Case study on large-scale heat pumps in the modernisation of the district heating system of Vienna, Austria

For more information

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Figure 1: View of the large heat pump in Wien Simmering (source: Segalla, 2018). ©Wien Energie / Zinner

Introduction

Specific information about the technology	
Set-up area	Vienna, Austria
Process application	Waste heat recovery (water and power)
Heat capacity output	40 MW
Heating capacity equivalence	25,000 households
Heat pump manufacturer	Friotherm
Commissioning	2018

Heat pumps are important for increasing energy efficiency and the reliability of renewable energy sources. If they are powered by renewable electricity, they might become a critical technology for decarbonising district heating systems. Scenarios made by the project Heat Roadmap Europe shows that with an expansion of European district heating systems, it is possible to cover up to 50 per cent of the heating demand in Europe, with 25 per cent of this energy coming from heat pumps.[1] This has the potential to reduce CO_2 emissions from the European heating sector by more than 70 per cent compared to the current situation.

In modern district heating systems, which exclude coal or gas as fuels, large-scale heat pumps are unavoidable solutions to achieve high production efficiency, energy stability and a significant decrease in CO_2 emissions.

A large heat pump in Vienna's Simmering power plant, financed by Wien Energy with total investment costs of EUR 15 million, is the largest in central Europe. It supplies the equivalent of 25,000 households with district heating from waste heat and ambient heat from the Danube Canal. The power plants surrounding the Danube in Vienna continuously produce waste heat, which is emitted into the nearby Danube Canal. The heat pump makes this waste heat usable again and generates heated water used for the district heating system at 100 to 150 °C.[2]

Governance and technology

Wien Energie's power plant, Simmering, is owned by Wien Energie GmbH, which is the largest energy supplier in Austria, with EUR 74 million in district heating investments into annually.

The Simmering power plant[3] is located in the 11th district of Vienna. With around 1.2 gigawatt (GW) of installed electricity generation capacity and 1 GW of thermal, it provides electricity and heat to the city of Vienna. In addition to gas and steam turbine plants, there is also a biomass power plant, a hydroelectric power plant and a photovoltaic plant operated there. Waste heat from these plants was previously transferred to the Danube Canal. This is why, in 2018, a large heat pump was added, which uses the cooling circuit of the power plants as an energy source. When the surrounding power plants are not working, it is also possible for the heat pump to use water from the Danube Canal as a heat source, as the heat pumps are able to use water with temperatures as low as 6 °C.[4]

[1] Henrik Lund et al., 4th Generation District Heating (4GDH): Integrating smart thermal grids into future sustainable energy systems, *Energy*, 1–11, 15 April 2014.

[2] KLINGER Holding, 'Wien Energie and KLINGER Gebetsroither installed Vienna's first large-scale heat pump', *KLINGER Holding*, 15 January 2018.

[3] Wien Energie, 'CHP plant simmering', *Pagestrip*, accessed 19 April 2022.

[4] V. Wilk et al., Structuring information on industrial heat pumps and preparation of guidelines, *IEA HPT*, 19-21, August 2019.

