Perspectives of biomass co-firing from the operators point of view

Erland Christensen
VGB is a voluntary association of companies, for which power plant operation and the appropriate technology are an important basis of their business.

Our goal is to promote and optimise:

- the operational safety and environmental compatibility
- availability and economic efficiency

of existing and new plants for power and heat generation.
VGB Membership countries

VGB represents ~ 530,000 MW installed power capacity

EU 27: 472 Members in 20 Countries
Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Poland, Romania, Portugal, Slovenia, The Netherlands, Spain, Sweden, United Kingdom

Remaining Europe: 19 in 5 Countries
Croatia, Russia, Switzerland, Turkey, Norway

Outside Europe: 17 in 11 Countries
Argentina, Australia, Brazil, China, India, Israel, Japan, Libya, Mongolia, South Africa, USA

Total: 508 in 36 Countries

Fossil-fired Power Plants: 306,000 MW
Nuclear Power Plants: 130,000 MW
Hydro, Wind, et al. RE: 94,000 MW
Total: ~ 530,000 MW
In more than 90 Committees about 1,600 experts meet regularly for Information Exchange on all technical Power Plant Issues.
EWG BIOMASS

- Exchange of operating experience
- Fuel supply, quality and sustainability
- Biomass availability
- Guidelines/legislation
- Fire and explosion protection
- Co-firing, stand alone plants
- Combustion, gasification
- Corrosion and slagging problems
- Ash utilisation (in coordination with ECOBA)
- Research projects
European Working Group “Biomass” – Member Companies

- Nuon
- Vorweg Gehen
- MVB
- Dong Energy
- Enery
- Laborelec
- Boehringer Ingelheim
- EDF
- ESB
- Visnova Trading GmbH
- Eskom
- EnBW
- Fortum
- Vattenfall
- VarmeForsk
- Fraunhofer
- Electrabel
- Enel
- Fernwärme
- Fug Ulm GmbH
- Wien Energie
- Steag
Biomass: Development of biomass based electricity generation in the EU-27

Source: EUROBSERVER
What has to be considered?

- Fuel availability / price
- Fuel sustainability / quality
- Technical aspects
  - Storage
  - Milling
  - Conveying
  - Combustion
  - Deposits / Cleaning
  - Corrosion
  - Catalyst poisoning
  - Utilization of the by-products
  - Compliance with emission limits
- Investment and Business Case
Biomass imports to Europe and global availability

- Research project on the availability of biomass in 2020 in the EU-27, as well as the global availability
- Main objective → Evaluation of the 2020 renewable energy targets in EU-27 based on domestic solid biomass supply potentials supplemented by imports

Results:

<table>
<thead>
<tr>
<th></th>
<th>TWh</th>
<th>Mtoe</th>
<th>Mio.t wood pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand 2020 solid and liquid biomass</td>
<td>232</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>Demand 2020 solid biomass</td>
<td>131</td>
<td>120</td>
<td>260</td>
</tr>
<tr>
<td>Supply gap 2020 solid biomass</td>
<td>28-42</td>
<td>26-38</td>
<td>55-85</td>
</tr>
<tr>
<td>Global market volume 2010</td>
<td>8</td>
<td>7.4</td>
<td>16</td>
</tr>
<tr>
<td>Imports EU-27 2010</td>
<td>1</td>
<td>0.9</td>
<td>2</td>
</tr>
</tbody>
</table>

- Global availability (technical potentials) exists to supply these volumes
The supply gap of 26-38 Mtoe between projected demand and projected supply in Europe would be available on global markets. Available volumes of biomass are highly dependent on market price development.
Sustainability

**Sustainability issues:**

- Deforestation
- Destruction of rainforest
- Competition with food production
- Working conditions and human rights in the country of production
- Need for and recovery of fertiliser (global phosphate resources)

**Recommended criteria of the EU:**

- Prohibition of biomass from land converted from forest, high carbon stock areas and highly biodiverse areas
- Common greenhouse gas calculation methodology; minimum greenhouse gas savings at least 35% in 2010 (50% in 2017, 60% in 2018) compared to EU's fossil energy mix
- Differentiation of support schemes in favour of high efficiency installations
- Monitoring of the origin of biomass
Sustainability - approaches

**Green Gold Label (GGL)**
- global certificate for sustainable biomass
- covering production, processing, transport and final energy transformation
- over 25 biomass producers/traders are GGL certified

**Initiative Wood Pellet Buyers (IWPB)**
- unites utilities that fire large quantities of wood pellets
- enabling trading of industrial wood pellets among partnering companies
- Sustainability Principles for Woody Biomass Sourcing and Trading
- Wood pellets fuel specification

**Imported wood pellets fulfill the greenhouse gas saving criteria of the EU**

- Wood pellets Baltic Europe
  - Transport raw material: 100% - 0.6%
  - Wood pellet production: 100% - 9% (electricity), -0.9% (primary energy)
  - Transport final product: 0%
  - Sea transport: 100% - 2.5%
  - Total: 87%

- Wood pellets British Columbia
  - Transport raw material: 100% - 1%
  - Wood pellet production: 100% -12% (electricity), -4% (primary energy)
  - Transport final product: 0%
  - Sea transport: 71%
  - Total: 71%

