ReUseHeat – Excess heat recovery from data centre in Braunschweig, Germany

1. Project summary

Name of the system	ReUseHeat - excess heat recovery from a data centre
Year of construction	2018 - 2019
Location of the system	Braunschweig, Germany
Name of the owner	Veolia Deutschland GmbH
Participating organisation	BS|ENERGY, Braunschweiger Versorgungs-AG & Co.KG.
Urban heat source	Data centre
Heat customer	Energy efficient residential area
Contact point BS Energy	Marta Rudzka, marta.rudzka@bs-energy.de

Figure 1. Project data

Total planned heated floor area in buildings connected	> 48000	m^2
Trench length for heat distribution network (LTDH)	2750	m
Trench length for high temperature network supplied by CHP	671	m
Trench length for cooling network	218	m
Thermal energy production	2300	MWh
Total heat demand	2116	MWh
Average pipe diameter in the heat distribution network	DN125-DN40	mm
Annual average supply temperature in the heat distribution network	70	°C
Annual average return temperature in the heat distribution network	40	°C
Annual average supply temperature in the cooling water network	25	°C
Annual average return temperature in the cooling water network	18	°C
Annual average outdoor temperature	10	°C
Energy savings yearly	1,284	MWh
CO2 savings yearly	304	t CO2
Heat pump COP	3,6	
Heat pump working liquid	CO_2	

Figure 2. Characteristic parameters

2. DHN in Braunschweig

Veolia's subsidiary BS|ENERGY owns and operates the district heating grid and the supplying power plants in Braunschweig. With its 263 km central district heating network in Braunschweig, BS|ENERGY serves 8,000 heat customers in Braunschweig which represents about 56,000 houses and apartments as well as commercial and municipal buildings, thus covering approximately 45% of the city's heat demand. On average about 804 GWh are sold per year. Peak heat demand on average amounted to 320 MW over the last years.

Heat is generated centrally at two combined heat and power (CHP) plants in the town centre (HWK Mitte) and in in the northern suburbs (HWK Nord), which feature a total of four generation systems as well as two peak boiler stations in the southern (HW Süd) and western (HW West) suburbs.

