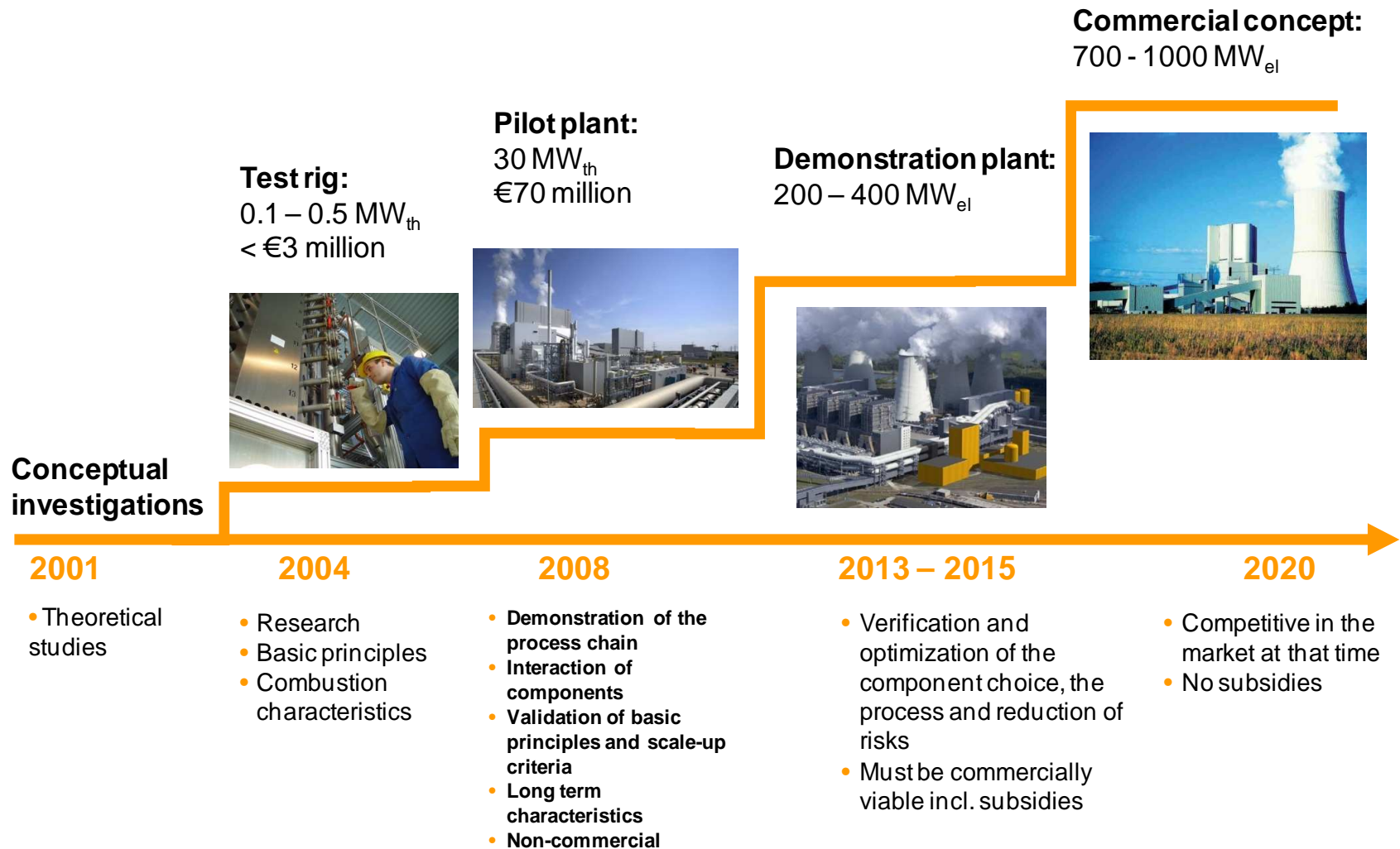
The world will not stop using fossil fuels.

Coal is the one fossil fuel which combines the greatest potential with the strategic optimum
Coal enjoys a global renaissance.

CCS is **THE** key technology for developing a CO₂ lean energy system based on the reality of fossil fuels – especially coal



CCS – Our Roadmap



Oxyfuel Pilot Plant in Schwarze Pumpe



- » operating hours oxyfuel: 3.100
 - » operating hours air mode: 1.500
 - » hours oxyfuel: 1.600
 - » captured amount of CO₂: 1.400 t
- Investment: approx. € 70 million plus operating expenses of €10 million € p.a.

