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The German energy policy dilemma between nuclear phase out, coal dominance and climate leadership:

A case for CCS?

Salzburg, 15 September 2008

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Overview

Introduction

Dynamics of CCS

Mitigation scenarios

Conclusions

Introduction

- Case study within TIPS Transformation and Innovation in Power Systems Project (2002-2007/8)
- Interdisciplinary approach to understanding innovation dynamics and potential contribution of selected innovations to a sustainable electricity system
- Technological, governance, and behavioural innovations
- Research questions for case study on CCS:
  - Ecological effects
  - Dynamics of the innovation process
  - Potential contribution to future electricity system
  - Conclusions for shaping innovation dynamics

Brief history: major climate and energy policies and measures in Germany

- 1987 German Bundestag „Enquete Commission on Climate Change“
- 1990-2005 official target of reducing CO_2 emissions by 25%
- 1998 Electricity market liberalisation (grid regulator in 2005 only)
- 1999 Ecological tax reform
- 2002 Nuclear phase-out until 2020
- 2005 European Emissions Trading Scheme
- Feed-in payments for „green“ and „energy efficient“ electricity
  - 1990 Feed-in Law with fix remuneration for electricity from renewables, followed by 2000 Renewable Energy Sources Act
  - Cogeneration law 2000/2002: bonus payment for cogen electricity
- Financial support programmes for efficiency and renewables
- Command and control instruments to enhance energy efficiency in households (heating, insulation etc)

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- Tradition of applying a mixture of policies & measures

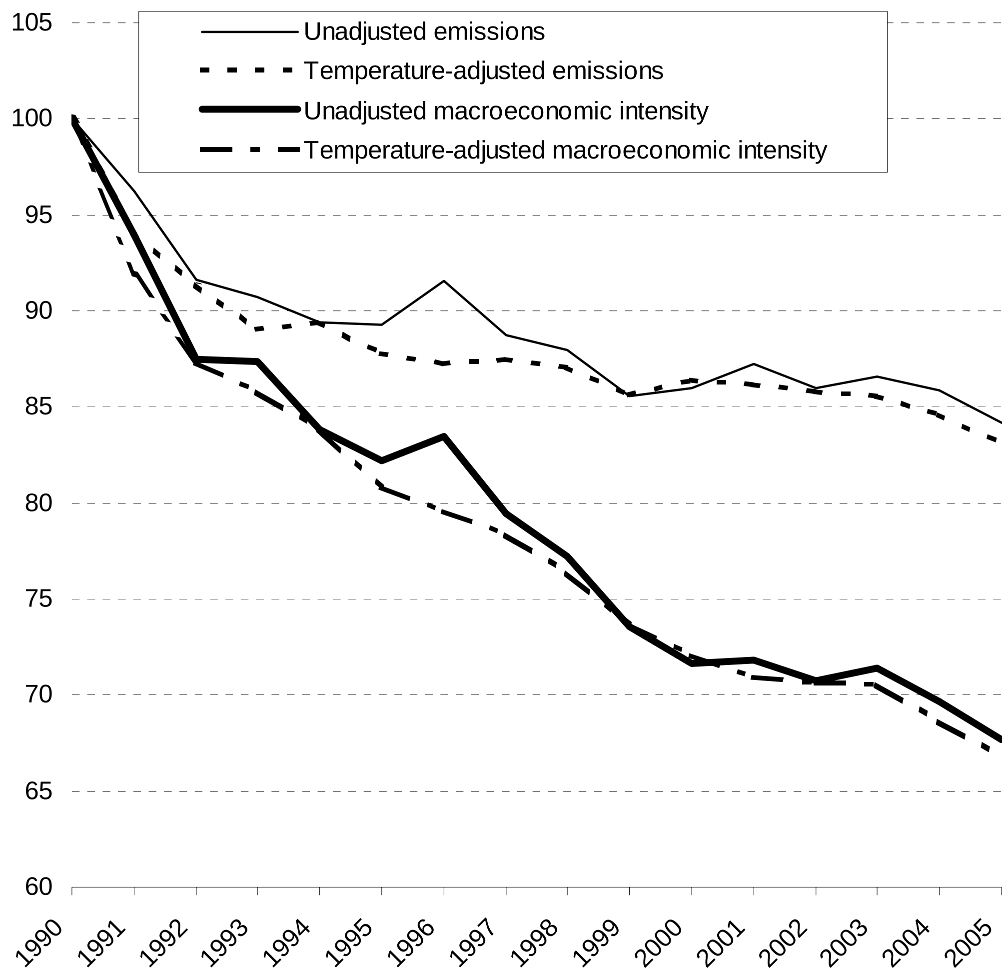
(cont.)