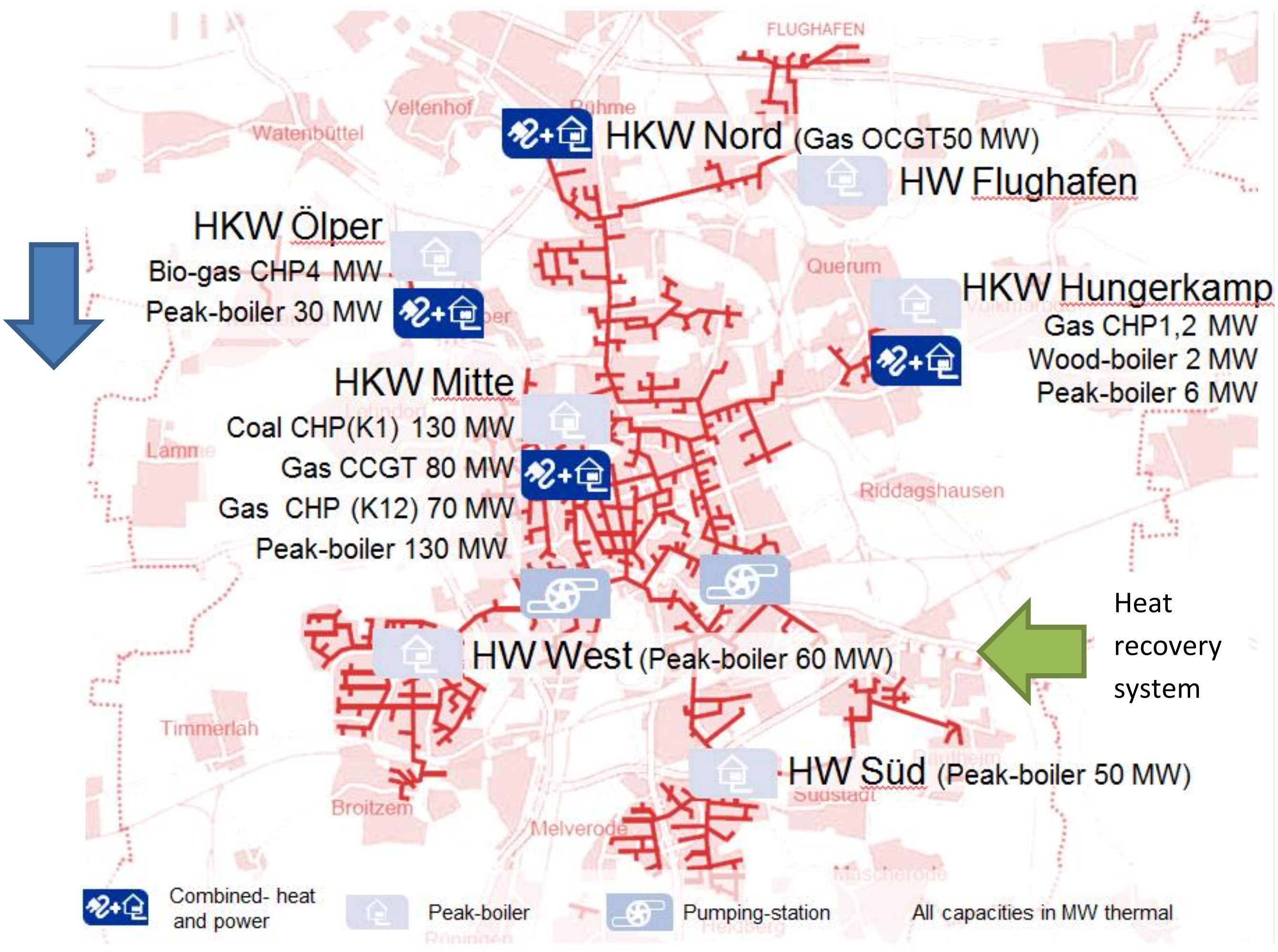

Figure 3. Heat generation, current state

3. General description of the project

A local property developer requested DH during the early planning phase of a new residential area. With the simultaneous construction of a new data centre in the adjacent parcel, Veolia identified this as an opportunity to develop an innovative DHN that would valorise the waste heat from the MW-sized cooling system of the data centre. Extracting heat from the data centre reduces the need to cool the data centre and associated energy consumption accordingly.

