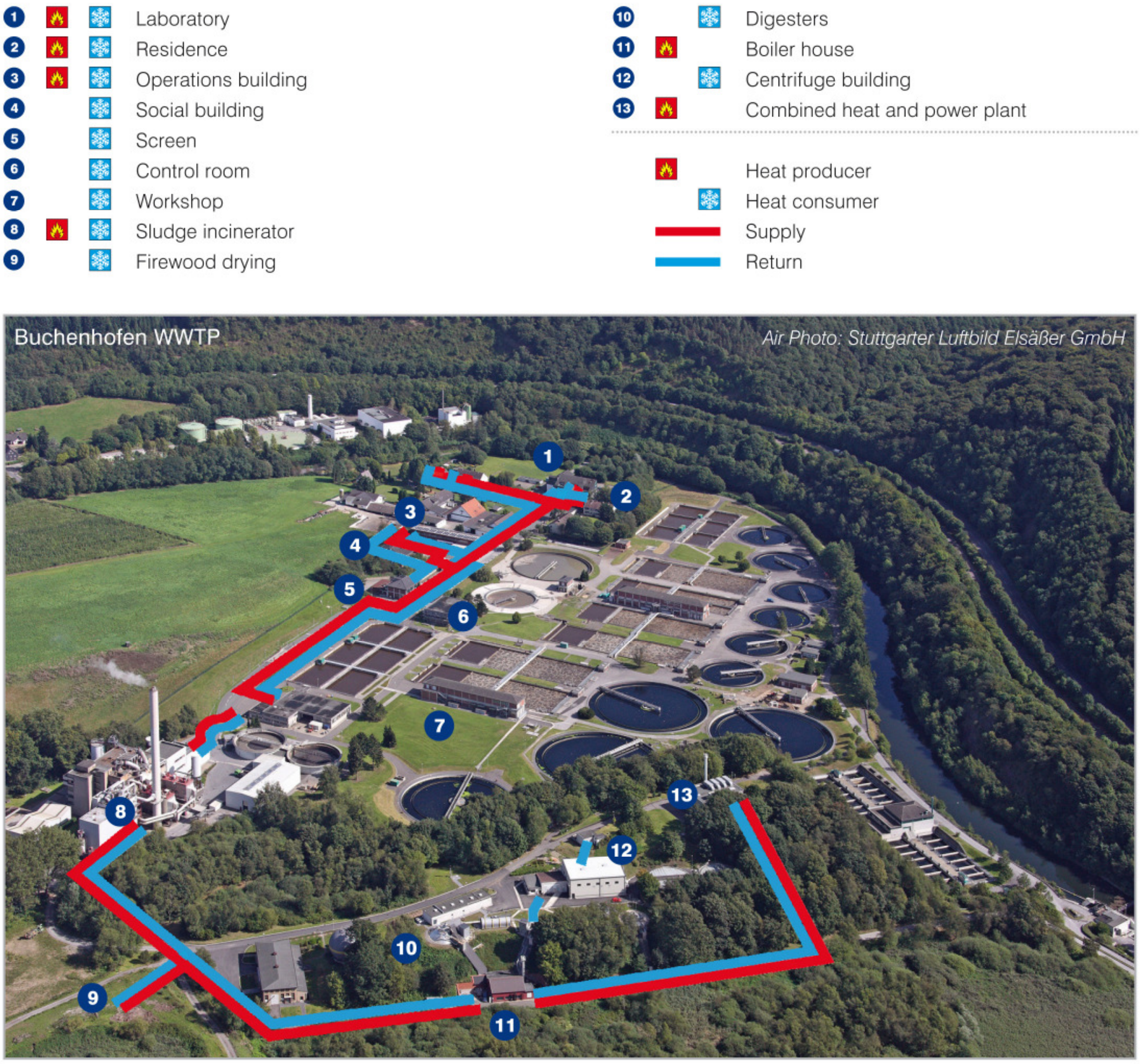
Decentralised heat grid for WWTP Buchenhofen



1. Background

In today's world, climate change and finite fossil fuel resources lead to the importance of energy efficiency in waste water treatment plants. Not only electrical, but also thermal energy can be seen as a "resource". Energy production, distribution, and consumption affect both the environmental and economic performance picture of the treatment plant.

