Clean Coal for Europe – Making CCS work

Vattenfall: A European Energy Company (slide 2)

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.

Various technologies - one strategy (slide 3)

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.

CCS - a global perspective (slide 4)

Having said that, I have to admit that – with today's knowledge – CCS is practically the only short-tomid-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. <u>Developing CCS</u> (slide 5)

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

Clean Coal for Europe – Making CCS work

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-

Clean Coal for Europe – Making CCS work

cause we have severely underestimated the socio-political aspects of CCS and CO₂.

Neither CCS not CO_2 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 Zeiß 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





2030

Ocean 8%

Hydro 12%

Fossil-based

with CCS 16%

Gas 4%

Wind 12%

CCS – A Global Perspective

- 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 CO₂ lean energy system based on the reality of fossil fuels – especially coal

Others 2.1% **Nuclear** 15.7 % Hydro Fossil 16.1 % fuels 66.1%

global electricity supply - 2008



Developing CCS





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



Roadmap for implementing carbon capture

Commercial-scale PP: 500 - 1000 MW_{el}





Roadmap for implementing carbon storage





The CCS pilot plant: Successful testing of CO₂ capture



- > The CCS pilot plant serves the purpose of testing CO_2 capture according to the Oxyfuel process.
- \succ 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

Са	pture		Transport		Stora	age	
Block G (O	xyfuel)				Bir	kholz	
Capacity gross: Capacity net: Production: Efficiency net:	250 MW 167 MW 1.3 TWh 36%	the			Distance: Storage capacity: Storage type:	60 km up to 100 mill. t Saline formation	
Emission total: Emission captured:	1.4 mill. t 1.3 mill. t		Altmark Brandenburg Neutret	bin	Neutrebbin		
Capture rate: Block F (I	93%		Berlin Sachsen-Anhalt Jänschwalde	kholz	Distance: Storage capacity: Storage type:	130 km up to 100 mill. t Saline formation	
thereof PCC Capacity net:	534 MW 50 MW 494 MW	- mar					
Production:	3.5 TWh	3			Altmark	(owned by GDF)	
Efficiency net: Coal consumption: Emission total: Emission captured: Capture rate: Capture rate (treated flue g	36% 4.1 mill. t 3.9 mill. t 0.4 mill. t 10% gas): 90%				Distance: Storage capacity: Storage type:	300 km ~450 mill. t Gas reservoir	
Two ca as part	pture tecl	nnologie plant	S		Three alterna	ative storage locatic	ons

being explored in parallel





The CCS power plant: Advancing the concept





Advancing the concept - Key results of the technical modifications

	Previous concept	Current concept	
Efficiency (Oxyfuel)	28 %	36 %	
CO ₂ emissions per kWh			
- Oxyfuel	145 g/kWh	78 g/kWh	
- PCC (rel. to treated flue gas)	149 g/kWh	107 g/kWh	
Captured CO ₂	2.7 Mt/a	1.7 Mt/a	

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 of storage reservoir exploration

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 CO₂ storage.





Transposition of the EU Directive into German law

- 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

- 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



Preconditions for implementing the project

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







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.



VATZENFALL

Thank you for your attention!

