Let’s start with some key figures:

We are the No. 5 company in Europe for electricity production and No. 1 for municipal heat production.

In 2009, about 40,000 employees in eight countries served 7.5 million electricity customers and 5.6 million network customers in our three core businesses: electricity, heat and gas.

We face a very diverse energy mix in each country and thus are accustomed to work within very diverse business environments, markets, and socio-political settings. So, naturally, the role of coal also differs in our respective markets.

Our CO₂ emissions make us certainly a part of the climate change problem – but we are fully committed to become a part of the climate change solution as well and reduce our emissions.

To achieve our ambitious goal we will have to make use of every suitable technology and explore various pathways. We believe in a robust portfolio approach and a broad energy and technology mix. Contrary to many published opinions, I am fully convinced that our energy future will not be characterised by a monoculture, but by diversity. I would even argue that more diversity will be vital for the resilience of our industry and society and that we should avoid as much as possible to do “technology picking”. We cannot know today where technological progress will lead us. There is no silver bullet.

Having said that, I have to admit that – with today’s knowledge – CCS is practically the only short-to-mid-term technological solution to radically reduce the CO₂-emissions from burning fossil fuels (and to reduce the process-based emissions from many other industries such as steel and concrete, as well).

Outside of Europe, Coal has been the fastest growing energy source of the last decade. And as much as one might wish: renewable energies and efficiency gains just will not be enough to keep up with demand.

Globally CCS is crucial to meet any reasonable climate targets.
Clean Coal for Europe – Making CCS work

Coming to the challenges to make CCS work, this slide shows the whole technological chain.

The upcoming proposal by energy Commissioner Oettinger on the energy infrastructure package (to be adopted on November 17th) will mark a milestone for transport infrastructure as it supposedly contains CO2 infrastructure as a new infrastructure need.

Roadmap for implementing CARBON CAPTURE (slide 6)

Our company has been on a decade-spanning journey of CCS R&D. We have recently and successfully entered the stage where you move out of the laboratory into the real world. It has always and right from the start been our aim to verify and optimise this technology and to make a substantial contribution to the full commercialisation of CCS.

Roadmap for implementing carbon STORAGE (slide 7)

The storage part of CCS marks a special challenge on various sides.

You can see the roadmap starting with a feasibility study, screening process etc. For storage purposes, three alternative locations are being explored in parallel, each of which has the potential to store at least the amount of CO2 necessary for the expected lifetime of the demo plant.

The CCS pilot plant: Successful testing for CO2 capture (slide 8)

Since our Pilot Plant at Schwarze Pumpe opened up operations in September 2008, we obtained invaluable insight into running an industry-sized oxyfuel plant.

Some of you might have visited the site, and those of you who have not, please accept my invitation to do so. It is definitely worth a visit!

I am very proud to be able to say that the results obtained from this pilot so far have not only met but exceeded our expectations. And we will continue our research work for at least three more years, even expanding the original project by inviting new partners.

CCS-Demonstration Project Jänschwalde (slide 9)

We chose our power plant site at Jänschwalde in the State of Brandenburg, where – today – we generate about 22 TWh annually on the basis of lignite, providing enough electricity to serve 5 million
people. With an installed capacity of 3,000 Megawatt, Jänschwalde is Vattenfall’s largest power plant site in Germany.

We plan to use two capture technologies: post-combustion capture and oxyfuel, with an added capacity of 300 MW, making use of best practice in today’s power plant technology.

We also hope to achieve the lowest possible CO₂-emissions per kilowatt-hour: markedly less than 100 grammes of CO₂ per kilowatt-hour. This translates into less than 25 % of BAT for a state-of-the-art natural gas-fired power plant. A remarkable fact for a lignite plant!

**The CCS power plant: Advancing the concept (slide 10)**

Due to the experience we gained, we decided to change the concept and built a new unit for the 250 MW Oxyfuel demonstration plant.

