Biomass Technologies
Thermal Energy and CHP

Central Washington
Biomass Energy Workshop
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What is Biomass?

Forestry residuals and “clean green” wood waste: wood from tree trunks and branches, chipped

Compressed wood, pellets, bricks: untreated wood with limited bark content, compressed by machine

Mill residuals: a mixture of untreated and treated wood in form of shavings, chips, sawdust

Construction waste: untreated wood that has been used in commerce prior to its energetic utilization

Ag fuels: straw, grasses, corn stover, purpose-grown feedstocks

Modified from Viessmann Manufacturing
Biomass Heat and CHP

- **Efficient**: modern heating and CHP systems have high conversion efficiency (>85%)
- **Clean**: modern biomass CHP systems have very low particulate, NOx and CO emissions
- **Economical**: cost effective, fuel prices lower than oil, propane and electricity
- **Sustainable**: CO$_2$ neutral, regionally abundant, compliments sustainable forestry
Efficient
Conversion Efficiency as %

- 25% Biopower (no heat capture)
- 50% Cellulosic Ethanol
- 85% Biomass Heat and CHP
Development of emissions of Austrian Biomass Boilers, measured by the federal agency for agricultural engineering Wieselburg (BLT)

Efficient
Development of emissions of Austrian Biomass Boilers, measured by the federal agency for agricultural engineering Wieselburg (BLT)
Clean

Particulate Emissions (lbs/mmBtu)

- EPA Certified Woodstove: Very Low Emissions Possible
- Pellet Stove: 10-20x cleaner than EPA-certified woodstoves
- Modern Pellet Boiler (no flue gas cleaning): 10-20x cleaner than EPA-certified woodstoves
- Gas Furnace: Very Low Emissions Possible
- Biomass CHP (with flue gas cleaning): Very Low Emissions Possible

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Economical

Fuel Cost Comparison

Gas is cheap, but most rural locations depend on Propane, Oil and Electricity.

Rich in biomass energy resources!

Fuel Costs $/mmBtu

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating oil</td>
<td>$25.18</td>
</tr>
<tr>
<td>Electricity</td>
<td>$23.44</td>
</tr>
<tr>
<td>Propane</td>
<td>$23.37</td>
</tr>
<tr>
<td>Natural gas</td>
<td>$10.00</td>
</tr>
<tr>
<td>Wood briquettes, packaged</td>
<td>$14.06</td>
</tr>
<tr>
<td>Wood pellets, bagged</td>
<td>$14.06</td>
</tr>
<tr>
<td>Wood pellets, bulk</td>
<td>$10.80</td>
</tr>
<tr>
<td>Wood chips, pulp quality @ 35% MC</td>
<td>$9.05</td>
</tr>
<tr>
<td>Wood chips, hog fuel @ 35% MC</td>
<td>$5.43</td>
</tr>
</tbody>
</table>
Thermal Energy Technology
Thermal Load Profile for Commercial/Institutional Building
Estimated Heat Load Coverage by New Wood Boiler

Hourly Heat Demand (KWhr)

- Calculated Heat Load (kW/hr)
- Estimated Wood Boiler Load Coverage
Biomass Boiler Systems

Image: BIOS Bioenergy (http://www.bios-bioenergy.at)
Residential Heating
Cordwood Boiler

Cordwood Boiler
Photo: Windhager
Small Commercial Heating

Pellet Boilers

Photo: Windhager
Commercial Heating
Modular Boiler Systems
Commercial Heating
Modular Boiler Systems
Pyrot

1. Secondary air controlled by rotary fan
2. Ash removal
3. Fully moving grate
4. Feed screw conveyor with barrier layer
5. Ignition fan
6. Regulated primary air
7. Rotary combustion chamber
8. Two-pass heat exchanger
9. Safety heat exchanger
10. Pneumatic pipe cleaning
11. Flue gas recirculation
12. Induced draught fan with Lambda probe and temperature sensor

Photo: Viessmann GmbH
Institutional Heating
Steam Boiler
Institutional Heating
Steam Boiler
Fuel Handling and Storage
Pellet Delivery
Prairie City, OR
Wood Chip Bins
For Mill Waste
Wood Chip Bins
For Mill Waste
Walking Floor
Wood Chips
Technologies for Cogeneration
Biomass Combined Heat and Power (CHP)

- Radiation and heat losses: 8%
- Thermal output: 75%
- Electricity output: 14 - 15%
- Heat and electricity losses ORC: 2 - 3%

Biomass input (NCV) = 100%

Thermal oil ECO
- Combustion air pre-heater
- Hot water ECO

Thermal oil boiler

ORC process
Cogeneration Technologies

• Steam Turbines (>2 MW)
  » Backpressure turbine (heat and power 100% coupled)
  » Extraction/Condensing turbine (heat and power partially decoupled)

• ORC Turbines (65 kW – 5 MW)
  » Thermal oil-fired ORC turbine
  » Pressurized hot water-fired ORC turbine
Steam Boiler Technology

Image: BIOS Bioenergy (http://www.bios-bioenergy.at)
Steam Turbine

Image: Siemens (http://www.energy.siemens.com)
Thermal Oil Boiler Technology

Image: BIOS Bioenergy (http://www.bios-bioenergy.at)
Thermal Oil Boiler Technology
ORC Turbine

* Turboden ORC units can be also fed with saturated vapor or superheated water.

Image: TURBODEN (http://www.turboden.eu)
ORC Turbine
Our Services

• **Design/Build:** Biomass energy installations including complete system engineering, procurement and construction (EPC)

• **Consulting:** Technical expertise in biomass energy systems and project management, including feasibility studies for institutional, commercial and industrial biomass facilities

• **Energy Services:** Thermal energy supply from investor and community-owned thermal energy generation assets
Thank you!

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