IEA/NEA JOINT WORKSHOP ON "POWER GENERATION INVESTMENT IN LIBERALIZED ELECTRICITY MARKETS"

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Investment in Coal-Fired Power Generation

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- Significance and characteristics of coal-fired generation in Europe
- Changed boundary conditions of coal-fired generation
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- Consequences of the changed boundary conditions on investment in coal-fired power plants
- Conclusions
Coal's role in the long-term power generation energy mix

Coal will go on being a crucial pillar of power generation in the long term.
Age structure and demand for new plants

Substantial replacement investment in coal-fired generation is required to avoid capacity shortages.
Liberalization of energy markets
- Revenue erosion suffered by power plants (in Germany: up to 40 %)
- Higher demands on flexibility of power plants
- Replacement/new construction of power plants hardly feasible under economic efficiency aspects

Stricter environmental standards and regulations
- Insufficient European harmonization of environmental standards
- One-sided CO₂ penalty through emissions trading

State interference and support programs in favour of non-coal technologies and generation capacities
- Further increase in cost pressure and flexibility requirements of conventional power plants

Serious deterioration in boundary conditions of coal-fired generation through full liberalization on the one hand and state control at the expense of coal on the other
Emissions

- Comprehensive flue gas cleanup is standard today in coal-fired generation.

- Existing power plants across Europe upgraded by retrofits. Example: Emission reduction through retrofit of the Rhenish lignite mining area's 10,000 MW power plant portfolio (1983 - 92).

Highly efficient flue gas cleanup guarantees minimum emission levels of coal-fired power plants.
Efficiency

- Breakthrough in efficiency increase during the 90s thanks to supercritical power plant technology; efficiency of new plants:
  - 70s/80s: 36 - 38%
  - since 90s: 43 - 48%

- CO₂ reduction through replacement of all power plants that are older than 20 years by state-of-the-art plants: CO₂ emissions of European power plants in bn t/a:
  - Plants > 20 years: η = 31%
  - Plants < 20 years: η = 36%

Already today, modern coal technology opens up the largest global CO₂ reduction potential
Focuses of further development

Efficiency
- Target: efficiency > 50% by 2015/20
  - New materials / 700 °C power plant
  - Lignite pre-drying

Competitiveness
- Cut in investment costs (standardization, capacity increase)
- Increase in availability

Flexibility
- Increase in controllability and application range

Ambitious development targets of coal-fired generation contribute to environmentally compatible and low-cost power supply
RWE Rheinbraun:

“Lignite-fired power generation capacity of 10,000 MW at 4 locations, producing some 70 TWh/a of base-load power

Integrated operation of opencast mines and mine-mouth power plants

Entire value chain, i.e. from mine to terminal, under one roof

Comprehensive retrofit measures
  – 80s: flue gas cleanup
  – 90s: turbine upgrade

Agreement with the state of North-Rhine/Westphalia: Successive replacement of old plants until 2030 by eco-friendly and climate-sparing state-of-the-art power plants

In 2002, the first 1,000 MW BoA*) unit of the Niederaussem power plant went on stream
  – global frontier technology in coal-fired power plant engineering
  – net efficiency of more than 43 %

*) BoA = lignite-fired power plant with optimized plant engineering
Successive renewal of the 10,000 MW power plant portfolio

Substantially aggravated boundary conditions for BoA 2 already
Program can only be implemented if long-term planning and investment certainty is given
Serious deterioration in investment conditions, Comparison: BoA 1 and BoA 2

<table>
<thead>
<tr>
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<th>BoA 1</th>
<th>BoA 2</th>
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<tbody>
<tr>
<td>Project start</td>
<td>1995</td>
<td>2002</td>
</tr>
<tr>
<td>Electricity prices</td>
<td>€ct ≈ 4.0 /kWh</td>
<td>€ct 2.3 /kWh</td>
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<tr>
<td>CO₂ penalty</td>
<td>-</td>
<td>EU Directive</td>
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<tr>
<td>Environmental regulations</td>
<td></td>
<td>Stricter environmental and emission regulations EU Large Combustion Plant Directives EU Waste Incineration Directives</td>
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The pressure of liberalization is incompatible with the non-uniform and unpredictable regulations in the fields of environment and climate.
Consequences of Changed Boundary Conditions (2)

Significantly increased risks in the liberalized market

Full costs were passed on to the customers via prices
⇒ very limited investment risks

⇒ Wide range of investment risks
  - Electricity price development risks
  - Fuel price development risks
  - Environmental legislation risks
  - CO₂ penalty risks

For coal, the situation is aggravated by
  - Long financing periods
  - High capital expenditure

New instruments required for risk management
New instruments for risk analysis and risk evaluation of investment at RWE Rheinbraun

- Power generation market model
  used to calculate developments in wholesale prices by simulation of the European producer market as a pool market.

Basis:
- Range of products including all power plants and options for new plants in Europe with their costs (capital, operation, fuel)
- Demand curve as identified by separate forecast
- Fuel prices as identified by separate forecast

Result:
- Wholesale prices resulting from a capacity-driven determination of the intersections of supply and demand (hourly)
- Utilization ratio of the various power plants
- Shutdown and construction of new plants (The power plant with the highest ROI is built.)
New instruments for risk analysis and risk evaluation of investment at RWE Rheinbraun (2)

- Corporate planning
  Planning calculations performed for the company covering a period of up to 50 years (corresponding to the life of the mines and power plants) in the form of external accounting, i.e. including
  - income statement
  - balance sheet
  - cash flow statement
  and including/excluding the new investment project.

- Risk management
  Permanent process covering all risk factors that are relevant to lignite production and power generation in the form of continuous monitoring and evaluation of the defined risks
Conclusions:

- Support necessary a power plant renewal in order to prevent capacity shortages
  - Investment leeway restricted by liberalization must not be further reduced by additional state control
  - Political boundary conditions must be created to ensure long-term planning and investment certainty

- Give CO₂ reduction a sustainable shape through balanced targets geared to market conditions
  - Efficiency increase is the best route towards CO₂ reduction
  - New technology for old power plants brings max. reduction, not the latest and highest-cost frontier technology
  - Innovative technologies need financial support
  - One-sided CO₂ penalty favours gas and nuclear energy but does not solve the problem of energy supply

- Ensure fair competition through uniform European environmental standards and regulations
  - Power is freely transportable; therefore, uniform environmental boundary conditions are especially important to avoid misallocation