Strategic Goals of the CCS Demo Project

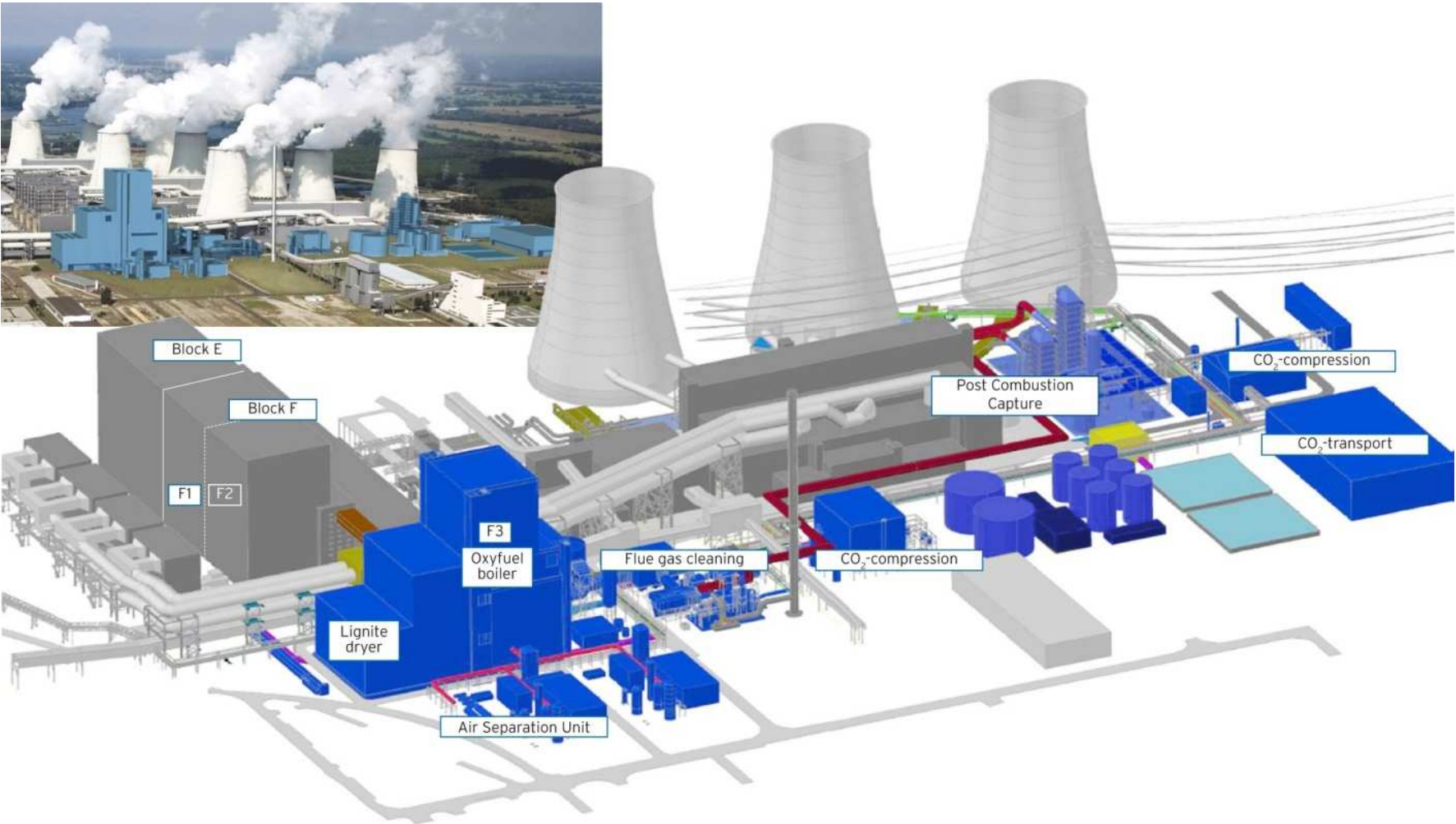
- **Use the knowledge from the pilot plant at Schwarze Pumpe** to build and operate a demonstration plant which guarantees the knowledge to erect and operate the first generation of commercial CCS power plants.
- **Technically and economically validate the entire CCS chain** including the demonstration of two capture technologies, Oxyfuel and post-combustion capture, as well as safe CO₂ transport and storage.
- **Increase acceptance** of CCS technology in society and politics, and provide confidence in a safe technology.
- Contribute to Vattenfall's overall ambition of **Making Electricity Clean** by means of reducing specific CO₂ emissions from Vattenfall's operations by 50% in 2030, and being climate-neutral in 2050