**Key results of the technical modifications (slide 11)**

We are aiming at the highest possible efficiency for a CCS demo and found the lever to increase efficiency towards at least 36 per cent electrical net efficiency for the new concept.

**Status of storage reservoir exploration (slide 12)**

What is the actual state of play for the storage exploration?

- We have received the permits for exploration of the Birkholz-Beeskow and Neutrebbin storage structures.

- We have submitted the main plan for operations and the special plan for seismics operations for Birkholz-Beeskow to the authority LBGR

- The main plan for operations is currently in the phase of public participation.

**Next step: Exploring the geological formation (slide 13)**

The exploration is necessary in order to be able to evaluate an to ensure the security of geological formations.

Before starting any permit procedure we want to be sure that we’ve chosen the right underground and that we are able to answer open questions – to ourselves and to the public.
Transposition of the EU directive into German law (slide 14)
Before getting the permit, we need to have a legal framework for the storage and Germany has to transpose the CCS directive into national law.

It might sound commonplace to you, but investments on the scale of a CCS demo plant do need a reliable legal and regulatory framework.

Unfortunately, after the great start at European level, some member states are regrettably lagging behind.

We also face more uncertainties than ever when it comes to the market environment for CCS. Without going too much into the details I think it’s only fair to say that the future of a legally binding global climate regime and carbon markets still lies very much in the dark.

For time’s sake I’ll skip most of what I would have to say about the German CCS law. I would only like to state that we see considerable room for improvement. At least if the German Government is still serious about having a CCS demo plant being built in Germany.

Preconditions for implementing the project (slide 15)
The preconditions to make CCS work are three-fold.

Obviously CCS is still in a demo phase and not yet commercial. Therefore subsides are needed. The NER300 call which was published yesterday gives us some hope in this field.

I just addressed the legal framework.

What we have not discussed yet and what might be the major challenges is the one of public acceptance.

This is a moment to be self-critical. We – as an industry – have far too long addressed CCS primarily from an engineer’s point of view. And from the point of view of an engineer, this is not rocket science. So we were pretty confident that we would be able to deliver. Perhaps we were over-confident. Be-
cause we have severely underestimated the socio-political aspects of CCS and CO₂.

Neither CCS not CO₂ are well-known to the general public. We did extensive social research only to find out that people tend to be rather weak on the knowledge-side but amazingly strong when it comes to having an opinion.

**Public Acceptance – Dialogue and Transparency** (slide 16)

We are now trying to overcome the acceptance problem inter alia via an intensive dialogue and even increased transparency.

Some of our activities like the community information office are listed here.

A very good example for this public outreach is the Regional Advisory Council initiated by the Brandenburg Ministry of Economy. This council encompasses all relevant stakeholders of the region where the exploration is intended to take place. The explicit aim is to include all concerned parties in a dialogue about how to proceed with the exploration and permitting process. Transparency and accountability are the twin core values in this outreach and I can only hope that this appeals to the reason of all concerned parties.

**Conclusion** (slide 17)

The way forward to CCS success is still long. Some of the prerequisites are there, some others have to follow. Political support is crucial in order to reach an investment-friendly framework and also to get public acceptance.

I appreciate your participation this evening. It shows that we are on the right track.
Clean Coal for Europe
Making CCS Work

Dr. Hartmuth Zeiβ
Chairman of the Managing Directors
Vattenfall Europe Mining & Generation
Vattenfall: A European Energy Company

- Europe’s fifth largest generator of electricity and the largest producer of municipal heat
- Net sales 2009: 19.85 billion €
- Operations in Sweden, Finland, Denmark, Germany, Poland, the Netherlands, Belgium and UK
- 7.4 million electricity customers
- 5.6 million network customers
- Business along the entire value chain
- 40,000 employees
- 100% owned by the Swedish state
Various Technologies – One Strategy

Wind Energy

Biomass

CCS

Nuclear

2008

2030

Wind 1%

Hydro 24%

Fossil-based 47%

Nuclear 28%

Coal 20%

Fossil-based with CCS 16%

Gas 4%

Ocean 8%

Nuclear 22%

Bio 6%

Wind 12%

Hydro 12%
• The world will not stop using fossil fuels.

