Biomass & Waste Co-firing in Coal Power Plants

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Ronald Rost – Head of Sales

Vattenfall Europe PowerConsult GmbH, Vetschau, Germany
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| **Shared Services** |

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3 | Biomass and Waste co-firing in coal power plants - Dr. D. Seibt
Confidentiality – None
Vattenfall Engineering – Key Facts

• Approx. 1,000 employees
• Turnover: 154 MEUR
• Technical, management and environmental engineering and consulting services for the energy sector
• Active all over the world with focus on Europe
• Providing services through:
  Vattenfall Europe PowerConsult GmbH, Germany
  Vattenfall Europe PowerConsult East d.o.o., Serbia
Biomass – at Vattenfall

• has a long history of working with biomass in producing heat and electricity and plans to increase co-firing of biomass in coal power plants to reduce fossil emissions of CO₂.

• has currently more than 40 heat and power plants fuelled in full or in part by biomass.

• uses more than 3 million tonnes of biomass per year, an amount that is steadily increasing.

• intends to allocate significant resources and efforts to build a substantial, highly reliable and sustainable biomass supply chain.

• is one of the world’s leading companies in the sector.
Biomass – traditional product – large future market

Biomass seen as a Fuel Development over Time

- Wood chips (residues)
- Wood chips (logs)
- White pellets/ briquettes
- Black pellets/ Briquettes: Steam explosion • Torrefaction
- Carbonization: R&D stage

Fuel Development

today

Confidentiality – None
Biomass Co-firing CHP Moabit
Project Motivation

- Climate protection agreement between the city state of Berlin and Vattenfall, signed on 8 October 2009
- Agreement about sustainable procurement of wood was signed on 15th April 2011

Moabit’s Wood Co-Firing impact on the commitment is shown in the chart below:

Moabit can deliver a CO₂ reduction up to 250.000 t/a from 2014 (Commercial Operation date) on
CHP Moabit - Location in the Berlin district heating system

CHP Moabit
(100 + 51 MW_{el}
136 + 3x35 MW_{th})

- Cogeneration power plant*
- Block cogeneration power plant*
- Heat only plants

* Installed electrical power
** Molten-Carbonate-Fuel Cell
**CHP Moabit – Main process flow of Unit A**

**Furnace with "integrated" Environmental Protection**
CHP Moabit – Project Features

- CFB Boiler 240 MWth for bituminous coal (designed for max. 40 % lignite)
- Substitution of 50 % of combustion heat capacity by virgin wood (chips/pellets)
- already 10 % wood co-firing realised by earlier project
- Co-firing of ~ 40 t/h
- Biomass from the vicinity around Berlin and international markets
- Construction of a plant for unloading, transport, intermediate storage and dosing of biomass
- Wood delivery via ship throughout the whole year from nearby BEHALA facility
- Intermediate storage of 9,000 m³
- Heat exchange system to be tied-in into water steam cycle
CHP Moabit – Fuel Features

- **Biomass types:** virgin wood chips, wood pellets
- **Water content:** 10 – 55 %
- **Particle size:** 10 – 100 mm
- **Density:** 160 – 700 kg/m³
- **Ash content:** 0.5 – 2 %
- **Heating Value (raw):** 9 – 18 MJ/kg
CHP Moabit - Location Map

- Oversize particle separation
- Unloading building
- Feeder to biomass storage
- Feeder to boiler house
- Boiler house
- Turbine house II with biomass storage

View 1
Overall view
Use of biomass at CHP Moabit
Lot 1 Crane
Lot 2 Bulk Material Handling
Lot 3 Conveyer
Lot 4 Fire protection
Lot 5 Electrical Equipment
Lot 6 Instrumentation & Control
Lot 7 Steel and Metal Construction
Lot 8 Fuel dosing
Lot 9 Heat exchange system
Lot 10 Civil works
View of CHP Moabit – Red brick historical parts
• Semiautomatic crane is used for ship unloading
• Separation of oversized particles by classifier to protect the SICON® Belt
• Conveying of Biomass to the storage site by closed conveying system (SICON®)
Transport to intermediate storage

- Föhrer bridge
- Enclosure for oversized particles separation
- Feeder 2 with enclosure
- Housing
- Unloading system
Biomass handling and storage in a former turbine hall

(Non-)ferrous separation  Vertical conveyor 2

Feeder 3

Feeder 2

Vertical conveyor 1

Feeder 5 (Feeder to boiler)

Transferring hopper

Biomass storage

Indoor crane
Temporary Storage

- Biomass flow will be divided into two flows in the receiving area of the former turbine hall
  1) *direct supply of the CFB Boiler* (180 m³/h)
  2) *storage of the remaining biomass* (320 m³/h)
- Full automatic crane will be used for fuel handling
  - *Storage*
  - *Removal from storage*
  - *Relocating of biomass inside the storage*
- Storage area is divided into Sections each Section consist of 6 Fields
Temporary Storage

