ETIP Bioenergy
European Technology and Innovation Platform

Bioenergy Fact Sheet

Biomass CHP facilities

Definition

A combined heat and power (CHP) plant is a facility for the simultaneous production of thermal and electrical resp. mechanical energy in one process. As compared to power plants using solid fuels with efficiencies of 20-45 %, the overall process efficiency is significantly higher, 80-90 %, as the otherwise rejected heat is also transferred to consumers.

Biomass CHPs are operated with different kinds of solid-, gaseous- as well as liquid fuels or residues (Fig. 1).

Biomass feedstocks and technologies

Solid fuels include wood, forestry and forest industry residues, agricultural and agroindustrial residues and the biological fraction of wastes. Most solid fuels and some high solids content liquid industrial wastes (such as molasses and black liquors) can be directly fired in a combustion unit, producing heat which then powers a thermodynamic steam or ORC turbine cycle. State-of-the-art combustion plants are equipped to meet stringent environmental requirements.

Solid, relatively dry biomass feedstocks can, in particular at smaller capacity, be gasified by partial combustion to fuel gas. Wet biomass residues and wastes (sludges, vinasse, manure etc.) as well as crops and by-products such as molasses can be processed by anaerobic digestion to a biogas with methane as the main energy-carrying component. Both fuel gas and biogas can - after cleaning - be directly used in internal combustion engines at efficiencies higher than possible with steam and ORC turbines at smaller capacity, say < 5 MW_{el}.

Liquid biomass fuels, e.g. biodiesel from rape seed or ethanol from sugar and starch crops, are rarely used as a base-load fuel in stationary applications for cost reasons. However, a wide spectrum of solid and liquid industrial by-products and residues – bark, bagasse, black liquor, molasses, stillage, vinasse, and others – are used as fuel in CHP installations in scales from 1 to well over 100 MW_{el} in magnitude.

The most relevant paths of biomass feedstocks to heat and power are shown in Fig. 1.

Applications

Applications range from small scale generation e.g. on a farm-scale up to large facilities for industrial sites or city district heating grids, and depending on the application different technologies are being used. Typical electric capacities for various applications are listed in Table 1.

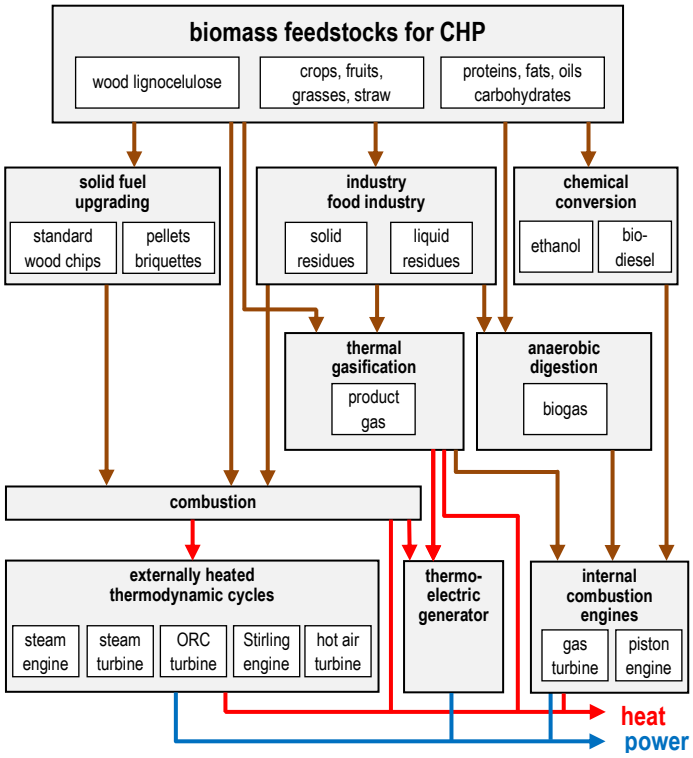

Fig. 1: **most relevant paths of biomass feedstocks to CHP**

Table 1: **biomass CHP applications and preferred technologies in different power ranges**

power range	application	preferred technology
50 kW_{el} - 1 MW_{el}	multiple dwelling hotels local heating grids	anaerobic digestion or thermal gasification with internal combustion engines or ORC turbines and steam engines.
1 - 10 MW_{el}	hospitals commercial enterprises regional heating grids	ORC plants (< 6 MW_{el}) steam engines steam turbines
10 - 30 MW_{el}	district heating grids industrial site	steam turbines
50 - 300 MW_{el}	district heating grids industrial sites, powerplants	steam turbines biomass alone or co-firing in retrofitted fossil fuels plants