Demo Plant Jämschwalde by Numbers



- Existing plant, 3000 MW in total, 6 x 500 MW Units
- Feasibility Study completed (April 2009)
- Installation of two CCS Technologies:
 - Oxyfuel (equivalent to 260 MW_{el})
 - Post combustion capture (equivalent to 125 MW_{el})
- Up to 2.7 million t CO₂ capture p.a.
- Real carbon reduction
- Planning process initiated
- Assessment of various potential storage sites
- Start of operation is planned by middle of 2015

CCS Concept Jämschwalde



Storage Options

I. Altmark

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

II. Brandenburg

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



CCS Costs

CCS overall cost journey – reference case

€/tonne CO₂ abated; rounded to €5; European rollout scenario

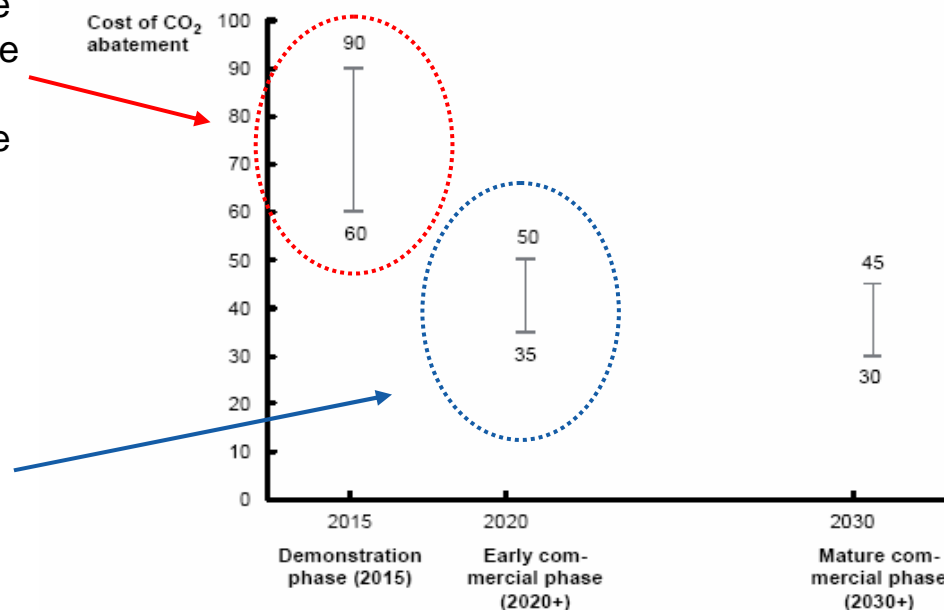
Ranges for technology / fuel and onshore / offshore combinations (reference cases)

┆ Highest
┆ Lowest

The **cost of CO₂ abated** for the CCS demo project Jämschwalde will be on the lower end of this range. In the best case it will be approx. **55 €**.

Under consideration of the **scale up effect** and **efficiency improvements**, that are expected until the commercial introduction in 2020 Vattenfall is confident to reduce the costs per abated t of CO₂ by more than 50%.

=> **25 – 35 €**



Note: Cost for other CCS options (e.g., coal retrofit, industry) will vary

Source: McKinsey & Company, Carbon Captur & Storage – Assessing the Economics 2008

Funding is essential for the demonstration phase. In the commercial phase, no further stimulation is needed as the carbon price will be sufficient for the costs.

3-fold Challenges

1. **Legal framework**: speedy transposition of CCS directive (2009/31/EC)

2. **Financing**: Jämschwalde demonstration plant project:

investment costs ~ €1.500 million

➤ € 180 Mio: EEPR?