• Coal is the one fossil fuel which combines the greatest potential with the strategic optimum

• CCS is THE key technology for developing a CO\textsubscript{2} lean energy system based on the reality of fossil fuels – especially coal
Developing CCS

Capture
CO₂ Sequestration

Transport
CO₂ Pipeline

Storage
Geological Storage

Target: Parallel development of technology for carbon dioxide capture and storage.
Roadmap for implementing carbon capture

- 2001: Feasibility studies
  - Theoretical studies

- 2004: Test rigs: 0.1 – 0.5 MW_{th}
  - Research
  - Fundamental principles
  - Combustion characteristics

- 2008: Pilot plant: 30 MW_{th}
  - Demonstration of the entire process chain
  - Interplay of components
  - Validation of results gathered with test rigs
  - Investigation of scale-up criteria

- 2015: Demonstration plant: 300 MW_{el}
  - Verification and optimisation of the selected components
  - Risk mitigation
  - Proof of commercial operability (subsidising still required for this step)

- 2020: Commercial-scale PP: 500 - 1000 MW_{el}
  - Economic ally viable and competitive power plant concept
  - No subsidies needed
Roadmap for implementing carbon storage

**Feasibility studies**
- Theoretical studies
- Ongoing R&D injection projects (Sleipner, In Salah)

**Screening**
- Screening
- Research
- Fundamental principles
- Pipeline model computations

**2001**

**2004**
- Altmark project
- Demo: EGR
- Demonstration of the full process chain
- Operating experience with injection
- Research

**2010 / 2011**

**2015**
- East Brandenburg aquifer project
- 1st step: repository exploration
- Qualification of reservoir structures
- Opening-up of the reservoir
- Pipeline construction
- Operation over 15 – 20 yrs

**2020**
- Economically viable transport and storage infrastructure

**Pilot phase**
- EGR / CO₂ injection of 100,000 t

**Demo phase for storage**
- CO₂ injection of >1 m t

**Commercially viable concept**

**Concept**
- Injection of CO₂
The CCS pilot plant: Successful testing of CO₂ capture

Facts and figures:
- Capacity: 30 MW\textsubscript{thermal}
- CO₂ capture rate: > 90%

Results of operation:
- Operating hrs since Sept. 2008: 6,000 hrs
- CO₂ quantity captured: 3,100 t

➢ The CCS pilot plant serves the purpose of testing CO₂ capture according to the Oxyfuel process.
➢ The obtained results of operation meet the expectations regarding CO₂ capture.
➢ Further potential for technical optimisation is available, and is being tested continuously.
CCS-Demonstration Project Jänschwalde

Capture

- **Block G (Oxyfuel)**
  - Capacity gross: 250 MW
  - Capacity net: 167 MW
  - Production: 1.3 TWh
  - Efficiency net: 36%
  - Coal consumption: 1.5 mill. t
  - Emission total: 1.4 mill. t
  - Emission captured: 1.3 mill. t
  - Capture rate: 93%

- **Block F (PCC)**
  - Capacity gross: 534 MW
  - thereof PCC: 50 MW
  - Capacity net: 494 MW
  - Production: 3.5 TWh
  - Efficiency net: 36%
  - Coal consumption: 4.1 mill. t
  - Emission total: 3.9 mill. t
  - Emission captured: 0.4 mill. t
  - Capture rate: 10%
  - Capture rate (treated flue gas): 90%

Transport

- **Birkholz**
  - Distance: 60 km
  - Storage capacity: up to 100 mill. t
  - Storage type: Saline formation

- **Neutrebbin**
  - Distance: 130 km
  - Storage capacity: up to 100 mill. t
  - Storage type: Saline formation

- **Altmark (owned by GDF)**
  - Distance: 300 km
  - Storage capacity: ~450 mill. t
  - Storage type: Gas reservoir

Storage

Three alternative storage locations being explored in parallel.