The Buchenhofen Waste Water Treatment Plant, the largest waste water treatment plant of the Wupperverband, clarifies the waste water from 600,000 citizens from the city of Wuppertal. At the site in Buchenhofen is also located the sludge incineration plant of the Wupperverband. Here the sludge from the waste water treatment plants is dried and thermally combusted. The sludge incinerator (SVA) produces very high thermal energy quantities. In this context, it is interesting to look at the possibility of using thermal energy on site and to also examine whether a more energy-efficient operating mode exists for the formation of a heat network connecting to external loads.

A study about the technical and economical possibility of establishing such a decentralized heat grid was conducted by Ingenieurbür Friedrich on behalf of Wupperverband.

1.1 Task and Approaches

In a **basic evaluation** of the current state, the production and consumption of heat within the limits of the current system with typical and characteristic parameters is to be determined.

Based on this **scenario**, changes in the production side and also in the system boundaries should be described and accounted for. The **production side** is to address the future heat production of the new CHP modules and the possible heat extraction from the sludge incinerator.

In addition, the **consumer side** is to critically examine and develop ways of reducing the heat consumption, or the reduction of peak power.

The balance of the free heat is to consider whether the supply and external loads on the **establishment of a district heating network** is technically feasible and economically reasonable. External consumers in the vicinity of WWTP Buchenhofen (laboratory and houses) and in the surrounding area (from 0,5-2 km: Bayer and Bayer Sports Park sewage treatment plant) are to be considered.

In particular, technical possibilities for **connecting the heat input** from the sludge incinerator are to be discussed and a preferred solution is to be developed.

2. Actual State

2.1 Description of the local heating network

At the WWTP Buchenhofen a district heating network is operated, which is shown in Figure 1. The network has a length of 2 x 1,300 m (supply and return) with dimensions from DN 100 to DN 150 mm.

The district heating network is powered by three generators (CHP, boilers in the boiler house and boilers in new buildings). The boilers are operated with oil. The following consumers are connected to the heat grid:

- Anaerobic sludge stabilization
- Social and operational buildings (6 in total)

The largest consumer is the anaerobic sludge stabilization (digestion) of the sludge pipe heating and radiation losses at a relatively constant heat loss. In addition, a number of buildings connected to the district heating network show a fluctuating heat loss depending on usage.