➤ € ??? Mio: NER300 (Art. 10 a para 8) ETS directive (2009/29/EC)

- establishing the framework in 2009

- Project selection in 2010

=> is important to keep the timeline 2015 realistic

➤ € up to 1.000 million: MS, Vattenfall & possible partners

} max 50 %

3. **Acceptance**:

➤ Private: information office (Bürgerbüro Beeskow), IZ Klima

➤ Public: role of government/politicians, science & research (universities, PIK, GfZ, etc)

A close-up photograph of a pair of hands holding an open oyster shell. Inside the shell, several pearls of various sizes are visible. The background is softly blurred, showing what appears to be a crowd of people. A semi-transparent blue circle is overlaid on the left side of the image.

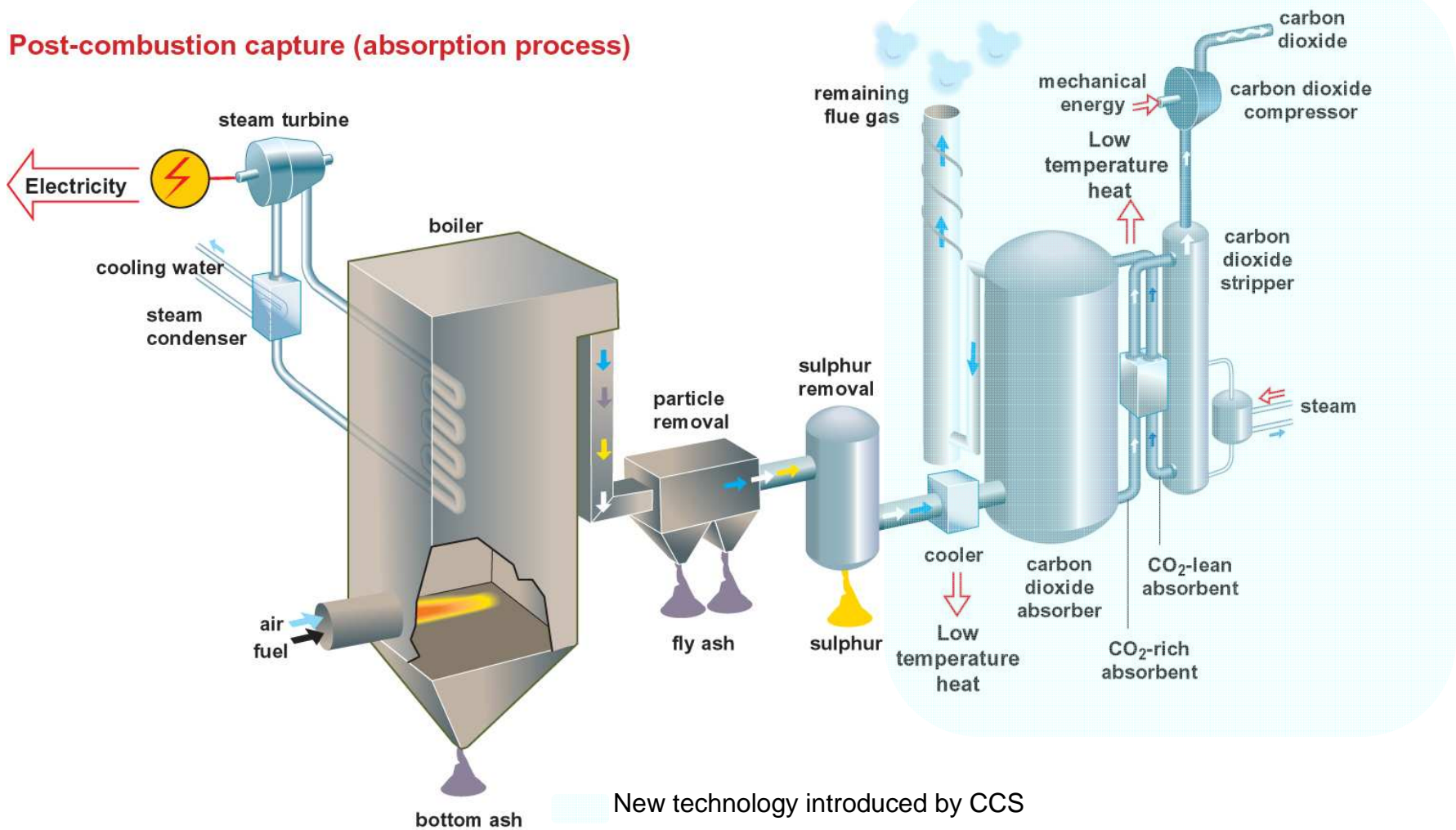
Thank You for Your Interest

The Vattenfall Group

Creating value for the future

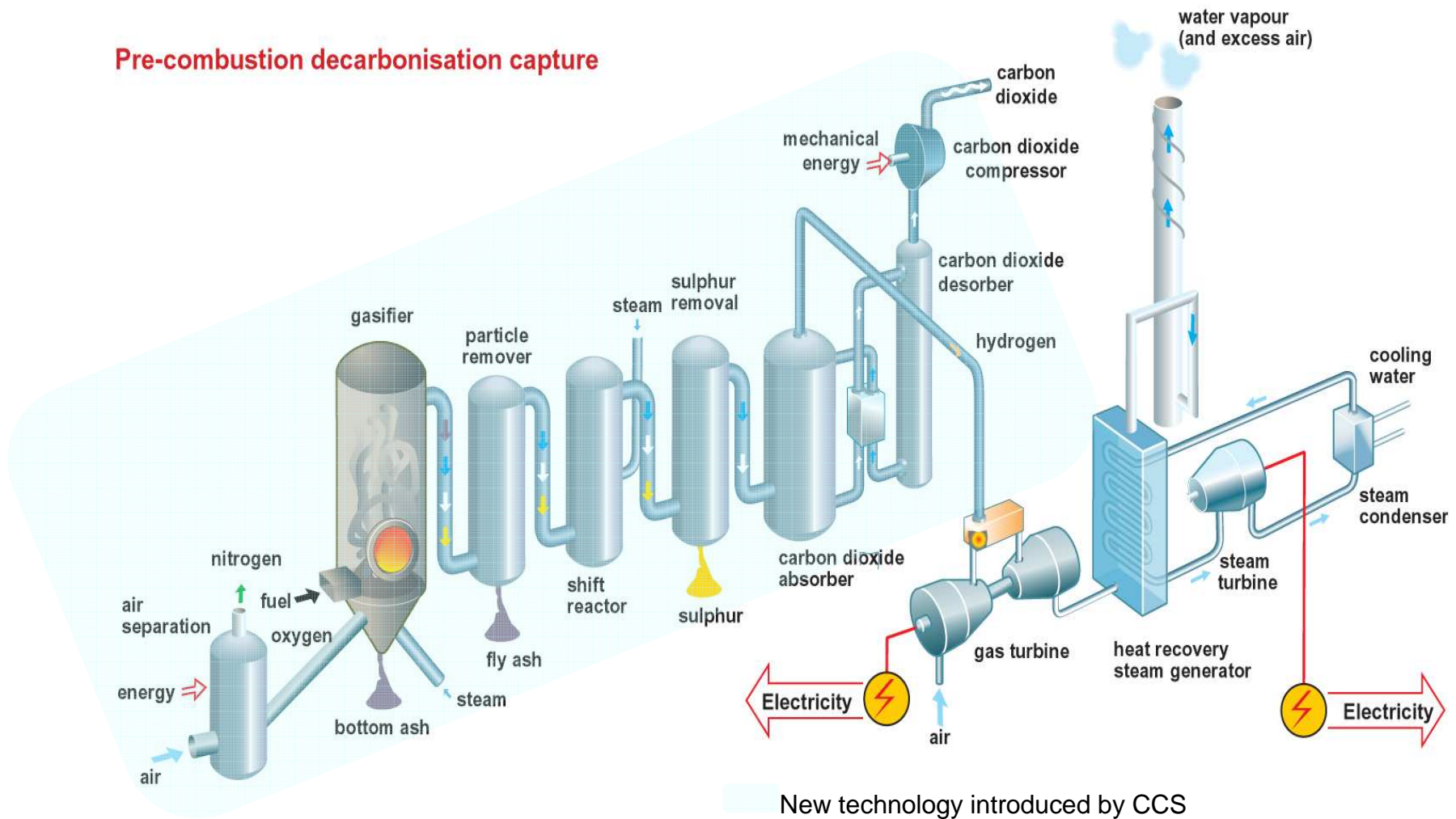
Option 1: Post-Combustion Capture

Post-combustion capture (absorption process)



Option 2: IGCC

Pre-combustion decarbonisation capture



Option 3: Oxyfuel