• The full automatic crane is capable to “time-staple” the stored biomass
  => *possibility to demonstrate to the authority the storage period of max. 1 week*

• Removal of biomass according to the boiler demand and the FIFO principle (storage period max. 7 days)

• Monitoring of the storage area by Infrared (IR) camera and selective removal of biomass with a temperatures > 60°C
Fire Protection

Main focus:
- Construction of biomass plant in the area of the existing plant requires different adjustment in inventory (expansion of fire monitoring, fire protection roof of machine hall)
- Monitoring of temporary storage with IR cameras and specification of alarm temperatures
- Installation of spray levels divided into sections above biomass storage
- Automatic spraying units in the tunnel area and from conveyor bridge to feed regulating
- Dry extinguishing system along the pocket belt conveyor, in the building of coarse grain resistance and in machine hall
- Installation of combustion gas detectors and expansion of fire detection system
1. Alarm temperature $t > 60^\circ\text{C}$
   - relevant area of biomass storage is to be fed to co-firing immediately

2. Alarm temperature $t > 75^\circ\text{C}$
   - relevant area is to be cooled down and subsequently fed to co-firing
   - targeted monitoring by operator
Waste co-incineration
Thermal exploitation of waste must meet the following minimum conditions:

- Calorific value of waste ≥ 11 MJ/kg
- The heat created must be used
- Combustion efficiency of at least 75%
- The final residue produced is to be stored without further treatment

### Composition of waste with high calorific value

<table>
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<tr>
<th>Composition of waste with high calorific value</th>
<th>Shredding light fraction</th>
<th>Dual System residues</th>
<th>RDF from mech.-bio. plants</th>
<th>Industrial waste</th>
<th>Domestic waste</th>
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</thead>
<tbody>
<tr>
<td>Source A Source B</td>
<td>Source A Source B</td>
<td>Source A Source B</td>
<td>Source A Source B</td>
<td>Source A Source B</td>
<td>Source A Source B</td>
</tr>
<tr>
<td>share in normal operation [W-%]</td>
<td>10 25</td>
<td>10 20</td>
<td>10 20</td>
<td>50 5</td>
<td>20 30</td>
</tr>
<tr>
<td>Calorific value [MJ/kg]</td>
<td>19 15</td>
<td>12 20</td>
<td>15 17,5</td>
<td>11 24</td>
<td>13 8,5</td>
</tr>
<tr>
<td>Water content [W-%mass]</td>
<td>15 3</td>
<td>20 10</td>
<td>20 15</td>
<td>24 10</td>
<td>65 30</td>
</tr>
<tr>
<td>Ash content [W-%mass]</td>
<td>10 57</td>
<td>20 15</td>
<td>30 17</td>
<td>30 12</td>
<td>12 25</td>
</tr>
<tr>
<td>Sulphur [W-%mass]</td>
<td>0,6 1,5</td>
<td>0,5 0,2</td>
<td>0,5 1</td>
<td>0,51 0,5</td>
<td>0,14 0,2</td>
</tr>
<tr>
<td>Cl + F [W-%]</td>
<td>0,3 1,8</td>
<td>0,2 3</td>
<td>0,2 1</td>
<td>0,18 0,8</td>
<td>0,2 0,5</td>
</tr>
</tbody>
</table>
Vattenfall Experiences in Waste Co-incineration

- **Power Station Schwarze Pumpe**

  1600 MW_{el}, fuels: lignite (PC), residue derived fuel, fibre slurries; operated by Vattenfall Europe Generation

- **Power Station Jaenschwalde**

  3000 MW_{el}, fuels: lignite (PC), residue derived fuel; operated by Vattenfall Europe Generation

- **Power Station Lippendorf**

  1800 MW_{el}, fuels: lignite (PC), sewage sludge; operated by Vattenfall Europe Generation

- **Power Station Boxberg**

  1900 MW_{el}, fuels: lignite (PC), sewage sludge, animal meal; operated by Vattenfall Europe Generation
Waste Co-incineration at Jaenschwalde 6 x 500 MW
Waste Co-incineration at Jaenschwalde 6 x 500 MW

8000 m³
Waste Co-incineration at Jaenschwalde 6 x 500 MW
## VPC range of services for Biomass/Waste-to-Energy projects

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<td>Commissioning</td>
<td>Revision management</td>
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<tr>
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<td>Basic design</td>
<td>Documentation</td>
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<td>Permit application</td>
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Many Thanks for your Attention!