IEA Bioenergy
Technology Collaboration Programme

Best Practices on flexible bioenergy

Wood-based CHP with biochar production for negative emissions

Frauenfeld, Switzerland

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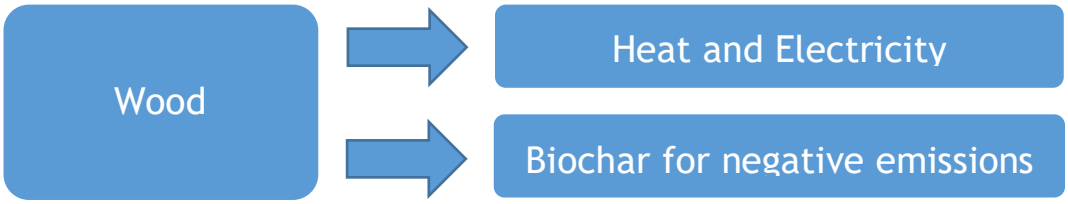
Project description

The otherwise unused wood from forest and landscape management, e.g., storm wood is converted in a pyrolysis type thermochemical process at 850 °C to a gaseous fuel and biochar. While the wood gas is converted in four gas engines to produce renewable electricity for around 8,000 households and heat that is used by a sugar factory and the regional district heating network, biochar is also discharged from the process. Part of the CO_2 stored in the wood is therefore not released and is permanently removed from the atmosphere in the form of biochar. The biochar is used in agriculture to improve the soil, as a feed additive or as active carbon for water cleaning.



Base information	
Link for more information	https://www.bioenergie-frauenfeld.ch/
Contact person	S. Ellenbroek, stefan.ellenbroek@energie360.ch
Location	Frauenfeld, Switzerland
Owner/Operator	Bioenergie Frauenfeld AG
Technology supplier	Syncraft, Knoblinger
Start of the project	May 2022
Construction year	2021-2022
Status	1st of a kind in the country
Feedstock	Wood chips
Products	Electricity, heat, biochar
Size	Input: 25,000 t/yr wood chips; Output: 30 GWh/yr electricity, 40 GWh/yr heat, 3,500 t/yr biochar
Type of flexibility provided	Combining production of multiple products: electricity, heat, and biochar (enables negative CO_2 emissions)
Investment cost of the plant (€)	Unknown

Technical and Commercial Details

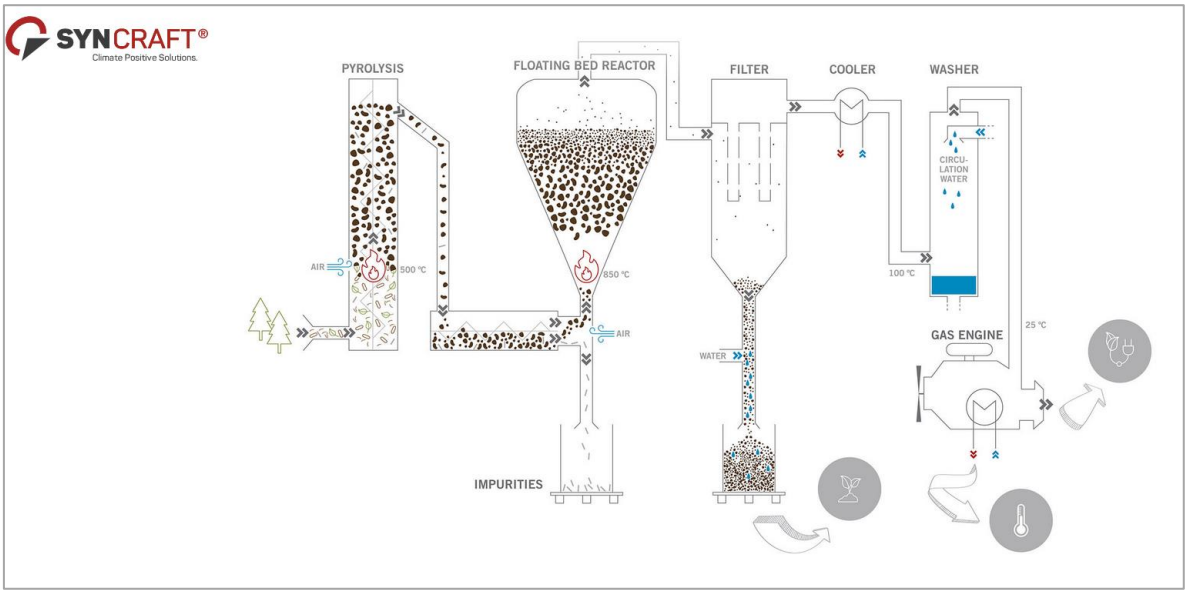
- The plant is at commercial scale. Assuming 8,000 operation hours per year, 25,000 t wood chips per year with 30-35% humidity represent around 10 MW_{th} input (LHV); the produced electricity corresponds to 3.75 MW_{el} and the heat to max 5 MW_{th}. The biochar contains most of the residual energy; as overall efficiency, 92% is indicated due to thorough heat integration.
- The plant offers a decent efficiency to electricity, while up to one fourth of the energy is separated as solid carbon which can be considered as negative emission if used in agriculture.
- CO_2 removed from the atmosphere: 9,000 tonnes per year.
- The combination of combined heat and power (CHP) production and biochar for negative emission is the first of its kind in Switzerland or even in Central Europe.

Process description:

- The wood-fired power plant operates eight independent process lines in parallel.
- The fresh forest chip material is dried with heat generated within the wood power plant.
- After drying, the wood chips are transported to the pyrolysis reactor via screw conveyors. The pyrolysis reaktor heats the chips to 500 °C under controlled air supply. The organic compounds in the wood chips are converted, and valuable biochar is produced.
- Now the biochar enters the fluidized bed reactor, where a part of the biochar is converted into wood gas at 900 °C (gaseous fuel).
- In the filter system, the remaining fine biochar particles are separated from the wood gas. The wood gas is then cooled and sent to the gas engines.
- After the pyrolysis process, four special gas engines convert the wood gas into electricity and renewable heat.

1. After drying, the wood chips are transported to the pyrolysis reactor via screw conveyors, where valuable biochar is formed. 2. The biochar enters the fluidized bed reactor, where a part of the biochar is converted into wood gas. 3. The remaining fine biochar particles are separated from the wood gas in the filter system. Source: Bioenergie Frauenfeld AG, 2022.

Four special gas engines convert the wood gas produced from biochar into electricity and renewable heat. Source: Bioenergie Frauenfeld AG, 2022.



Flow chart of the process. Source: Syncraft, 2022.

Market opportunities

- So far, no economic numbers are available, but the economic feasibility will depend on the wood price one the one hand, and the value of heat, electrcity, and biochar (or negative emissions), on the other hand.

Lessons to Industry

- It is possible to combine production of energy carriers or heat and electricity, and realisation of negative emissions at the same time.