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Factsheet T.2.2

In depth analysis of the case study in Weiz-Gleisdorf

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ETHICS	Deliverables related to ethic issues	☐
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OTHER	Software, technical diagram, algorithms, models, etc.	☐

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1. INTRODUCTION

The inter-municipal district heating network along the Weiz-Gleisdorf axis represents a significant collaborative initiative by district heating network suppliers from the municipalities of Weiz, Unterfladnitz, St Ruprecht, Wollsdorf, and Gleisdorf. The suppliers involved are actively pursuing the formation of a network association aimed at exploiting the substantial potential for integrating locally available renewable energy sources into the regional energy infrastructure. This strategic interconnection is designed to establish a robust and sustainable energy framework capable of meeting the heating demands of residential areas, urban centres, and industrial establishments distributed along this axis.

Currently, concepts are being developed to merge the distinct district heating systems of these municipalities into a unified, intercommunal network. This integration is expected to increase heat generation capacities significantly, transitioning from the existing annual production of approximately 100 GWh to a projected range of over 200 GWh. The project thus addresses the dual objectives of achieving increased energy distribution and enhancing system sustainability.

Presently, the collective district heating infrastructure has a capacity of 71.6 MW_{th} for heat production. However, plans are in place to augment this capacity to about 100 MW_{th}, entirely sourced from renewable energy. This development encompasses not only the expansion of the distribution network but also substantial increases in heat storage capabilities. By achieving a fully renewable district heating system with expanded infrastructure and storage capacities, the Weiz-Gleisdorf initiative aims to set a benchmark for regional sustainability, ensuring long-term energy efficiency and environmental compatibility.

2. THE DISTRICT HEATING SYSTEM (AS IS)

2.1 Energy generation

The current status quo of the district heating system along the Weiz-Gleisdorf axis is characterised by a diversified portfolio of heat generation technologies, primarily harnessing renewable and locally available resources. The total installed thermal capacity across the towns involved encompasses biomass boilers fuelled by wood chips with a cumulative capacity of 33.9 MW_{th}, solar thermal installations contributing 1.9 MW_{th}, industrial waste heat recovery systems accounting for an additional 12 MW_{th} and one bio-oil boiler with a capacity of 10 MW_{th}. Complementing these renewable-based systems, fossil fuel-based plants include two oil boilers with 10 MW_{th} and natural gas boilers totalling 3.0 MW_{th}. Furthermore, a heat pump system utilising thermal energy from wastewater treatment contributes an additional 0.8 MW_{th} to the supply portfolio.

Based on operational data from the year 2023, these generation assets collectively supplied approximately 100 GWh of thermal energy to the local district heating networks. Additionally, the existing infrastructure includes decentralized thermal storage capacities comprising 12 heat storage units distributed across the municipalities, providing an aggregate storage volume of 1,050 m^3.

The primary energy consumption associated with the operation of these heating systems, detailed in the accompanying table, amounts to a total annual value of approximately 135.5 GWh.

Table 1. Primary Energy Consumption

Primary Energy	Biomass	Natural Gas	Oil	Electricity	Waste Heat
Consumption [GWh/year]	127.5	3.6	0.33	1.8	2.3

2.2 Energy Distribution Network and Consumers

The district heating systems along the Weiz-Gleisdorf axis currently consist of five distinct operators independently supplying heat to a total of about 1,200 customers and heat consumers in different municipalities through separate networks. Each operator maintains its district heating distribution infrastructure, characterised by its technical parameters, including network length, thermal peak load, and varying infrastructure ages, as outlined in the accompanying table.

Table 2. Technical Aspects of the District Heating Networks (Status of 2023)

Town	Network Length [km]	Connected Load [MW]	Construction Year (beginning)
Gleisdorf	11.7	10.7	2000
Wollsdorf	4	5.2	2023
St. Ruprecht	5	4.9	2001
Unterfladnitz	1.5	0.5	2006
Weiz	55	47	1995
Total	**77.2**	**68.3**	

Operational temperature regimes within these district heating networks predominantly adhere to supply/return temperature schemes of 80-90°C / 50-60°C, utilising hot water as the heat carrier medium. An exception to this standardisation is the town of Weiz, which operates its district heating system at higher temperatures, specifically maintaining a supply/return temperature scheme of 90-105°C / 50-60°C, respectively.

The operational control strategy across these networks uniformly employs weather-compensated regulation, dynamically adjusting supply temperatures in response to outdoor ambient temperature fluctuations. This approach optimises heat distribution efficiency and reduces heat losses, particularly during transitional seasonal periods with milder weather conditions.

The technical data of heat generation and heat distribution are summarised in Table **2** for the individual heating networks.

