Views to WtE processes
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Year 2020

- Net Sales: 3,7 bn€
- EBITA-%: 9,8
- Employees: 14 000

Locations in India

Leading process technologies, services and automation for the pulp, paper and energy industries
Examples of Valmet’s recent deliveries

Valmet’s Energy Business unit is focusing on Multifuel-fired Fluidized Bed boilers and gasifiers, Flue Gas cleaning systems and Fuel Upgrades for existing boilers

<table>
<thead>
<tr>
<th>Waste-to-energy – RDF</th>
<th>Multifuel power</th>
<th>Biomass conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zibo Green Energy, China</strong></td>
<td><strong>Ofunato Power Inc, Japan</strong></td>
<td><strong>PT Cikarang Listrindo, Indonesia</strong></td>
</tr>
<tr>
<td>• CFB boiler: 35 MWe, 80 bar, 520°C</td>
<td>• CFB boiler: 75 MWe reheat, 65/57 kg/s, 142/27 bar, 557/540°C</td>
<td>• Converting existing coal fired CFB boiler to biomass-coal combustion</td>
</tr>
<tr>
<td>• Fuels: 300 000 tpa RDF</td>
<td>• Fuels: PKS, EFB pellets and coal</td>
<td>• Fuels: Palm Kernel Shell (PKS) + Coal</td>
</tr>
<tr>
<td>• Start-up: 2018</td>
<td>• Driver: FIT - Renewable power to grid</td>
<td>• Driver: Renewable power to customers</td>
</tr>
<tr>
<td>• Driver: Reliability and high efficiency</td>
<td>• Start-up: June 2019</td>
<td>• Start-up: 2021</td>
</tr>
</tbody>
</table>
Towards Circular Economy

Evolution of waste management

- Landfill
- Waste incineration
- Energy recovery
- Resource & energy recovery

Further on to 100% recycling through material and chemical recycling

Valmet solutions
Resource-efficient fuel sources

Waste
- Recycled wood
- Municipal solid waste (MSW)
- Industrial waste – Package waste, paper mill rejects
- Fossil side-streams
- Pulp & paper industry by-products
- Agro by-products

Pre-treatment
- Mechanical processing, separating metals and glass
- Sizing the fuel
- Sizing the fuel
- Mechanical and chemical processing

Solid Fuel
- RDF (Refuse Derived Fuel)
- SRF (Solid Recovered Fuel)
- Pet coke
  Asphaltene pellets
- Forest residue, sawdust, bark, sludge
- Pre-processed agro pellets
  (EFB, straw)
Waste processing gets more complicated when moving towards recovery of energy and chemicals – but it must be done!

Towards Circular Economy

- Landfilling
- Incineration of untreated waste
- Waste pre-treatment to RDF (MT/MBT)
  - RDF-Combustion at high-efficiency
  - AD/Composting
  - RDF-Combustion or Gasification

Outcomes

- Energy
- Metals
- Ash

- Energy
- Metals
- Glass
- Inerts
- Ash

- Energy
- Chemicals
- Nutrients
- Metals
- Glass
- Minerals
- Ash
Typical Indian MSW is not applicable for incineration without pre-treatment

- Kitchen waste and trash get mixed
- Low calorific value and high moisture
- Seasonal variations

<table>
<thead>
<tr>
<th>MSW composition</th>
<th>Mass-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen, food and bio wastes</td>
<td>66.7</td>
</tr>
<tr>
<td>Wood</td>
<td>1.2</td>
</tr>
<tr>
<td>Paper &amp; Cardboard</td>
<td>5.2</td>
</tr>
<tr>
<td>Textiles and fabric</td>
<td>2.6</td>
</tr>
<tr>
<td>Leather and rubber</td>
<td>0.4</td>
</tr>
<tr>
<td>Plastics</td>
<td>13.8</td>
</tr>
<tr>
<td>Metals</td>
<td>1.0</td>
</tr>
<tr>
<td>Glass, porcelain, stones, soil, ash, etc.</td>
<td>5.6</td>
</tr>
<tr>
<td>Other</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moisture</th>
<th>Inerts (ash)</th>
<th>LHV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td>Moisture</td>
<td></td>
<td>10.4%</td>
</tr>
<tr>
<td>Inerts (ash)</td>
<td></td>
<td>5.1 MJ/kg</td>
</tr>
</tbody>
</table>

Plastics 35 MJ/kg
Textile 19 MJ/kg
Paper 16 MJ/kg
Organic waste 4 MJ/kg
Metals 0 MJ/kg
Glass 0 MJ/kg
DUO:
- Mechanical pre-treatment and mixing with industrial waste
- RDF-yield about 80%
- No nutrient recovery

TRIO:
- Combined mechanical-wet-biological pre-treatment
- RDF-yield about 50%
- Recovery of nutrients in organic fraction
TRIO – From 500 up to 3000 TPD MSW input

Integrated solution

- Recyclable materials recovered for recycling
- Organic fraction turned into fertilizers and power with Anaerobic Digestion
- Combustible fraction refined to RDF-fuel for high-efficient CFB-boiler power plant
Example of a powerful Policy
Japan shifting from Nuclear to Renewable electricity

- The first feed-in-tariff (FIT) system for renewable energy was enforced by Japanese government in 2012
  - Solid biomass fuels are included in this system
- Secured price for biomass electricity, 24 JPY/kWh
  - For twenty years starting from plant start-up
  - System allows to co-fire also fossil fuels but FIT is paid only for biomass portion
- FIT is applied at early stage of project development

This incentive system initiated numerous new projects

Renewable share in Japan increased from 9 to 15% in 5 years
- Target by 2030 is to increase it to a range of 25% (low scenario) – 34% (high)
Active countries in waste-to-energy at the moment
Feed-in-Tariff as common nominator in new waste-to-energy countries

New waste-to-energy countries triggering the market with FIT:
- Vietnam
- Malaysia
- Indonesia
- Australia
- United Arab Emirates

Mature waste-to-energy – countries renewing their policies:
- Taiwan: FIT for high-efficient plants only
- EU: Green Deal
  - 65% material recycling quota for each member country
  - Max 10% allowed to end up to landfills
  → 25% available for Energy Recovery or for Chemical recycling