High cogeneration performance by innovative steam turbine for biomass-fired CHP plant in Iisalmi, Finland

By utilisation of wood fuels Iisalmi CHP plant in Finland has achieved an electrical share as high as 40 percent. Fired with wood residues and peat the Iisalmi plant is a plant with high performance cogeneration. Wood fuels account for 70% of the heat output, and up to 30% green forest chips can be used. Total fuel use is 170 GWh.

High performance cogeneration

The project developer, owner and operator of the new 45 MW_{th} BFB-combustion cogeneration plant in Iisalmi is Termia Oy, part of the Atro Group (formerly Savon Voima Oy). Today about 80% of the district heat produced by Atro Group is made by indigenous biomass fuels. The target in 2010 is to make 90% of the district by biomass fuels.

Fired on peat and wood waste and handed over to the customer in November 2002, the plant's electrical output is sold to the parent company and heat locally to customers in Iisalmi.

Prior to the commissioning of the new plant, some 22% of the heat were generated by fuel oil, the other part from biofuels. In addition to Termia's own production, heat was bought from a nearby sawmill.

The district heating system based on 2001 data had a capacity of 44.2 MW and a yearly supply of 130 GWh. The total length of the network was 62.5 km and the annual fuel consumption 170 GWh. Heated space is in total 2.85 million m^3.

Heat was mainly supplied from the Parkatti heating plant, which incorporates a 15 MW fluidised bed hot water boiler, fired on peat and sawdust, and two 12 MW hot water boilers, fired on heavy fuel oil.

Feasibility confirmed

A feasibility study for a new cogeneration power plant was initiated in 1997, and a decision to build was made at the end of 1998.

Construction started in 1999, and the plant was brought into commercial operation in November 2002.

Termia Oy selected Electrowatt-Ekono Oy for a consult. Electrowatt-Ekono Oy was responsible for the complete design of the plant excluding architectural design.

Optimising the district heating turbine process - raising the power to heat ratio as high as possible without increasing investment costs - is a demanding challenge in the size of plant envisaged.

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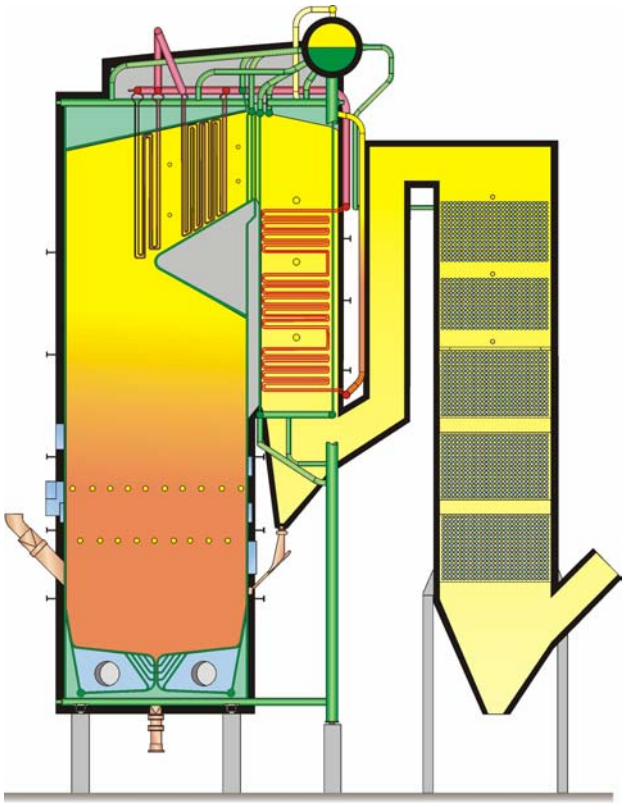


BFB boiler with fuel capacity of 48 MW. Foster Wheeler Energia Oy

Tenders for a district heating turbine and a steam boiler were requested with two different power-to-heat-ratio alternatives. The lower alternative was based on values that were normally used in Finland in the 1990's.

The higher power to heat ratio was the one selected, however. As a result, an additional 16% of electric output has been obtained, for only a 4% increase in investment costs.

Priorities in local biofuels

When the construction decision was made, on of the main objectives was to utilise as high a level of indigenous fuels (peat and biomass) as possible, at a high level of efficiency.