Source: Laborelec case study
### Fuel Quality

**Examples from the DEBCO project**

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Moisture (ca. wt%)</th>
<th>LHV a.r. (ca. MJ/kg)</th>
<th>Ash d.b. (ca. wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardoon (Kardia/GR)</td>
<td>8.0 – 14.0</td>
<td>14.0 – 16.0</td>
<td>7.5 – 15</td>
</tr>
<tr>
<td>Wood Pellets (Rodenuhize/BE)</td>
<td>6.4 – 9.0</td>
<td>16.5 – 18.5</td>
<td>0.6 – 2.3</td>
</tr>
<tr>
<td>Lignite (Kardia/GR)</td>
<td>53.9</td>
<td>5.4</td>
<td>29.3</td>
</tr>
<tr>
<td>Lignite*</td>
<td>50.0 – 60.0</td>
<td>2.0 – 10.0</td>
<td>2.0 – 10.0</td>
</tr>
<tr>
<td>Hard Coal*</td>
<td>2.7 – 14.0</td>
<td>20.0 – 32.0</td>
<td>1.0 – 15.0</td>
</tr>
</tbody>
</table>

*Source: „Biomass pellets in the power plant sector - A market analysis –“ VGB, Institute for Energy and Environment

- Biomass fuels have a wide range in all parameters
- Biomass fuels have a lower LHV compared to fossil fuel
- Biomass fuel have relatively low ash content
- Compared to low quality fossil fuels biomass might be an upgrade (s. Kardia Lignite)
Co-combustion of biomass and pulverized coal

1. **Fuel storage**  Health (CO, fungi), self-ignition
2. **Milling**  Mechanical problems, fire, explosion
3. **Combustion**  Slagging and corrosion
4. **Superheater**  Fouling, HT corrosion
5. **Economiser**  CaSO$_4$ deposits
6. **DeNO$_x$**  Catalyst poisoning (K, P, As, Ca)
7. **Air Preheater**  Blockage, LT-Corrosion
8. **ESP**  Efficiency (Ash resistivity)
9. **Fly Ash**  Utilisation in cement and concrete (Ca, P)
10. **FGD**  Waste water treatment, gypsum quality
11. **Emissions**  Authorisation and legal aspects
    (Dust, NO$_x$, SO$_x$ ...)

Source: Laborelec
## Effects of conversion to co-firing

### Examples from the DEBCO project

<table>
<thead>
<tr>
<th>Power plant</th>
<th>Fusina (IT)</th>
<th>Kardia (GR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main fuel</td>
<td>Hard coal</td>
<td>Lignite</td>
</tr>
<tr>
<td>Biomass</td>
<td>RDF</td>
<td>Cardoon</td>
</tr>
<tr>
<td>Co-firing rate</td>
<td>5% (t.s.)</td>
<td>10% (t.s.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Power consumption for milling</th>
<th>Boiler efficiency</th>
<th>Unburned carbon in bottom ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Value fossil</td>
<td>-</td>
<td>80.7% - 82.0%</td>
<td>14.7% - 18.7%</td>
</tr>
<tr>
<td>- Value co-firing</td>
<td>+ 12%</td>
<td>77.2% - 81.0%</td>
<td>24.3% - 36.8%</td>
</tr>
</tbody>
</table>

- The power consumption of the mills is higher
  (100% wood pellets at Rodenhuize (BE) up to three times higher)
- Biomass has a different combustion behavior than coal → higher unburned carbon in bottom ash, different bottom/fly ash ratio
- Due to the lower LHV and higher moisture content the boiler output and efficiency will typically be lower
Biomass storage

Germination of cardoon seeds on the fuel blend

Spontaneous combustion of lignite/biomass piles

- Self-ignition → material loss and safety issues
- Formation of dust → danger of explosions, HSE (closed storage areas)
- Biomass tends to absorb water/leach organic compounds → loss in heating value, HSE
- Microbiological degradation → loss in heating value

Source: Agriconsulting, 2010
Biomass fuel typically contains high amounts of Alkalis and Chlorine (Straw, Cardoon …)

- High temperature Chlor corrosion $\rightarrow$ material loss (Furnace, Superheater …)
- Sticky deposits $\rightarrow$ lower heat transfer
Why biomass co-firing?

- Co-firing is one of the most cost effective ways to use biomass, existing infrastructure can be used.
- High electrical efficiencies and low emissions, compared to small scale stand-alone installations.
- Wide range of usable biomass fuels and fallback option.
- Reduction of CO₂-emissions by saving fossil fuels.
- Approx. 10% (t.s.) co-firing rate in all EU-27 coal fired power plants (~1000 TWh/Y) would result to an electricity generation of ~100TWh/Y (EU target 2020 ~131TWh/Y).
Integration into the existing power supply

- High availability / base load / compensation of fluctuating renewable energy sources
- Growth potential for districted heating
- Securing and creating jobs in the energy and agricultural sector

Source: Heat road map 2050, University of Aalborg and University Halmstadt
What is necessary to stimulate the market for biomass co-firing?

- Technical development of key components and processes (e.g. mills, storage, H&S, ESP, DeNOx)
- Security of investment
  - EU wide common legal definition of biomass
  - Biomass fuel specification for international traded biomass
  - International binding sustainability criteria
  - EU wide common incentive system without capacity restriction
- Business case