Emissions trading and innovation in the German electricity industry

Berliner Energietage 2008
Emissionshandel für Treibhausgase: Rückblick und Ausblick

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Motivation

- The pace of technological advance has been described as “the single most important criterion on which to judge environmental policies” (Kneese/Schulz 1978)

- [Image: EU Emissions Trading]
Design of the investigation

• Aim: determine innovation effects of emissions trading in the German electricity industry

• Approach: panel analysis
  Survey 1: 2004 before the start of the EU ETS
  Survey 2: 2007 after 2.5 years of experience
  Identify differences induced by emissions trading

• Representative sample: 20 companies

• Addressed issues
  (Innovation Strategies)
  (Institutional innovations)
  Changes in operation
  Investment strategies
  Design options
Finding – changes in operation

- 60% of the companies reported changes in their merit order
  - Increased co-firing of biomass and substitute fuels
  - Shift from coal to gas (temporarily)
  - Hard coal plants were shut down on weekends, more starts per year than before 2005
  - Shifts from lignite to hard coal
  - Shifts from older to newer plants
- Shifts were reversed after prices dropped to zero
- Focus on efficiency rather than availability
- 40% did experience no changes in their merit order
  - Must run installations (cogeneration)
  - Only plants with similar technologies & fuels
  - Just one power plant
- Expected allowances prices
  - 2005-2007: € 11 to € 15/EUA (real: € 12 to € 13/EUA)
  - 2010: € 20 to € 25/EUA (2008 futures: € 20/EUA)
  - 2020: € 21 to € 30/EUA, 2050: € 28 to € 40/EUA
Findings – investment strategies (1)

- CO₂ price is the third most sensitive factor of investment decisions (after the fuel and electricity prices)
- Discussion on power plant investment has considerably intensified since 2004, new generation capacities up to 40 GW are in the pipeline, some are already under construction
- Convoy type of construction: two or three similar plants at different sites
- International utilities: locate coal power plants in Germany because it is considered as specifically coal friendly
- Current investment cycle
  - Intensified through the introduction of emissions trading
  - In Germany as well through the 14 year rule
  - Investment cost for coal power plants have soared from € 820 per kW in 2004 to € 1,500 per kW in 2007
Findings – investment strategies (2)

- Efficiency improvements in 80% of the companies, several triggered by emissions trading
  - installing more efficient frequency-controlled feed pumps
  - replacement of bladings
  - expansion of co-firing capacities
  - shortening of revision cycles (rather efficiency than availability)
  - Malus rule caused investments of € 70 million to raise the efficiency of 6 coal power plants to 36%
- Improved competitive positions of technologies
  - Renewables: biomass, wind
  - CCS (particularly larger companies)
- Project based mechanisms
  - Efforts of large companies substantially increased
  - Large budgets assigned
  - Additional departments with up to 20 staff
  - Focus: acquisition of low-cost credits (possibly development of projects)
Findings – design options (company perspective)

- Options most important to own company
  - Initial allocation: 21%
  - Overall cap: 20%
  - Consideration of CHP: 15%
  - New entrants: 14%
  - Base year, early action ↓
  - Transfer rule ↓

- Options which would trigger innovation in own company
  - Overall cap
  - Initial allocation
  - New entrants

- Share of companies reduced which believe that emissions trading would not trigger innovation in their company
Findings – design options (industry perspective)

• Innovation promoting design from an industry perspective
  – Cap: the more stringent, the more innovation
  – Auctioning: the higher the share, the more innovation
  – Allocation to incumbents: fuel rather than uniform benchmarking
  – Allocation to new entrants: fuel rather than uniform benchmarking
  – Treatment of closures: return allowances immediately
  – Duration of trading periods: 15 years
  – Specific rules: only CHP

• Options most important for innovation from an industry perspective
  – Cap 19%
  – Allocation to new entrants 18%
  – Reliable, international climate regime 14%
  – Duration of trading periods 14%
  – Share of auctioning 13%

• Transfer rule overestimated
Allowance prices and trading volume

Sources: ECX 2007
Change in fuel consumption compared to the base period

Sources: BMWi 2007, BMWi 2008, own estimates
Change in fuel consumption compared to previous year

Sources: BMWi 2007, BMWi 2008, own estimates
Development of energy and carbon prices

Sources: Point Carbon, EEX, Enernate/Spectron Deloitte & Touche, own calculations
Incentives for fuel switch from coal to gas

Sources: own illustration
Equilibrium CO₂ price which would trigger a switch from 40% coal to 48% gas

Equilibrium CO₂ price which would trigger a switch from 33% coal to 55% gas

CO₂ price (EEX)

Sources: Point Carbon, EEX, Energate/Spectron Deloitte & Touche, own calculations
Planned emissions by planned capacities

Sources: bdew, BNA, BUND, PLATTS, personal communications, compilation by Öko-Institut
Emissions in large coal power plants

Sources: EPER, CITL, own calculations

Sum
-7.9
-7.3

Years of commissioning
-10 -8 -6 -4 -2 -0 2 4
Mt CO₂ vs 2004

1957-1970
1968-1979
1972-1976
1976-1989
1999
1979-1980, 2000
1982 & 1985
1963-1974, 2002
1997 and 1998
2005
2006

Sources: EPER, CITL, own calculations
## Modeled impact of emissions trading 2006

### Changes in Fuel Consumption and Generation

<table>
<thead>
<tr>
<th>Type</th>
<th>TWh</th>
<th>Generation</th>
<th>CO2 Emissions</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Lignite</td>
<td>-18.8</td>
<td>-3.5</td>
<td></td>
<td></td>
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<tr>
<td>Hard coal</td>
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<td>-6.1</td>
<td>0.6</td>
<td>-7.4</td>
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<tr>
<td>Natural gas</td>
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<td>0.5</td>
<td>0.3</td>
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<tr>
<td>Biomass</td>
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</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>-4.5</td>
</tr>
</tbody>
</table>

**Sources:** arrhenius Institut, own calculations
Conclusions (1)

• Dimensions of emissions trading’s impacts on innovation
  – Before the start mainly soft institutional innovations which did not require large investments
  – Hard innovations which involved larger investments were postponed (2 to 4 years)
• Introduction of emissions trading: fostered soft institutional innovations but rather contributed to a delay of hard technical innovation
• CO₂ market works as intended but does – thanks to over-allocation – not yet generate the incentives to trigger substantial investments/innovation
• 14 year rule has contributed to a spike in the investment cycle
• Emissions trading has already induced efficiency improvements, particularly the malus rule
• Germany is considered as a coal friendly country by some internationally operating utilities
Conclusions (2)

- CCS would not yet have received this attention without emissions trading
- Renewables gained in competitiveness
- Efforts for project based mechanisms were increased only recently, mainly by large utilities
- Design options most sensitive for innovation
  - Overall cap
  - allocation to new entrants
  - long-term international climate regime
- Importance of transfer rule was overestimated

- Emissions trading started already to induced innovation but design could be adapted to increase innovation incentives
Thanks for your attention!

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