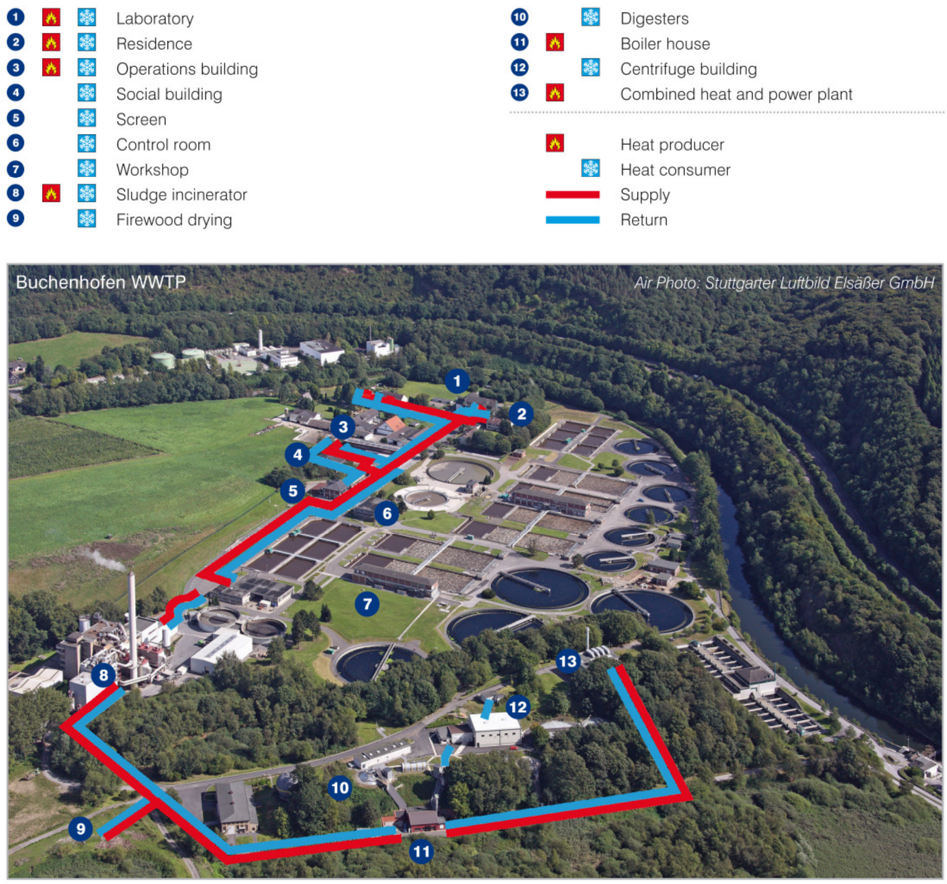


Figure 1: District heating network of the wastewater treatment plant Buchenhofen (The expansion of the network with the laboratory, residential buildings, and the split log drying is already included)

2.2 Heat balance of the current state

Overall in 2009, 10536 MWh of heat was produced. With relation to the self-energy production, the deficit was offset by 8.4% fuel oil (Figure 2). However, since heating oil was only used during the cold season (January – April and November and December) the deficit relates to this part of the year. In this case it is calculated to be 18.2 %. As shown in Figure 3, the use of fuel oil is necessary in the months of January to April. In the coldest month (January) the total heat demand is using 25%

of annual fuel consumption for heat production. In the months of May to October there is a surplus of thermal energy.