Recent targets and programmes

- EU 20-20-20 package
- CO_2 reduction of -40% between 2005-2020
- CO_2 reduction of -80% until 2050
- Renewables up to 25-30% until 2020
- Energy efficiency up by 20% until 2020 (compared to 2005)
- Cogeneration up to 25% of electricity generation until 2020
- Meseberg „Integrated Energy and Climate Programme“ 2007
  (Parliament passed package 1 in Dec 07 and package 2 in June 08)
- (and still nuclear phase-out until 2020)

CO_2 emissions and CO_2 intensity in GER, 1990-2005

in Germany, 1990 - 2005
1990 = 100



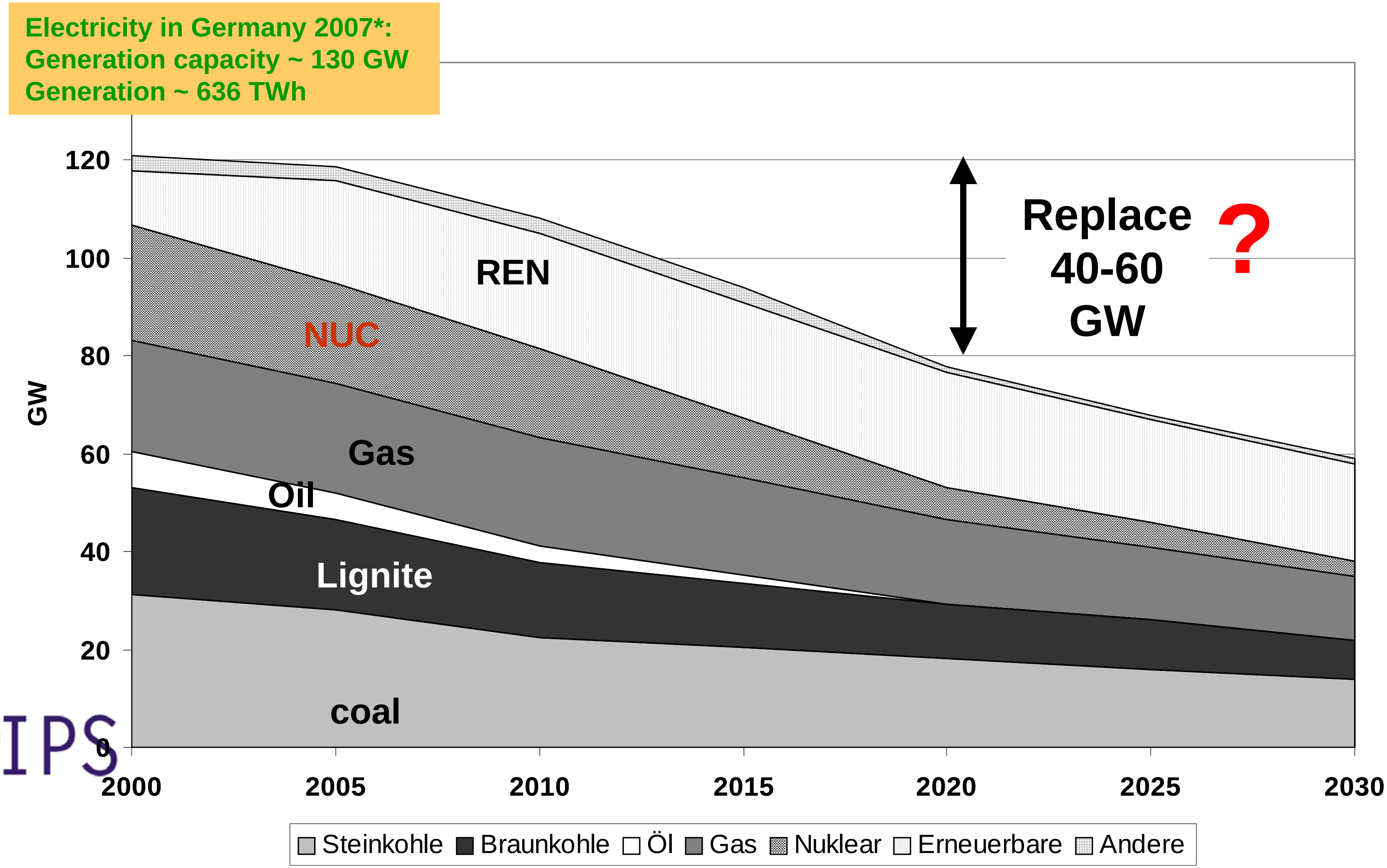
Special factor in GER:

