Excess heat from lignite mining in Bergheim, Germany

This case study is part of a project catalogue produced by ReUseHeat to provide inspiration on how to utilize excess heat from urban sources for heating and cooling purposes. The catalogue contains 25 existing or planned projects out of which 12 cases are Danish and 13 cases are from other European countries[2].

Facts about this case

Installed heat capacity: 865 kW (heat pump) and 314 kW (CHP unit)
Heat source: Excess heat from open pit mining (27 °C)
Heat pump COP: 3.04
Temperatures: 27 °C sump water is cooled to 21 °C. District heating intake temperature is 45 °C and delivered at 85 °C.

Overall system efficiency: 167 %
Period: Finished in December 2014
Organization: Stadtwerke Bergheim GmbH

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Source: Dürr Thermea GmbH[1]

Description

The thermal potential of sump water from open pit mining is used to supply heat to nearby communities through district heating networks. A high-temperature heat pump utilizes geothermal energy from lignite mining in Bergheim.

The city of Bergheim is located left of the Rhine river near Cologne, right at the centre of a mayor lignite open pit mining district. In Bergheim, approximately ten public facilities are supplied with thermal heat through the communal district heating network. Sump water is a by-product of lignite mining, as groundwater needs to be drained from the open pit mine. The sump water contains a large geothermal potential, with temperatures up to 27 degrees Celsius. Sump water is accordingly drained through pipes and transferred approximately 400m to a heat generation station. Here, temperatures are raised in a heat pump to approximately 85 degrees Celsius, and heat is sent through the local district heating network to supply local consumers such as sport centres and schools.

The heat pump has a heat capacity of 865 kW and is driven by CO_2 hereby enabling high-temperature delivery. It is supplemented by a 400 kW CHP natural gas engine, a heat storage and two existing natural gas boilers of 1860 kW and 2300 kW, functioning as peak load units. Electricity produced in the gas-powered CHP unit is, in combination with sump water, used in the heat pump. Hereby energy from the open pit groundwater is extracted and utilized. If the CHP unit produce more electricity than the heat pump demands, it is supplied to the national grid. The heat pump operates with a COP of approximately 3.0. The total CHP and heat pump system has an efficiency of 167% and as electricity is supplied directly to the heat pump, the unit corresponds to a high-efficient natural gas boiler.

The system is supplemented by an energy storage tank with a volume of approximately $25m^3$. The buffer tank increases flexibility of the overall system and is able to supply the heating network for several hours. Hereby, the system can deliver heat in periods when the sump water supply is limited due to maintenance or other events.

The heat pump system reduces the fossil fuel demand by 26% and reduce the CO_2-emissions by 32% compared to the previous system without utilization of excess heat. It lowers the heat prices in the community and is a reliable source of energy, as two sources, electricity and gas, are used. By extracting energy from the lignite mine, groundwater temperatures are decreased which derive environmental benefits.[2]

References

1. Dürr Thermea GmbH
2. Handbook - 25 cases of urban waste heat recovery