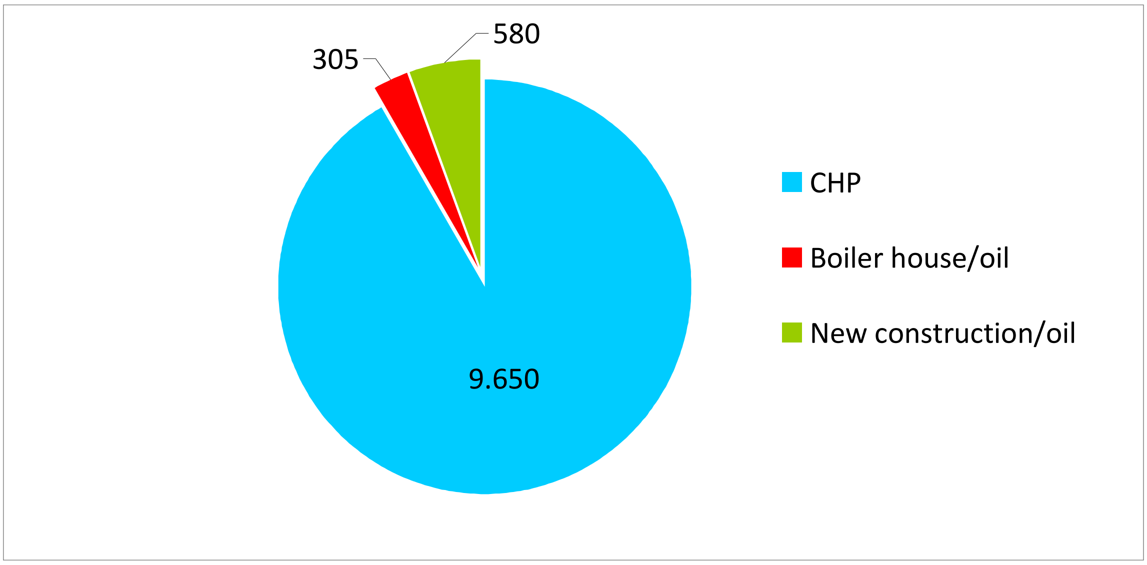


Figure 2: Distribution of heat production on producers in MWh / a

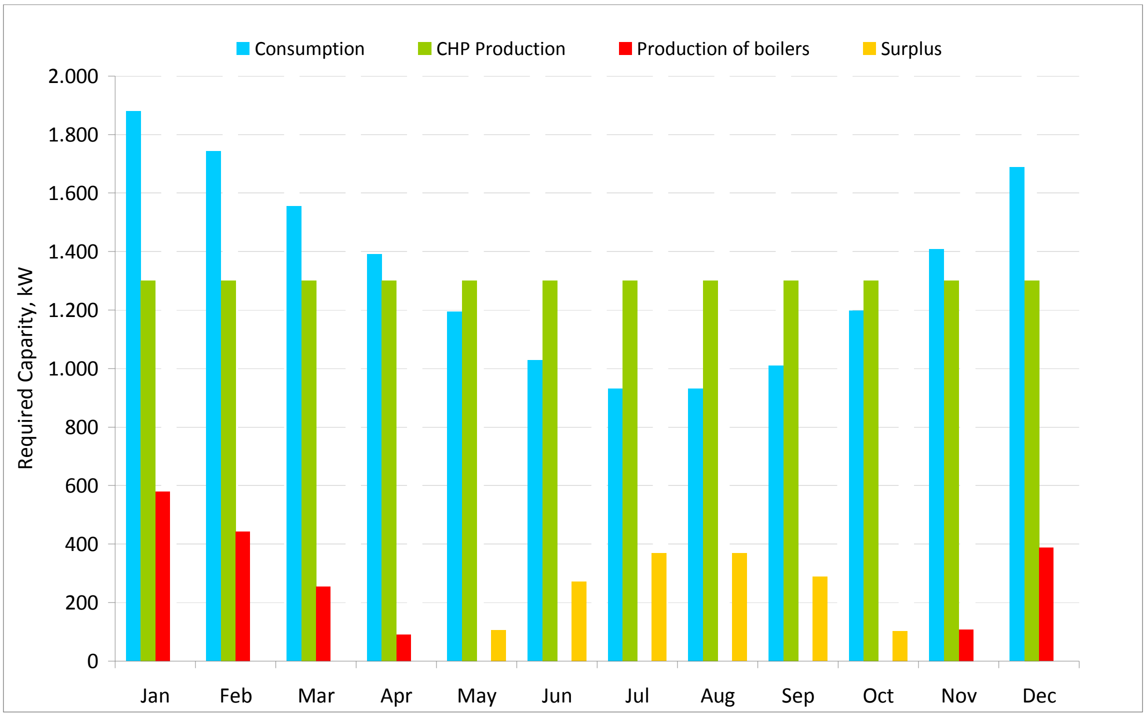


Figure 3: Possible heat balance for the water treatment plant Buchenhofen

3. Expansion of the decentral heat grid

With the connection of the sludge incineration to the decentralized heat grid, a high amount of thermal energy is made available. On the basis of this additional input of heat from the sludge incinerator, a scenario for an extended heat system was designed. A heat balance was prepared with consideration to the following consumers:

- WWTP Buchenhofen (Current energy consumption)
- Residential buildings and the laboratory
- Wastewater treatment plant of the company Bayer
- The Bayer sports park
- Drying of split logs

In Figure 4, it can be seen that the energy usage of the consumers is always below the total energy production from the CHP and the sludge incinerator. Even when wood drying equipment is operated, the amount of heat throughout the year is still sufficient.

Despite the amount of free heat, the connection of Bayer Sports Park to the heating network is not economically feasible. A connection of other new consumers is appropriate and advantageous with economic considerations.