- Reunification in 1990 and subsequent de-industrialization in East Germany

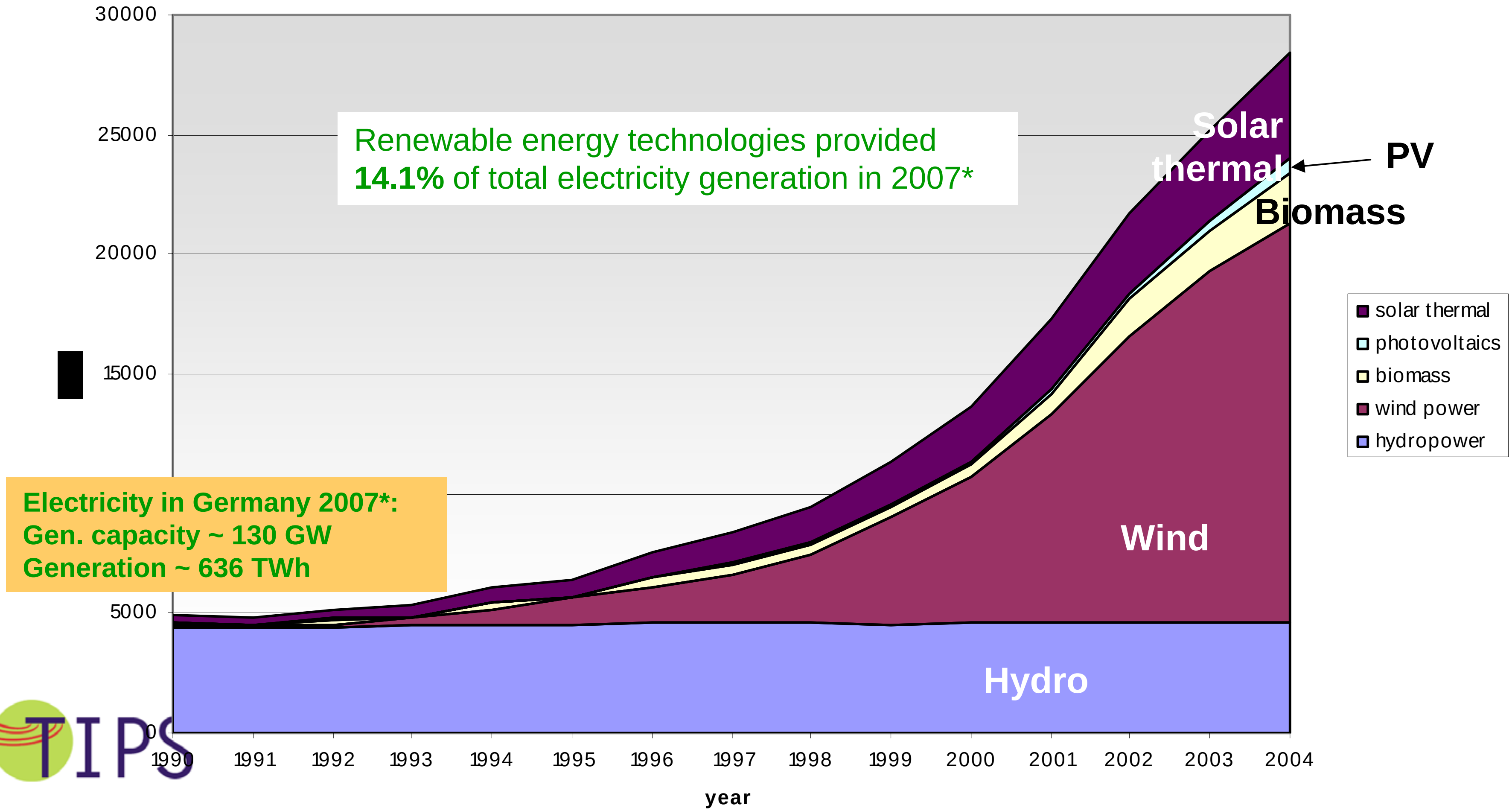
⇐ **absolute** emissions down to ~ 83% of 1990 level