The role of biomass CHP in the EU

There are various processes for the production of power and heat from biomass, and some 1,000 biomass-fired and around 17,000 biogas CHP facilities were operational in EU28 in 2016[1]. Taking Sweden as an example (where biomass CHPs cover 72% of total CHP electricity production), biogas facilities typically have capacities below 1 MW_{el} and biomass CHPs are typically in the range of 1 - 50 MW_{el}[2], although there are several facilities in the EU from 50 MW_{e} up to 260 MW_{el}[3]. The role of biomass CHP in the EU is shown in Fig. 2, which has been prepared based on data of the recent AEBIOM Statistical Report[4].

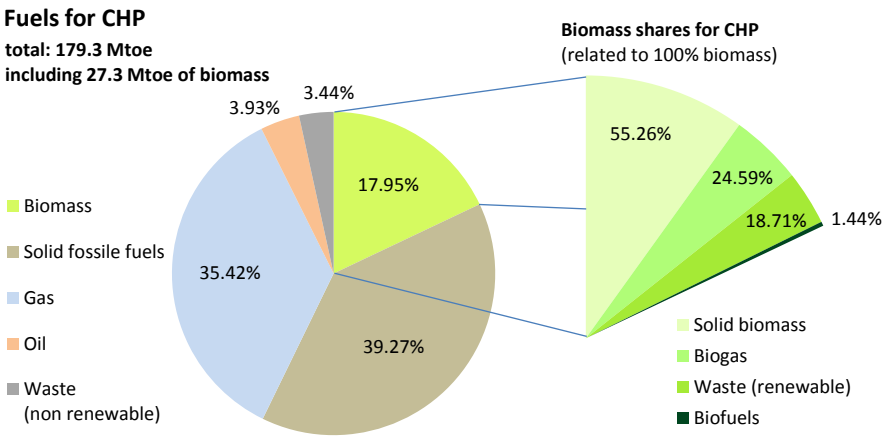

Fig 2: fuels and biomass shares for CHP in EU28 (status 2014[4])

Examples of biomass CHP plants

Operator:	**AustroCel Hallein GmbH** **Hallein, Austria** **Pulp processing enterprise**[5]
El. power:	33 MW_{el}
Thermal capacity:	30 MW_{th} used for process heat and district heating
Technology:	combustion (30 MW_{el}), anaerobic fermentation (3 MW_{el}) steam turbine
Fuels:	residues from pulp processing: celulose, sludge, bark

Operator:	**Stockholm Exergi** **Värtaverket, Stockholm, Sweden** **Biomass CHP plant**[6]
El. power:	130 MW_{el}
Thermal capacity:	310 MW_{th} used for district heating
Technology:	combustion in a circulating fluidized bed steam turbine, flue gas condensation
Substrate:	wood chips and forestry residues

Sources

1 IEA Bioenergy Task 32 Report: http://www.ieabcc.nl/publications/TEA_CHP_2015.pdf
2 https://bioenergitidningen.se/app/uploads/sites/2/2016/10/Biokraftkartan2017_web.pdf
3 http://www.alholmenskraft.com/en/company/bio-fuelled_power_plant
4 AEBIOM Statistical report 2017
5 http://www.salzburg24.at/austrocel-hallein-investiert-60-millionen-euro/5244438
6 https://www.fortum.com/about-us/our-company/our-energy-production/our-power-plants/vartaverket-chp-plant

Further information

http://www.etipbioenergy.eu/value-chains/products-end-use/end-use/combined-heat-and-electricity-production
http://www.etipbioenergy.eu/images/EIBI-3-power-and-heat-via-gasification.pdf
http://etipbioenergy.eu/value-chains/products-end-use/end-use/combined-heat-and-electricity-production