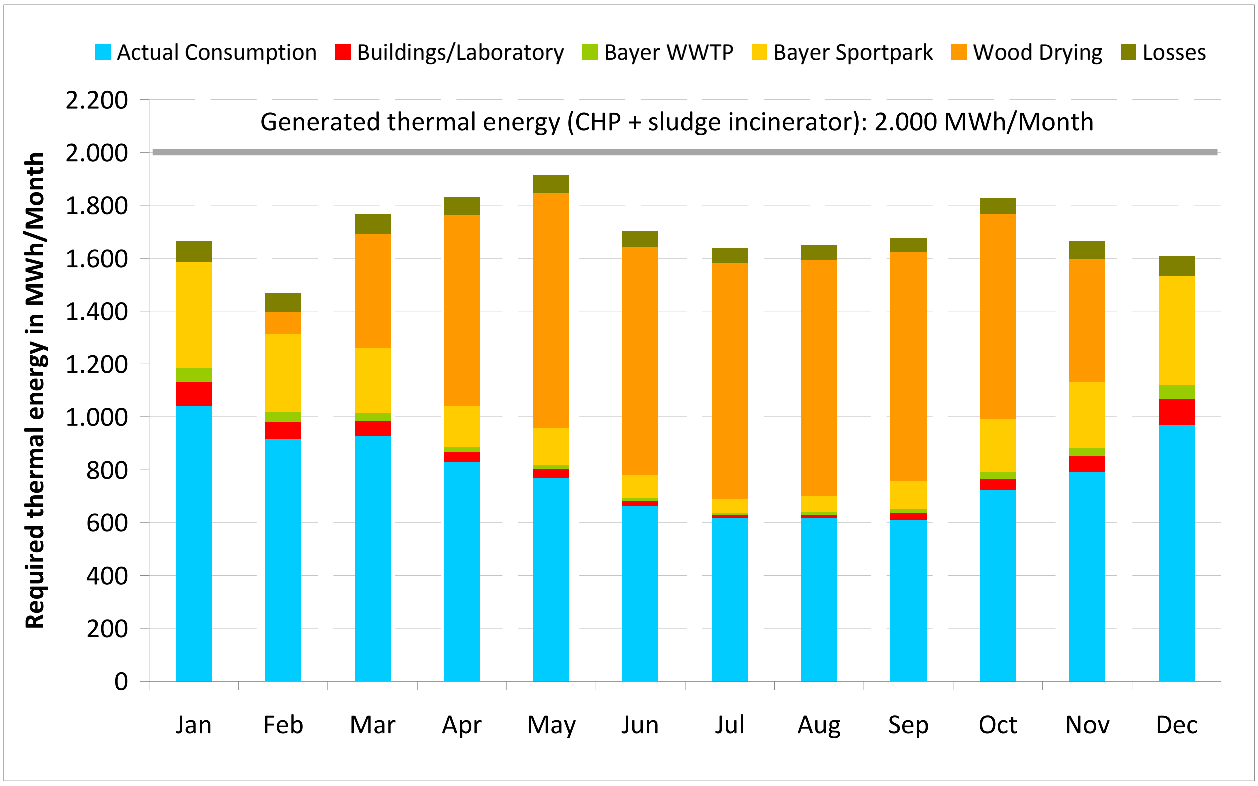


Figure 4: Balance of the thermal energy production of the decentralized heat grid

4. Summary and Outlook

With this concept, both the existing thermal power on the wastewater treatment plant premises and a heat balance established using measured values and assumptions of possible transit lines was described. Currently, a deficit of 8.4% exists in the thermal working which is balanced by heating oil.

From the diagram of the inventory, a heat balance was projected in the event that the cogeneration facility will be renewed. Taking into account the co-treatment of energy-rich co-substrates, a thermal deficit can be largely avoided.

Finally, on the basis of an additional input of heat from the SVA, a scenario for an extended heat system was designed. A heat balance was prepared with consideration of the connection between residential buildings and the laboratory, as well as wastewater treatment plant of Bayer and the Bayer sports park. After that there is only a small thermal power deficit. Even when wood drying equipment is operated, the amount of heat over the year is still sufficient.

Despite the amount of free heat, the connection of Bayer Sports Park to the heating network is not economically feasible. A connection of other new consumers is appropriate and advantageous with economic considerations.

The safe use of heat from the SVA requires that the temperatures in the heating power can are kept stable. Here, special attention is placed on the return temperature to the SVA. This temperature must always be low enough, because no heat can be transferred in the vapour condenser. In our view, the integration of the heat from the SVA is only possible at the location of the boiler house. As a type of application, we propose a combined variant return rise and flow injection on the consumer side.