⇐ CO_2 **intensity** down to ~68% of 1990 level

Reinvestment cycle in German electricity

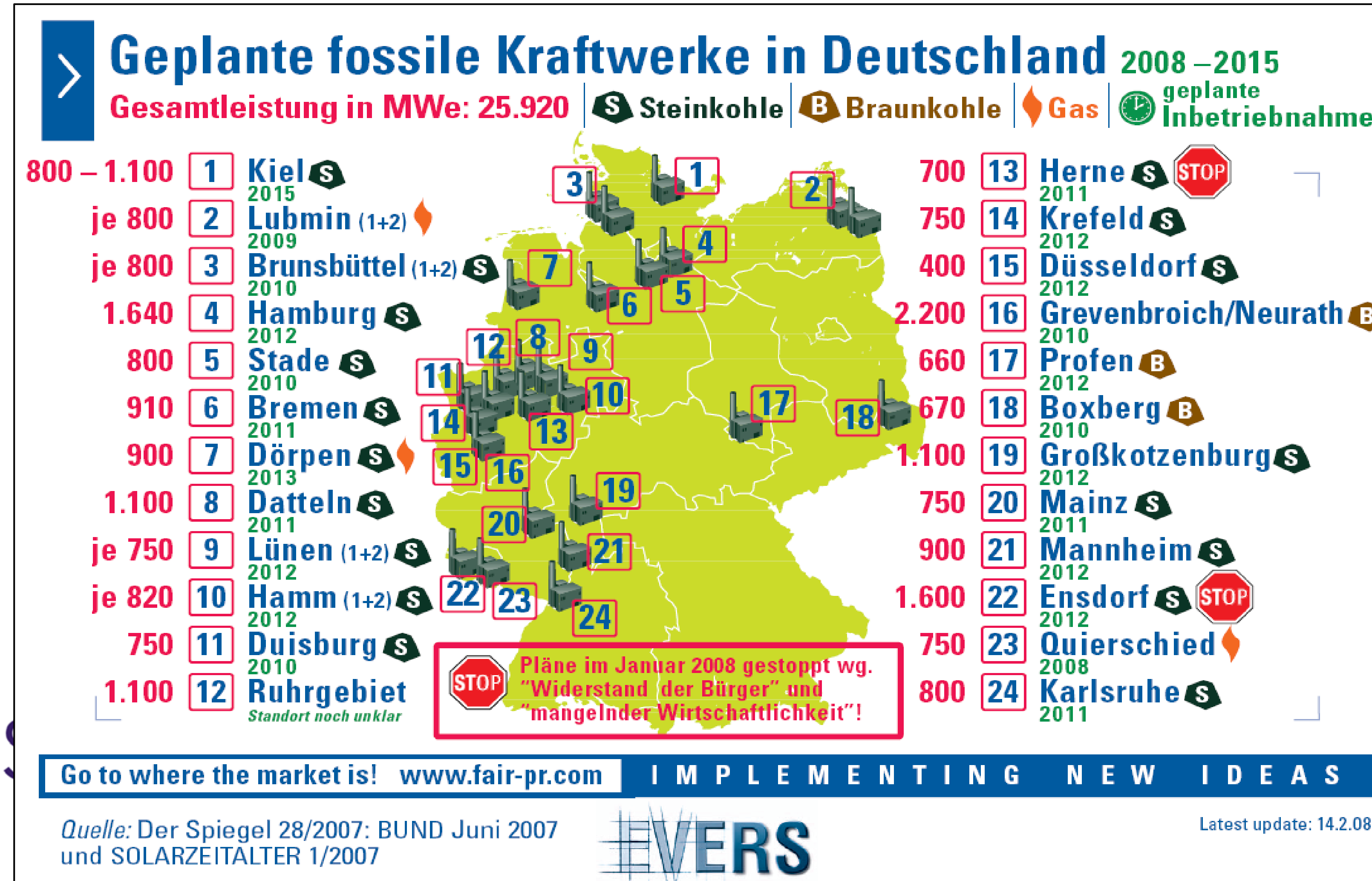


Renewable energy in Germany: Cumulative installed capacity 1990-2004



Source: Statistisches Bundesamt, BMWI, BDEW, AG Energiebilanzen.
2007 preliminary data, partially estimated.

New coal plants and public protests in Germany (from 1/2008)



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Interim summary

- Ambitious German climate targets, price(s) for CO_2
- Major investment challenges in power sector
- Dilemma between nuclear phase out, dominance of coal, reinvestment needs and protests against new “dirty” coal plants
- Renewables with increasing contribution - but enough to fill the gap soon enough?
- Efficiency also contributes to reduction in supply – but enough?

- **Question: What should be the role of CCS?**

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CCS state of the art and potential

Technology

- All options still under development (need for R&D)
- Scenarios: between 5 and 50 % of electricity generation with CCS

Economics, availability & timing

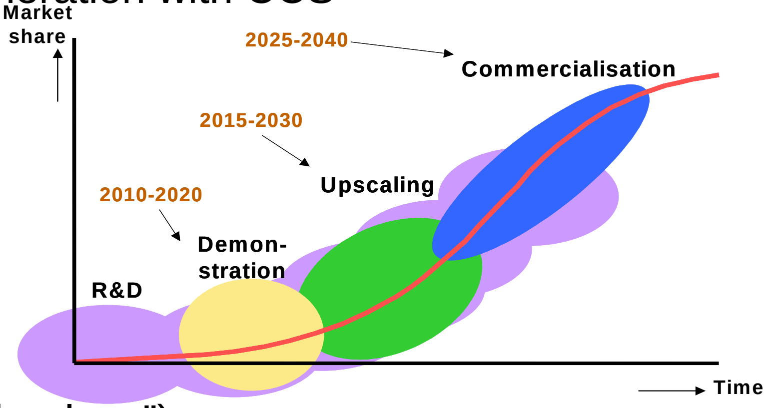
- Economically viable at a CO_2 price of 30 - 50 €/t (renewables too!)
- "Commercially" available not before 2020
- Only for large point emission sources (large power plants)

Storage

- Theoretical capacity of 40-150 yrs ("bridging technology")
- Many open geological issues (acid, leakage)

Leakage and the energy penalty

- Leakage from storage sites possible (slow vs. sudden release)
- Conversion efficiency decreases significantly (8-12 %-points)
  ➔ increase in resource depletion



Source: De Coninck and Groenenberg 2007

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Almost no CCS yet but many R&D activities

carbon sequestration leadership forum

CO_2 GeoNet

ZEP

COORETEC
Effizienz
Emission
CO_2 Reduktionstechnolo

CO_2SINK

CO_2 net

encapco_2

CASTOR
European ... logical storage of CO_2

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Accsept

RWE

GEOTECHNOLOGIEN · Forschung für die Zukunft

COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 23.1.2008
COM(2008) XXX

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006

(Text with EEA relevance)

{COM(2008) X final}
{SEC(2008) X}
{SEC(2008) X}

CCS activities

Name	Type and time of activity	Description, actors involved
International level		
CSLF	International forum, since 2003	Interministerial platform to foster the deployment of CCS
EU level		
CO_2STORE	Research project, 2003-2006	Storage of CO_2 in aquifers. 19 industry & research partners. EU FP5.
CO_2NET	Knowledge Transfer Network; resource and technical portal, 2002-2005; follow-up activities	To develop CCS as a “safe, technically feasible, socially acceptable option”. Network of 65 stakeholders from 18 countries. Initially under EU FP5, now self-funded by members.
CASTOR	Strategic project, 2004-2008	Focus on post combustion (65% of budget) and storage (25%). 30 industry & research organizations from 11 countries. EU FP6.
ENCAP	Research consortium, 2004-2009	Technology development. 6 large fossil fuel users, 11 technology providers, 16 R&T institutions. EU FP6.
Co2GeoNet	Research network of excellence, 2004-2009	Research & training/ dissemination network on storage-related issues. 13 scientific institutes. EU FP6.
ZEP	Technology Platform, since 2005	Strategic research agenda for low-emission power plants, involving industry, NGO, scientists, EU, etc. Funded by EU and industry.
ACCSEPT	Research consortium, 2006-2007	Assessment of acceptability. Research institutes & consultants. EU FP6.
CO_2SINK	Pilot plant research consortium, 2004-2009	In-situ R&D Laboratory for Geological Storage in Ketzin (GER). Industry & research institutes. EU FP 6.
National level (Germany)		
GEOTECHNO-LOGIEN	Special research program, since 2000	Projects on CO_2 storage. 62 research institutes, 38 industry partners. Funding by BMBF, BGR and DFG.
COORETEC	Research consortium, 2003-today	Economics ministry, research, industry
Oxyfuel	Pilot plant	Vattenfall, 30 MW, launch in 2008
IGCC+CCS	Demonstration plant	RWE, 450 MW, in 2014