Performance and operations

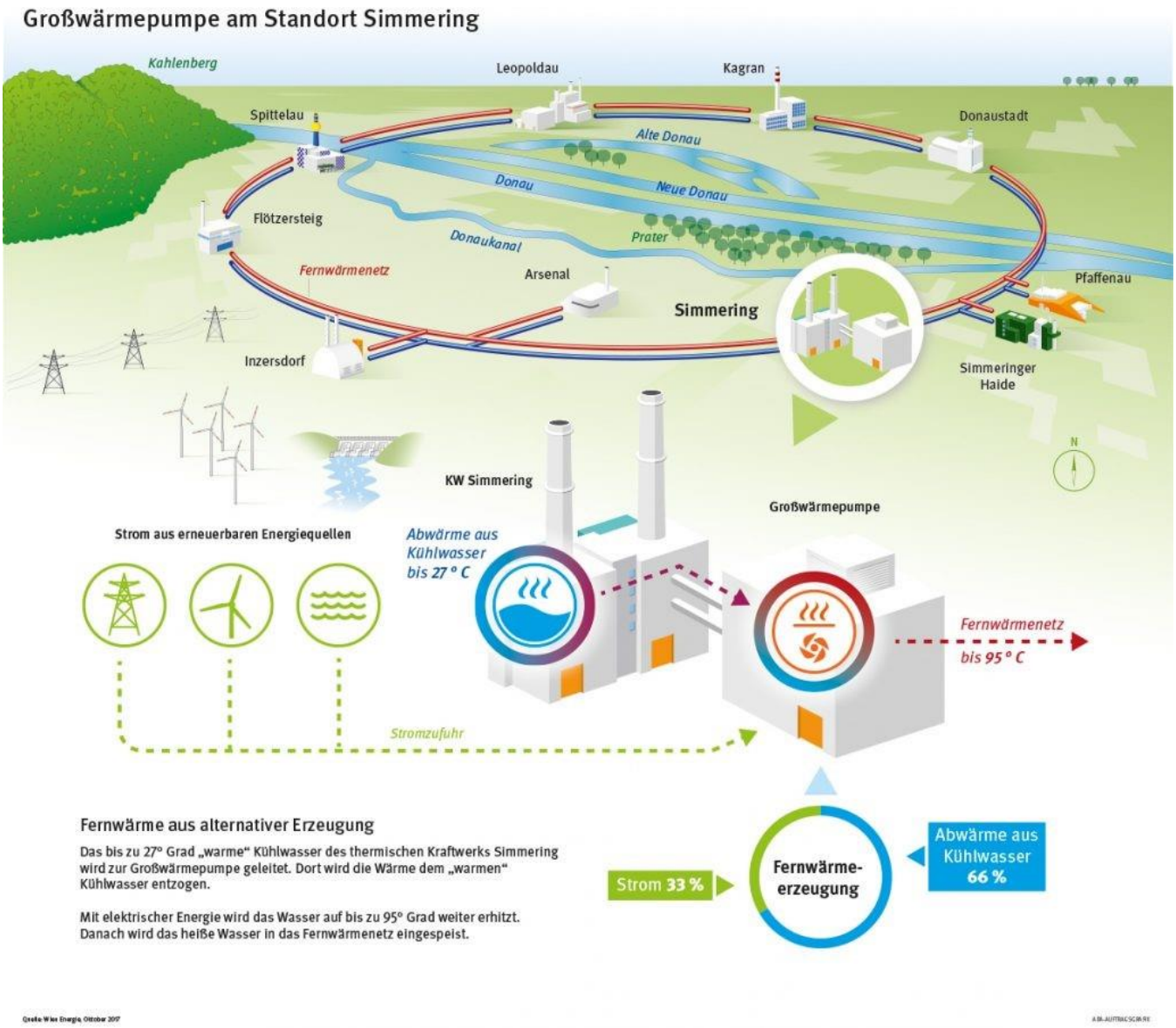

Figure 2 shows an illustrative representation of how the large heat pump is integrated into the power plant sites. ©Wien Energie / Zinner

The system consists of two identical compression heat pumps, shell-and tube heat exchangers with a total capacity of 18 to 27 MW. Each heat pump is equipped with a heat exchanger (subcoolers and condensers). The district heating water first flows through both subcoolers in parallel, then through the first stage condenser, then through the second stage condenser. By changing the valve positions, the condensers can also be used in parallel. This allows the flow temperatures and output of the heat pump to be varied to make the best possible use of the heat pump. Since the Vienna district heating network is operated with flow temperatures of up to 150 °C, the heat pump was integrated in a two-fold way: into a subnetwork with a lower operating temperature and also into the high-temperature heating grid.

The plant has fast commissioning period: it was announced in 2017 and finalised at the end of 2018. It had low start-up costs and today generates up to 150 GWh heat per year.[5]

Final remarks

The use of heat pumps is projected to increase in district heating systems because they can deliver heat with high efficiency and at the same time create a link between the heating and electricity sector by utilising intermittent renewable energy sources. In the case of Vienna, large-scale pumps are used for waste heat from various industrial sources, including generation from coal, gas, large-scale biomass or waste incineration. This kind of practice should be avoided, and priority should be given to the integration of variable renewable sources to achieve lowest CO_2 footprint of thermal energy.

There are many other potential waste heat sources that can be efficiently used for district heating combined with heat pump technology such as industry (data centres, steel works) or utilities (waste water treatment facilities, mega markets, shopping malls), as well as directly from air, geothermal or water reservoirs.

The integration of large-scale heat pumps in future district heating systems is important for multiple reasons:

1. Heat pumps play an important role in integrating more renewable energy and phasing out fossil fuels from the energy systems;
2. They enable district heating systems to balance the power grid when the production of electricity from intermittent renewable energy sources fluctuates;
3. They make it possible to utilise excess heat at low temperatures; and
4. They increase the flexibility of district heating systems by utilising multiple sources of heat.[6]

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[5] Wien Energie, Central Europe's most powerful large-scale heat pump pumps in Vienna, *Wien Energie*, 6 March 2019.

[6] Anton Faik, Heat pumps in district heating systems, *Celsius*, 28 May 2021.