Clean coal technologies - strengthening coal's contribution to sustainability

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STEAG – Expertise and Fields of Services

Fossils
- Coal
- Gas
- Heavy Oils/Resid.

Renewables
- Bioenergy
- Solar
- Wind
- „Green Island“
- Combined Plants
- Storage

Systems
- Fossils
- Renewables
- Systems
CO₂-Emissions of Different Power Technologies

Condensation (without CHP)

Specific CO₂ Emissions (tCO₂/MWheq)

- Lignite condensation ($\eta = 43\%$)
- Hard coal condensation ($\eta = 46\%$)
- Open gas turbine ($\eta = 39\%$)
- CCGT ($\eta = 59\%$)
- Hard coal CHP (degree of utilisation 78%)

With Combined Heat and Power
Greenhouse gas Abatement Cost Curve 2030 - Germany

Abatement cost 2030
USD 2010 real/tCO2e

Abatement potential 2030
MtCO2e

HDV: Heavy Duty Vehicles
Main Parameters of Walsum 10

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical power output</td>
<td>$790 \text{ MW}<em>{\text{gross}} \rightarrow 725 \text{ MW}</em>{\text{net}}$</td>
</tr>
<tr>
<td>Net efficiency</td>
<td>46 %</td>
</tr>
<tr>
<td>Fuel</td>
<td>Imported hard coals</td>
</tr>
<tr>
<td>Steam parameters</td>
<td></td>
</tr>
<tr>
<td>Live steam:</td>
<td>605 °C, 280 bar</td>
</tr>
<tr>
<td>Reheated steam:</td>
<td>620 °C, 62 bar</td>
</tr>
<tr>
<td>Start of construction</td>
<td>2006</td>
</tr>
<tr>
<td>COD</td>
<td>2013</td>
</tr>
</tbody>
</table>
Highest Efficiency

- Higher steam temperature: 535 °C → 605 °C
- Higher steam pressure: 190 bar → 280 bar
- Lower steam pressure at turbine outlet: 0.07 bar → 0.04 bar

Walsum 10 requires 20% less coal.
Load Change gradients

max. gradients for load changes in MW

- ±63 Nuclear Plant
- ±43 Hard coal (COD 2013, load range 40%-90%)
- ±35 Combined Cycle Plant (new)
- ±30 Lignite fired Plant (new)
- ±26 Hard coal fired Plant (new)
- ±10 Hard coal (COD 1989, 500 MW)
- ±8 Hard coal fired Plant (old)
- ±5 Lignite fired Plant (old)
- ±5 Hard coal (COD 1970, 350 MW, liquid ash)

Source: VDI Statusreport 2013, December 2013, with own additions
Fields for Retrofit Projects

Water Steam Cycle:
- Turbine / Condenser
- Preheating Train
- Feed Water Pumps

Steam Generator:
- Exchange of Heat Surfaces
- Fireing System
- Mills / Classifier
- Fuel Drying Systems

Others:
- Cooling Tower
- Dynamic of Operation
- Frequency Control

FGD:
- S-Removal
- Pressure Drop
- Demister

ESP:
- Dust Removal
- Pressure Drop
### Realisation of Steam Turbine Retrofits at STEAG

<table>
<thead>
<tr>
<th>Unit</th>
<th>Herne 3</th>
<th>Lünen 150 MW</th>
<th>Lünen 350 MW</th>
<th>West 1+2</th>
<th>Weiher 3</th>
<th>Bergkamen</th>
<th>Bexbach</th>
</tr>
</thead>
</table>

#### - Measures on turbine
- HP / IP
- HP
- HP / IP
- HP
- LP
- HP / LP
- LP

#### - Additional measures
- steam cond. (540 / 535 °C)
- HP heaters
- steam cond. (530 / 540 °C)
- boiler-modification
- Feed water pumps

#### - Blading
  - before retrofit
  - Reaction (R)
  - Impulse (I)
  - W1:R / W2:I
  - Reaction (R)

  - after retrofit
  - Reaction (R)
  - Reaction (R)
  - Reaction (R)
  - Reaction (R)

#### - Realisation of retrofit
- 2007
- 2007
- 1998
- 2006/2007
- 2006
- 2008
- 2010

#### - Manufacturer
- Siemens
- Alstom
- Alstom
- Alstom
- Alstom
- Siemens
- Alstom

#### - Load increase (at 100 % load)
- MW
- 7
- 7
- 15
- 8 (each)
- 17
- 30
- 7.2
Minimum load of STEAG Power Plants

Change in net load in „Kondbetrieb“

Completion of "target"

- Target of 110 MW achieved
- Target of 16 MW achieved
- Target of 15 MW achieved
- Target of 35 MW achieved
- Target of 15 MW achieved
- Target of 90 MW achieved
- 70 MW will aimed
- Target of 60 MW achieved
- Target of 80 MW achieved
- Target of 45 MW achieved
- Target of 60 MW achieved
Coal Power Plants take a decisive part in the energy transition

- contribution to **security of the supply**, replacement of nuclear power plants, diversified fuel sources, close to the consumption
- **stabilization of the system** through the efficient balancing of the strong fluctuations of renewable energies
- **containment of expenses** with low variable costs and high flexibility
- **CO2-reducing** by use of combined heat and power systems and modern technologies

... because a comparable technology is not available