CCS status and constellations in GER

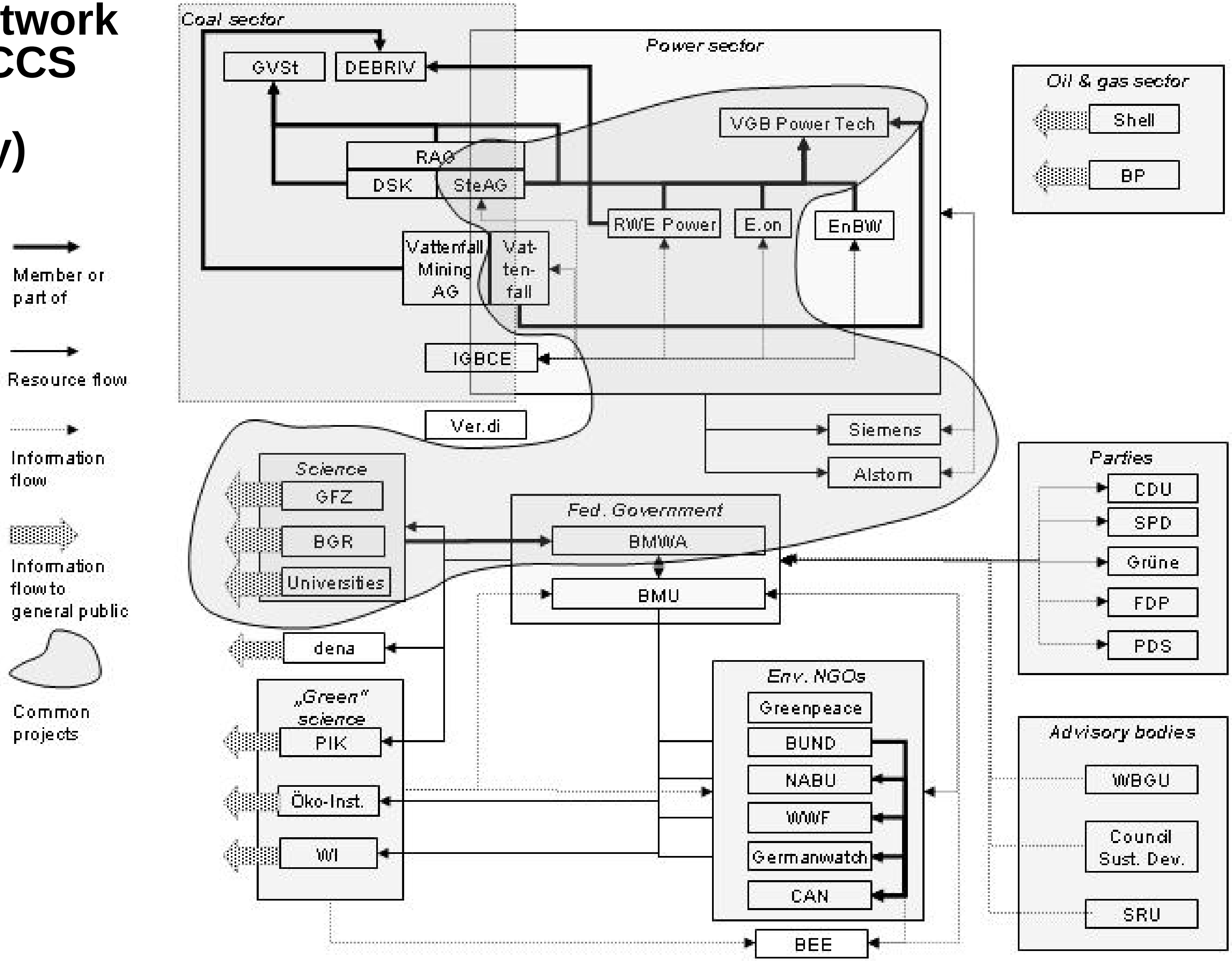
2008: Agenda setting phase almost done, policy & institutional framework in work

- German Government to support R&D (Integrated Energy & Climate Programme, Meseberg 2007)
- EU draft directive (January 2008)
- Increasing political debate about CCS framework and support
- Little public knowledge, mostly via media as multipliers
- Vattenfall oxyfuel pilot plant started to run in September 2008

Two relevant network structures can be identified

1. Drivers: Electricity industry, power plant industry, oil and gas industry, mostly technology-oriented researchers, the Minister for the Economy (BMWI), Ministry for Research (BMBF)
2. Critics: Some environmental NGOs (some less), Ministry for the Environment (BMU), renewable energy lobby, parts of scientific community

Actor network around CCS (in 2005, Germany)



Source: Fischer, Praetorius 2008

Dynamics of the CCS innovation process

- Increasing number of activities and of funding on EU and GER levels
- Government commitment to 2-3 national pilot plants
- Dynamics mostly led by research, some support by ESI and minerals/gas industry, and by industry ministries
- Never fierce opposition, but no enthousiastic drivers either, yet powerful protagonists
- CCS creates ambivalence and uncertainties which partly cause traditional coalitions to loosen
- Risks and uncertainty issues unsolved, creating financial flows towards research institutes, but not so much in industry yet Ongoing international process creating legal framework