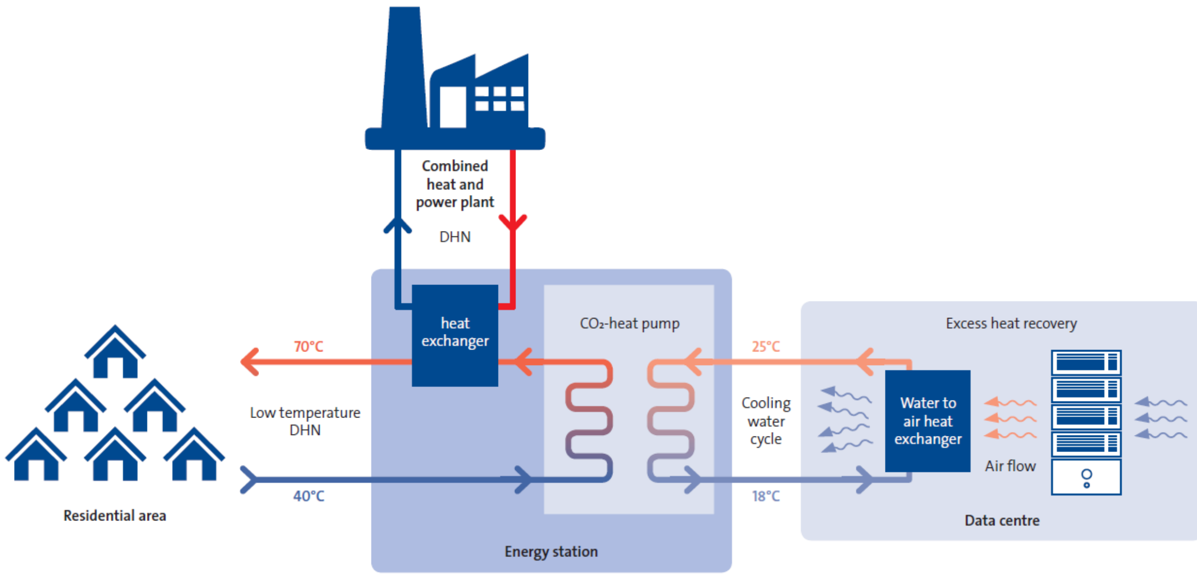

Figure 4. Heat recovery scheme

To supply a newly built energy efficient housing area consisting of 600 housing units with a net floor of 48.000m2, the low temperature 4th generation DHN will be used. The peak heat demand is estimated around 1.8 MW, and the base load will be covered by the waste heat recovery. The low temperature of the heat source implies using a heat pump to increase the DHN supply temperature to a satisfactory level. At the same time, keeping the temperature level of the DHN supply as low as possible is desired for high efficiency. A connection to the existing high temperature DHN of BS|ENERGY will also be provided, enabling flexibility and demand peak shaving. In addition, a fibre optic internet access infrastructure is part of the package for all clients.

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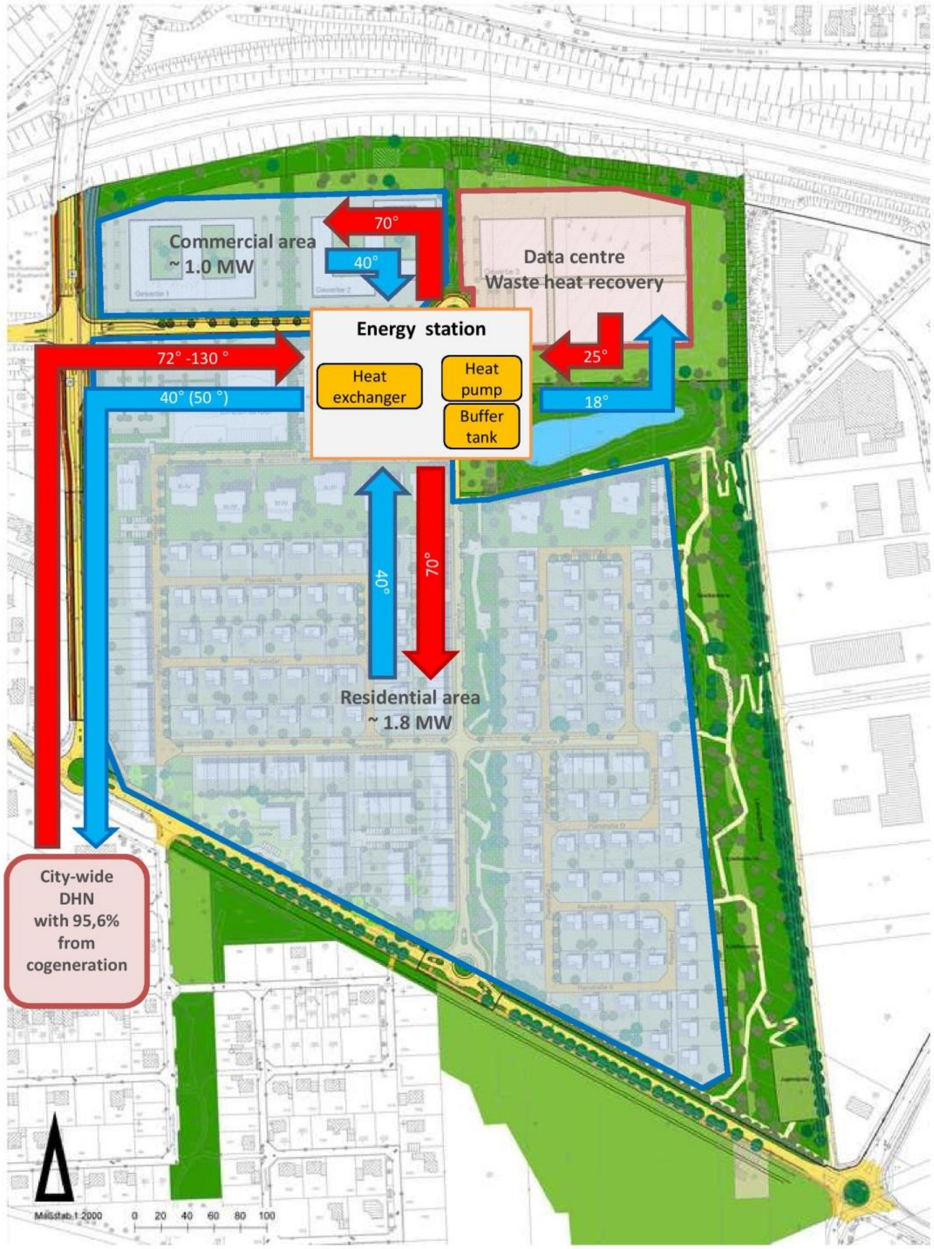