An environmental impact analysis was carried out. One main benefit of the type of plant ultimately selected was that the bulk of the fuel could be supplied from the surrounding area.

Fuel handling

Wood and peat are handled using the old fuel receiving and handling station and storage silo. From, here, fuel is fed into a 2000 m^3 intermediate storage silo. Recycled fuel is delivered to a dedicated receiving bin, from where it is transported to the main feeding conveyor, equipped with an electromagnetic separator. Fuel is conveyed by elevator to a screw feeder and into two 100 m^3 feeding bins, and then fed to boiler.

Investment supported by state

The government provided a € 2.7 million grant for the project, equivalent to 13% of the total €21 million investment budget.

Before the plant was built, Termia used approximately 95 GWh of indigenous fuels annually. Today, this figure is 220 GWh.

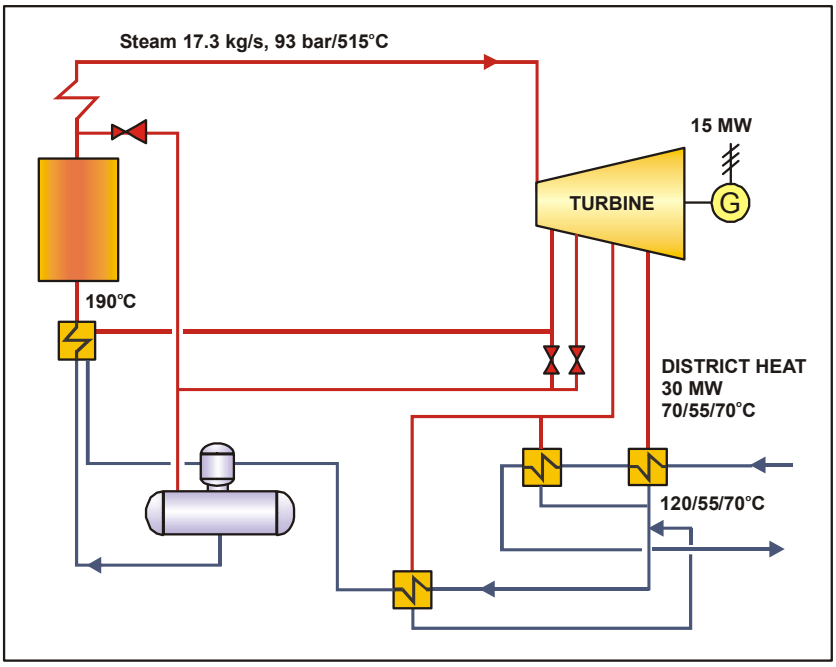
The main fuel is milled peat. Up to 30% of "green" chips from logging residues can be used. Recycled fuel can cover up to 3% of the total fuel requirement.

New plant will provide 85% of the district heat and 50% of electricity needed in Iisalmi town.

Modern technical design

The district heat output of the plant is 30 MW, with DH water temperatures of 55/85 ^{o}C. Backpressure electric output totals 14.7 MW at the generator terminals.

As the new plant has been built adjacent to existing heating facilities, the latter have been connected to the new unit, and their automation systems upgraded.



Process diagram of Iisalmi CHP plant.

The 45 MW_{th} steam boiler used is a multifuel-fired boiler, able to fire all biofuel and supplied by Foster Wheeler Energia Oy. The steam values after the boiler are 93 bar/515 °C.

Innovative steam turbine solution

The district heating steam turbine is a new single casing, two-stage model, with a double flow district heating tail.

This is the first unit of its type in Finland to be operated in this configuration, and has been supplied by Blohm & Voss Industrietechnic GmbH.

Steam flow is distributed to separate turbine flow sections in such a way that the steam is evenly distributed between both heat exchangers at higher DH water exhaust temperatures and at partial loads.

Technical data	
Boiler output	45 MW
Steam flow	17.3 kg/s
Steam pressure	93 bar
Steam temperature	515 °C
Fuel consumption	170 GWh
Electrical output	14.7 MW
District heat output	30 MW
Total investment	€21 million

This technical advance enables higher power generation output during the winter compared to a conventional backpressure turbine and the additional cogenerated power, which is achieved by 2-stage district heating water preheating, is not fully lost.

The power/heat ratio of plants with a similar size is approximately 0.4, in Iisalmi this figure is 0.49. The cost/benefit ratio is quite advantageous.

Additional information

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