➔ Increasing levels of legitimation & knowledge development & resource mobilisation & expectations

➔ Yet little public knowledge / acceptance to date

➔ Innovation process is creating momentum of its own

Reasons for dynamics and related risks

- CCS implies structural decision
  - Continues centralized system w/ large plants (carbon lock-in)
  - Limited compatibility with smaller-scale supply structures
  - CCS distracts money and attention from efficiency, renewables & distributed power
- CCS is incremental innovation - promises mitigation without change of electricity system structures

But

- Speculative technology with high degree of uncertainty
  - Technological and economic availability?
  - Risks and legal issues?
  - Future carbon price and costs?

➔ **Risk of overstating its mitigation potential by politicians**
➔ **Parallels to fuel cells and hybrid car hypes**

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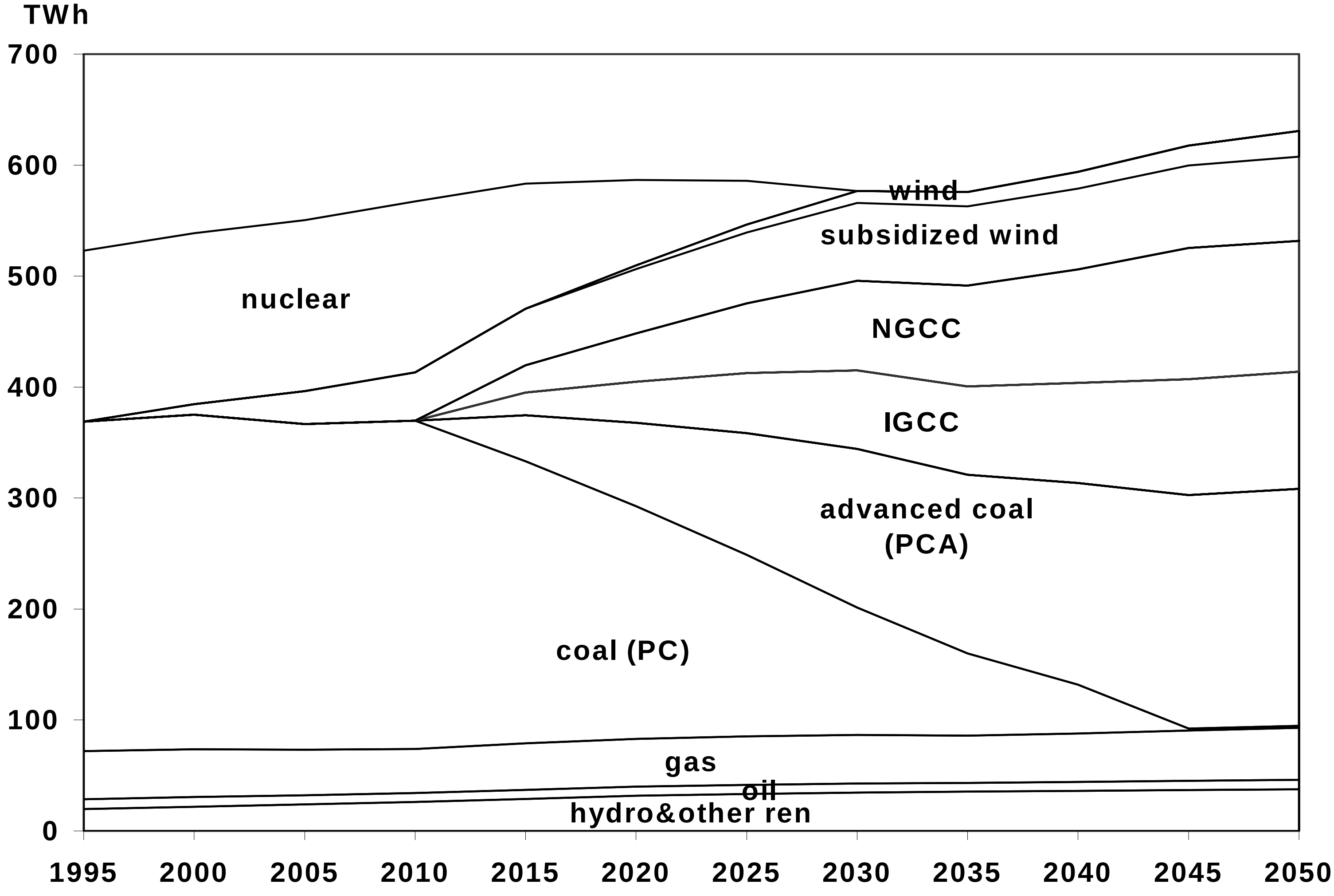
Overview