Figure 5. Excess heat recovery from data centre in Braunschweig

Excess heat recovery in Braunschweig is part of ReUseHeat funded by the European Union's innovative program Horizon 2020: www.reuseheat.eu. The project started in October 2017 and will last until September 2021. The production and operation of the heat recovery system starts in Q2 2019.

4. Technical description

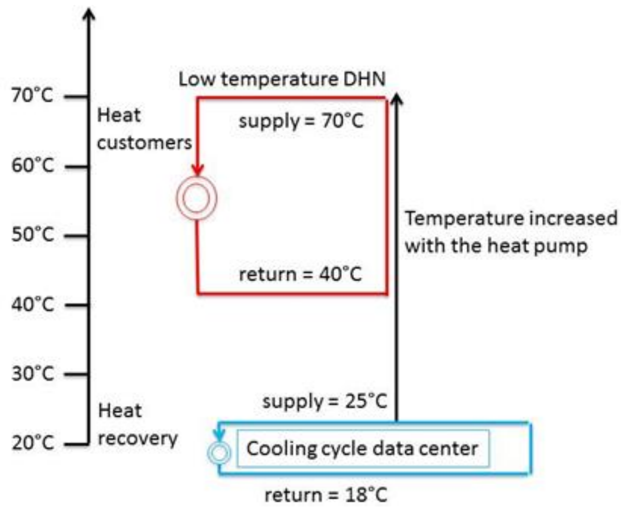

Figure 6. Application of the heat pump

Data centre operator transfers its excess heat to a cooling water cycle. The cooling water with a temperature of 25°C is forwarded outside of the data centre to the energy station. The heat pump boosts the temperature to the supply level of 70°C. The cooling water is now chilled to 18°C, an able to take up the excess heat again. The supply to customers is carried out through low temperature 4th generation DHN. The heat storage tank in the energy station with a capacity of 6m^3 is used to provide flexibility. The system is designed with the aim of providing the base summer load of heat demand for the houses. The rest of the heat demand is then supplied by the existing high temperature network powered by CHP through the heat exchanger. Such combination allows obtaining higher efficiency of the heat pump.

