Co-firing of Biomass and Coal

JAN SLEGL
CAPTURE AND TENDERING
Retrofit
Product portfolio

Offering & strategy solutions for all needs

Fuel Flexibility

Environmental Compliance

Life Extension

Re-powering & Efficiency

Integrated Solutions

CO₂

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### Alstom Retrofit Expertise

<table>
<thead>
<tr>
<th>Type</th>
<th>Alstom Fleet</th>
<th>Other OEM *</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boilers</td>
<td>903 units</td>
<td>557 units</td>
<td>1,460 units</td>
</tr>
<tr>
<td>Steam Turbines (since 1984)</td>
<td>451 units</td>
<td>320 units</td>
<td>771 units</td>
</tr>
</tbody>
</table>

* Other Turbine Original Equipment Manufacturer include GE, Siemens, Westinghouse, Parsons, MHI, Hitachi, Toshiba, Zamech, LMZ, Escher Wyss, Franco Tosi, Ansaldo, and Skoda

- All boilers and turbines (OEM independent)
- All boiler and turbine technologies
- Guaranteed redesign and rehabilitations
- Integrated retrofits

Alstom is a world leader
Co-firing Drivers

- Global awareness of greenhouse gases & commitment to reducing CO2
- Requirement to make existing coal fired assets greener
- Fast access to environmental incentives, as relatively quick project implementation
- Best CO2 reduction per euro spend
Options for Co-firing Biomass

Agenda

• Introduction
• Biomass Fuels
• Options for co-firing
• Experience
• Conclusions
Biomass Fuels

- Logs ~45% H₂O
- Woodchips 15-45% H₂O
- Pelletized wood ~10% H₂O
- Miscanthus ~20% H₂O
- Coppiced Willow ~45% H₂O
Biomass Fuel Challenges

• Fuel characteristics, importance of moisture content and density
• Volatility of Biomass fuels
• Spontaneous combustion – explosion risk
• ATEX/ DESAR/ NFPA directives
• Dust emissions / Biohazards
• Saleability of ash
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Biomass Co-milling – typically up to 3%

- Lowest initial cost
- Uses existing mills, which limits output
- Poor mill performance-
  - Throughput & fineness
  - Risk of mill fires
  - Poor mix of coal and biomass
Dedicated Biomass Co-firing - > 10% by mass

- More flexible, higher throughput
- Minimal outage requirements
- Equipment is specifically tailored for project
- Best CO₂ reduction V cost, of all co-firing solutions
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Alstom’s European Experience

Alstom has been active in biomass power generation for over 18 years.

Experience in working on a wide variety of various biomass fuels

Most co-firing projects look at between 10% and 20% biomass by heat input.

Co-firing is one of the most cost effective ways to reduce CO₂ in existing assets.
SSE - Fiddlers Ferry Power Station
Warrington, UK – 4 x 500 MWe
Fiddlers Ferry Co-Firing

• 4 x 500 MWe T-Fired Boilers - unit 2 and 4

• First dedicated Biomass co-firing plant in the UK

• Previously co-milling, decision made to move to dedicated co-firing system,

• 20% MCR Biomass by heat input basis

• Multi Biomass fuels; wood pellets, palm kernels, olive stones, olive cake <15% moisture

• Fast track project; executed in 2 phases
  
  − Phase 1, 4 month design study, customer engaged at all stages of project development, inc HAZOP
  
  − Phase 2, (EPC) Engineer, Procure and Construct two dedicated streams of Biomass co-firing, inc civils, mechanical & electrical installation and commissioning
Project drivers

- UK’s largest Power Station - producing ~7% of UK power generation
- To produce 10% of output (6 x 660 MWe) from Co-Firing (400MWe)
- To save over 2 million tonnes of carbon dioxide per annum
- To co-fire 1.5 million tonnes of biomass per annum, through the development of new ‘Direct Injection’ facilities
- Multiple fuel flexibility, mitigating supply risk
Alstom Drax Biomass Project

- Fast track project; in 2 phases
  - Phase 1, 4 month Design Study, Drax engaged at all stages of project development, inc HAZOP
  - Phase 2, (EPC) Engineering design, supply and installation of equipments associated with the main processing works (road unloading, storage & biomass milling) inc civils, mechanical & electrical installation and commissioning.

System in operation since Dec 2009
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Conclusions

- Dedicated system allows higher firing rates with greater reliability and availability
- Optimization of the biomass milling equipment without compromising existing mills
- Co-firing biomass is a cost effective way of offsetting CO2 whilst utilizing existing assets