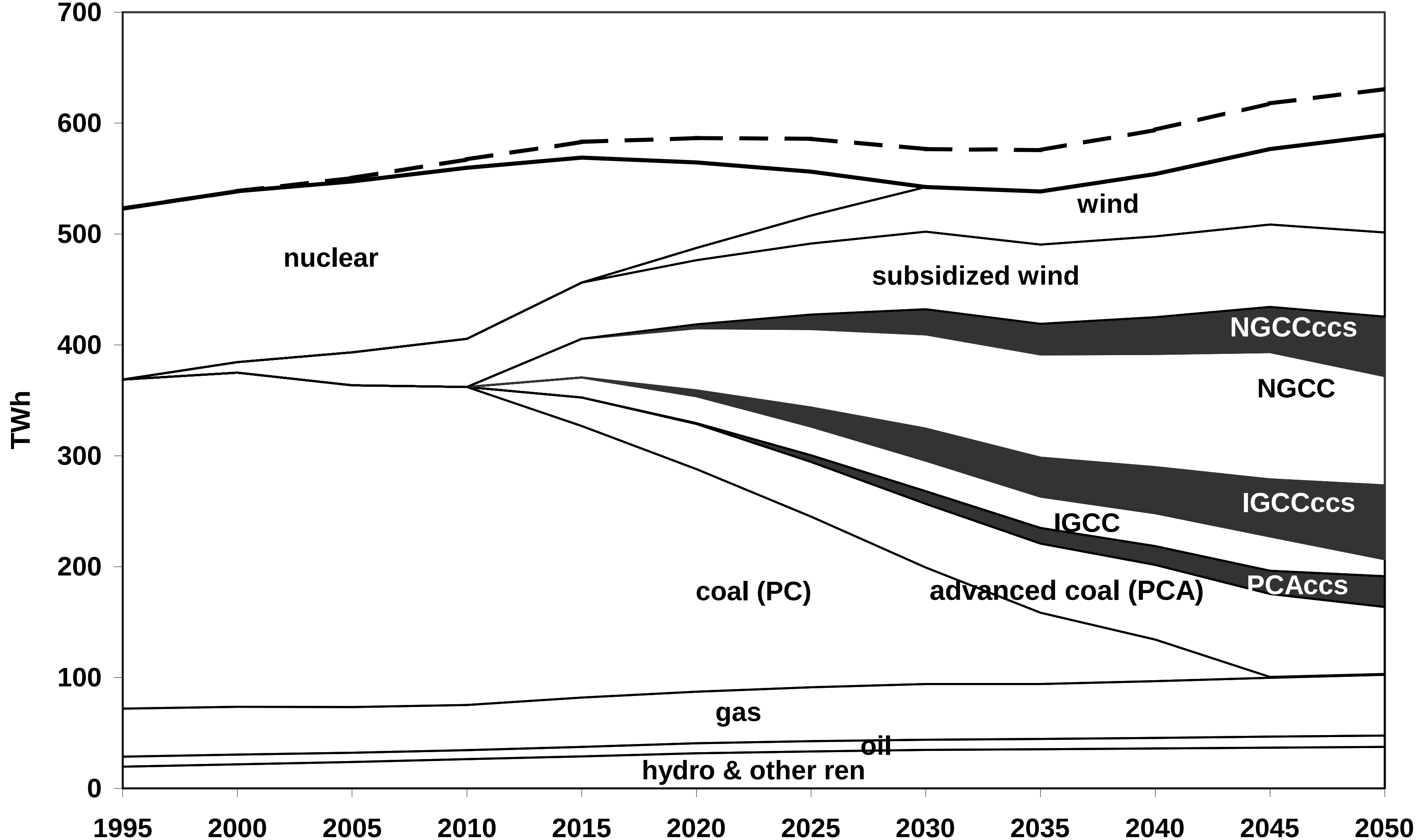
Potential impact on future electricity system: Mitigation scenarios

- Wide range of cost estimates for CCS
- Studies including CCS as a mitigation option conclude:
  - Lower economic costs when CCS is included
  - High uncertainties on costs
  - Time of commercial availability matters
- Most studies are of bottom-up type and include detailed technology information
- They lack interaction with rest of economy, take energy demand and macroeconomic development as given
- Macroeconomic (top-down) models lack technology detail
- Attempt to combine features from both models