Two capture technologies as part of demo plant.
Now: **New unit:**
- Oxyfuel 250 MW
- Retrofitting unit F:
  - PCC 50 MW

Previously: **Retrofitting unit F:**
- Oxyfuel 250 MW
- PCC 125 MW
Advancing the concept - Key results of the technical modifications

<table>
<thead>
<tr>
<th></th>
<th>Previous concept</th>
<th>Current concept</th>
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</thead>
<tbody>
<tr>
<td>Efficiency (Oxyfuel)</td>
<td>28 %</td>
<td>36 %</td>
</tr>
<tr>
<td>CO₂ emissions per kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Oxyfuel</td>
<td>145 g/kWh</td>
<td>78 g/kWh</td>
</tr>
<tr>
<td>- PCC (rel. to treated flue gas)</td>
<td>149 g/kWh</td>
<td>107 g/kWh</td>
</tr>
<tr>
<td>Captured CO₂</td>
<td>2.7 Mt/a</td>
<td>1.7 Mt/a</td>
</tr>
</tbody>
</table>

Use of best practice in power plant technology

- highest possible power plant efficiency for a CCS demo plant
- lowest possible CO₂ emissions per kWh: Oxyfuel less than 25% of BAT gas-fired power plant)
Status Birkholz-Beeskow:

- Permits for exploration of the Birkholz-Beeskow and Neutrebbin storage structures have been received.
- Main plan for operations, and special plan for seismic operations, submitted for Birkholz-Beeskow to authority LBGR.
- Main plan for operations currently in the phase of public participation.
Next step: exploring the geological formation

Vattenfall needs to explore the potential storage sites

- to be able to evaluate the suitability of the geological formations;
- to be able to answer open questions on a valid basis;
- as an essential step towards a permit procedure for later CO$_2$ storage.
Transposition of the EU Directive into German law

- The EU CCS Directive must have been transposed into national law by 25 June 2011
- CCS bill presented on 14 July 2010 (joint press conference of the Federal Ministries for the Environment and Economics)
- To be followed by a reconciliation process in the parliament (final decision in Q1 2011)
- Law can be enforced in summer 2011 at the earliest

- CCS Directive is an element of the EU’s “Green package“
- Publication of the “Green package“ in the EU Gazette on 05 June 2009
- **Enforcement of the Directive** after 20 days, i.e. on **25 June 2009**
- **Deadline for transposition** of the Directive into national law: **after two years**
Preconditions for implementing the project

Implementation of the CCS demo project in the German state of Brandenburg

- Subsidies
- Legal Framework
- Public Acceptance
Public Acceptance: Dialogue and Transparency

**DIALOGUE**

- Community information office opened 07 / 2009
- Regular information events on CCS
- Regional contacts programme (regular talks with regional political and media stakeholders)
- Regular talks with regional associations ("regulars' table")
- Regional Advisory Board (initiator State of Brandenburg; sort of "social dialogue")

**TRANSPARENCY**

- Extensive distribution of info materials
- Telephone hotline for community questions
- Regular newsletter on project progress
- Placement of information ads

*We take people’s fears in connection with CO2 storage seriously.*
*We fully rely on open and direct communication with the public.*
Conclusion:

- CCS is one of the technologies with crucial importance for climate protection from a sustainability angle.
- Germany – specifically Brandenburg - and Vattenfall are among the technology leaders, but losing momentum.
- The development of CCS will sustain important industries, and the resulting value creation and employment situation.
- Major prerequisites to its successful rollout are an investment-friendly legal framework and political support.
Thank you for your attention!