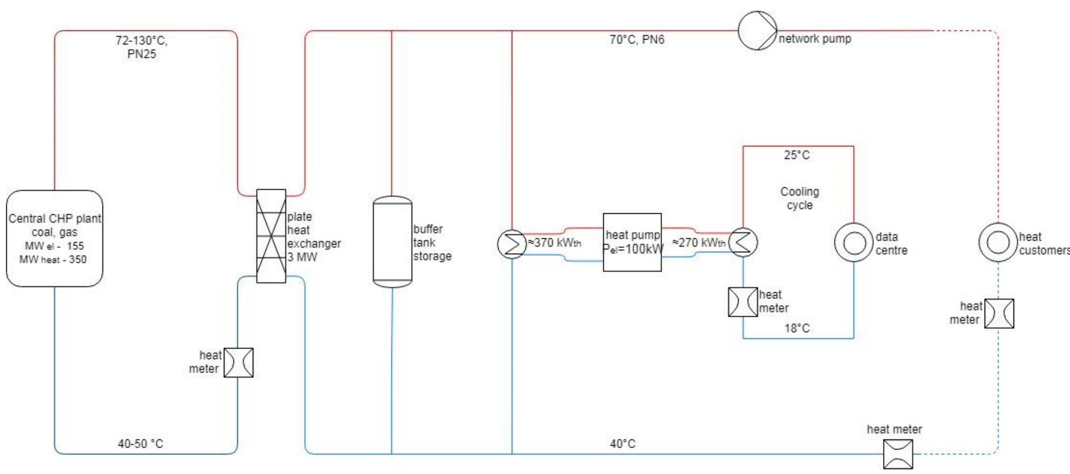

Figure 7. Conceptual diagram

5. Business model

The customers are private home owners. The contract is a ten year contract, this is the maximum number of years that a heating contract can run in Germany. Initially BS|ENERGY has written the contracts with the building developer, when the buildings are sold to private customers the contract are taken over by the new owners.

BS|ENERGY foresees to develop a business model that takes the value of green into account. In the future, low temperature heat recovery installations will support the company to diversify its heating offer. Also, the closer customer dialogue of the low temperature heat recovery installations will be solidified and improved over time, eventually leading to a closer partnership than is the case today.

6. Results of the project

Most of the electricity consumed by IT equipment in data centres is converted into excess heat. The cooling system represents up to 40% of their overall energy consumption.

In Europe, the total energy consumption of data centres was 56 TWh/year in 2007 and is expected to increase up to 104 TWh/year in 2020. The increase is mainly due to key drivers such as streaming services for movies and television, the emerging Internet Of Things (IOT) technologies and an overall increase in digital products and services. On the other hand, buildings are expected to become increasingly more efficient in reducing the thermal energy demand.[1]

That illustrates the high potential to create a new market for heat recovery solutions from data centres. Though heat recovery from data centres is an important part of a transition to a more sustainable heating system, and thus an integrant part of the EU's heating and cooling strategy, there are almost no practical references of large-scale implementation of such a concept.

Currently in Germany other demonstrations of excess heat recoveries from data centres that feed in a DHN are not common. There are no available examples of existing business models for such investments. Learnings from this project may empower numerous new excess heat recovery projects in future to recover heat instead of burning fossil fuels and thereby help to transform our cities into modern circular economies. The opportunity to carry out a similar project in another Veolia unit is currently being investigated.

With no heat recovery, the waste heat from the data centre would be discarded into the air and the housing area would need to install a decentralized gas fed system for heating and domestic

[1] https://www.reuseheat.eu/data-centres/

hot water. The demonstrator will be able to produce 2,300 MWh/yr of thermal energy, and to recover 1,750 MWh/yr of waste heat from the data centre.

The estimated COP for the heat pump is 3.6 and this is equivalent to an electricity demand from the heat pump of 580 MWh/yr. The average primary energy factor for electricity in Germany is 1.816 and this means overall primary energy consumption in the new scenario of 1,044 MWh/yr. Without the implementation of the waste heat recovery system, the thermal energy is produced through conventional decentralized gas boilers. Within the assumption of a primary energy factor for natural gas of 1.1, this is equivalent to 2,327 MWh/yr of primary energy that would be needed through natural gas boilers. This can be translated into an overall primary energy saving of 1,284 MWh/a. Considering an emission factor for natural gas of 275 g-CO_2/kWh and for electricity of 580 g-CO_2/kWh, this is translated into a global GHG emission savings of 304 t CO_2/a. Heat pump supplied with excess heat and electricity grid does not have negative impact on the local air quality comparing to supply from individual gas boilers.

Using low-grade urban waste heat leads to primary energy savings and related CO_2 emission savings. 4th generation low-temperature in DHN reduces energy losses in the network. The system is designed with the aim of providing the base summer load of heat demand for the houses. The rest of the heat demand will then be supplied by the existing CHP. Such combination will allow obtaining higher efficiency of the heat pump. This demonstration is an example of a new renewable energy businesses model.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768936.