Electricity sector baseline

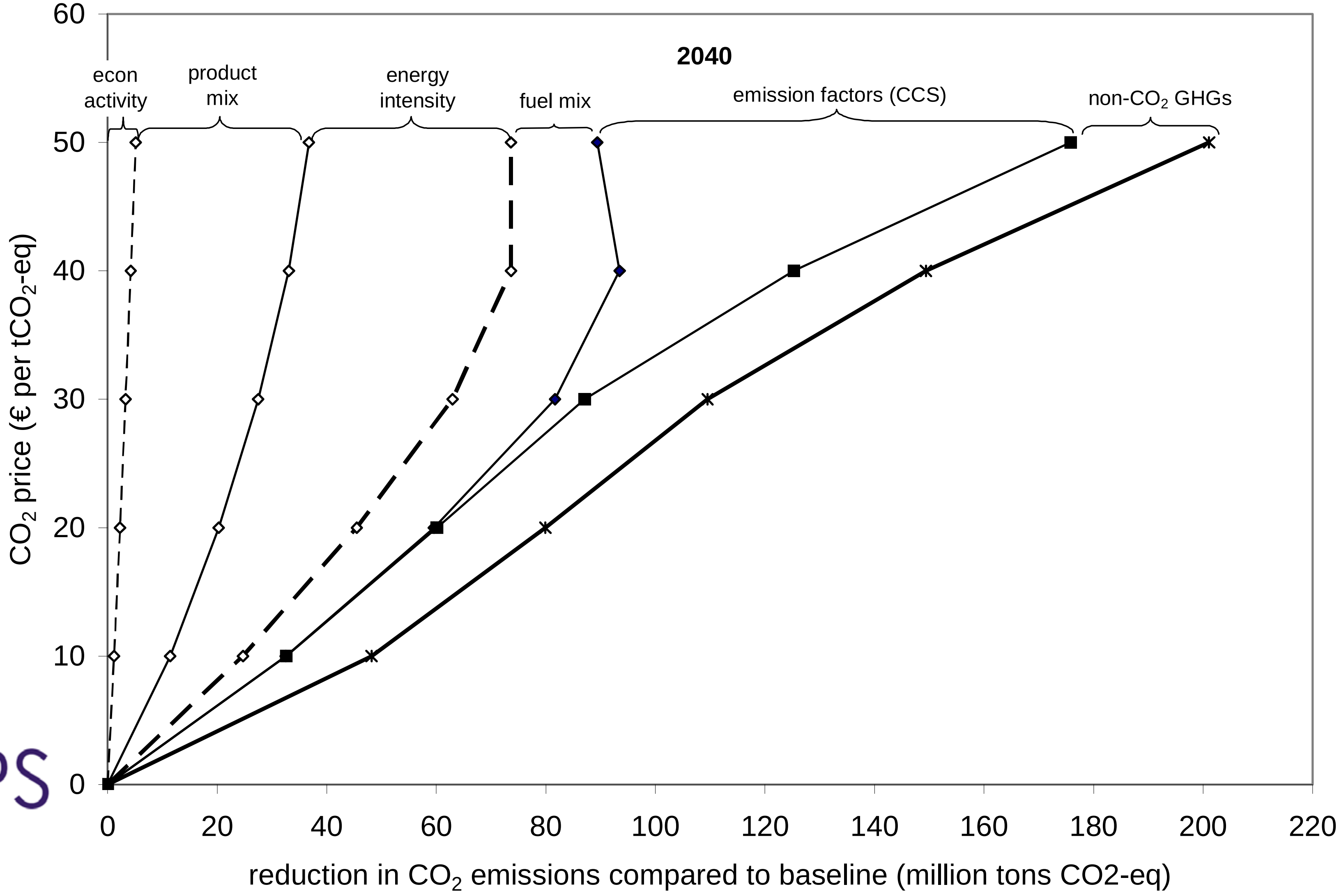


Electricity sector policy case



Stepwise policy €/tCO_2:	10	20	30	40	50	50	50	50	50	50

Simulated emissions reductions, Germany 2040



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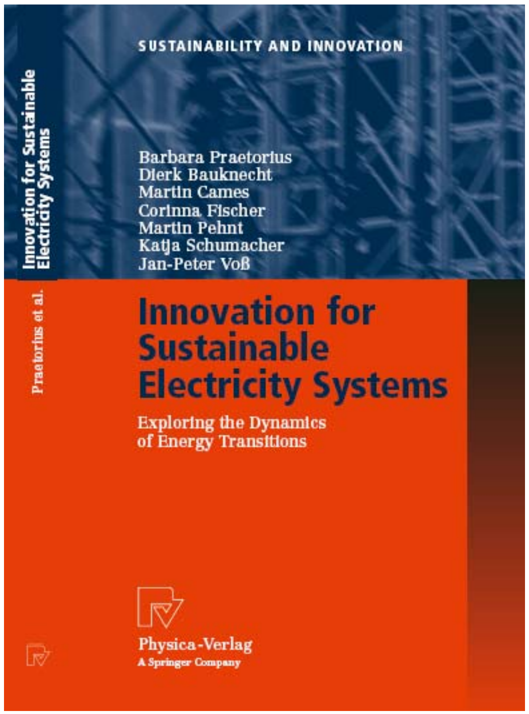
- ➔ It is likely that CCS will come (but timing unclear)
- ➔ CCS in GER important in relation to coal and nuclear power
- ➔ Capture ready is important for new coal plants to be politically acceptable
- ➔ Public awareness is low and acceptance unknown yet
- ➔ Given the many uncertainties, CCS may serve as one of many bridging technologies (a given mitigation target can be achieved a lower marginal costs when CCS is included)
- ➔ Stringent and reliable CO_2 policy framework is important
- ➔ Germany is likely to follow its strategy of a broad mix of measures for successful CO_2 mitigation (CCS + renewables + energy efficiency + other complementary efforts)
- ➔ ALL technology research efforts must be intensified (Climate "Apollo" Programme) to combat climate change!
- ➔ Timing and technology matter: CCS may only play a limited role in Germany, but may well play an important role worldwide (China etc)

Related publications on CCS and beyond



New book!

Praetorius, B et al. (2009), Innovation for Sustainable Electricity Systems. Exploring the Dynamics of Energy Transitions. Berlin, Heidelberg: Physica/Springer

Fischer, C; Praetorius, B (2008): Carbon Capture and Storage: Settling the German Coal vs. Climate Dispute? In: IJETM International Journal of Environmental Technology and Management, Special Issue on Energy Innovation, Vol. 9, Nos. 2/3, 2008, 176-203

Praetorius, B (forthcoming in 2009): The dilemma of German electricity politics and the potential future role of CCS. In: Meadowcroft J. (ed): The Politics of Carbon Capture and Storage. Edward Elgar. In preparation.

Praetorius, B; Schumacher, K (submitted): Greenhouse Gas Mitigation in a Carbon Constrained World: The Role of Carbon Capture and Storage. Submitted to Energy Policy, August 2008

Praetorius, B (submitted): On the dynamics of sustainable electricity innovations. Submitted to GAIA, July 2008

Thank you for your attention

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