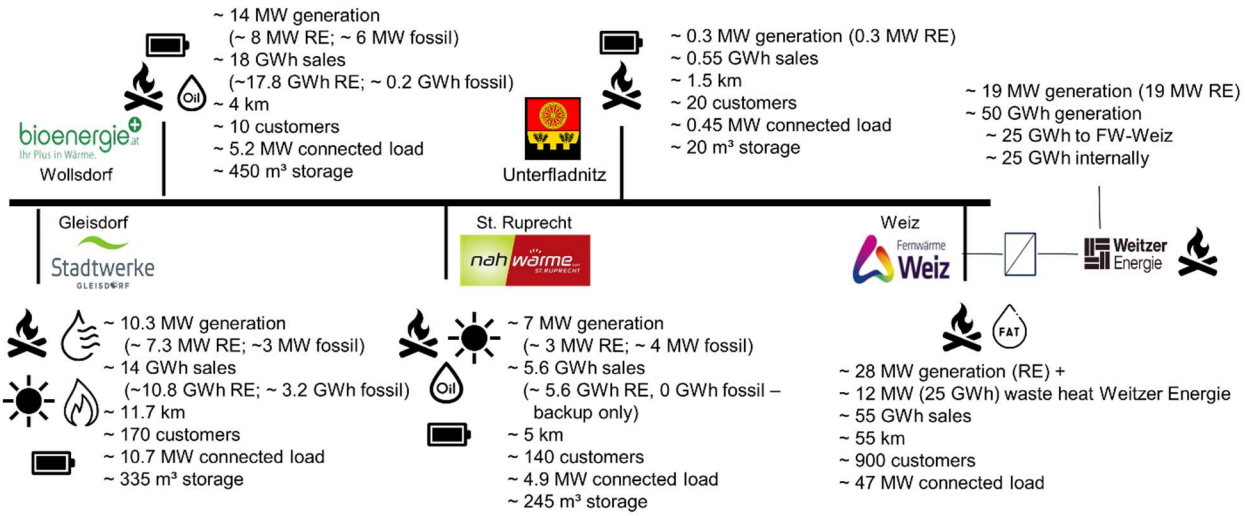

Figure 1. Status quo analysis of the district heating networks, including all heat generation units and storage facilities illustrating the present conditions intended for hydraulic integration within the planned inter-municipal district heating network.

3. UPGRADING MEASURES

The envisaged integration of currently independent district heating networks along the Weiz-Gleisdorf axis necessitates the implementation of comprehensive upgrading measures, following a holistic and systemic approach. This systemic integration aims to achieve substantial enhancements in heat generation efficiency, the incorporation of renewable energy sources, and the adoption of advanced technical solutions such as sophisticated monitoring systems, thermo-hydraulic network simulations, and digital planning tools.

Central to the upgrading strategy is the cooperative expansion of renewable generation and heat storage facilities, including but not limited to deep geothermal energy utilisation, solar thermal systems, cogeneration plants, and the exploitation of waste heat from low-temperature sources such as wastewater and industrial processes. Upon successful implementation, the inter-municipal heating network is projected to achieve a total installed generation capacity of approximately 100 MW_{th}, entirely derived from renewable sources, effectively phasing out fossil fuels completely. The aim is to elevate the existing annual production of approximately 100 GWh to a projected range of over 200 GWh. Besides the increase in generation capacity, an expansion of the network infrastructure, an increase in customers and the installation of additional heat storage will be necessary to achieve this goal.

Technical challenges associated with developing the inter-municipal network include establishing robust hydraulic interconnections among the existing individual district heating systems and heat generation facilities, effectively integrating large industrial consumers, and enhancing flexibility at heat generation plants through measures such as thermal storage integration and improved efficiency techniques, notably flue gas condensation systems for biomass boilers. In addition, an intelligent control system and a merit order system for the whole network are needed.

Evaluations of locally available renewable energy potentials are essential for achieving the sustainable operation of the integrated network. One significant option being investigated for medium-term integration is deep geothermal energy, driven by promising outcomes from drilling activities conducted by the oil industry, which successfully penetrated carbonate formations considered viable geothermal reservoirs. Given the planned network expansion and anticipated load profiles, it is feasible to assume full utilization of heat generated from a deep geothermal facility, thereby reinforcing the carbon-neutral ambitions of the project.

The potential of solar thermal energy as a generation source was already analysed at the location of the heating network St. Ruprecht, particularly addressing the challenge of managing its inherent volatility and minimising occurrences of collector stagnation during low-demand summer periods. An additional feasibility study for the integration of solar thermal energy was performed for Weiz. However, neither network has yet implemented the additional solar thermal plants.

In parallel, considerable emphasis is placed on harnessing energy from wastewater, specifically at the Gleisdorf wastewater treatment facility. Detailed monitoring data analysis of the 800 kW_{th} heat pump (generating about 4,000 MWh/a), already installed in Gleisdorf, validated the feasibility of utilising wastewater-derived energy through large-scale heat pump systems. Plans to further expand these renewable energy integrations are under consideration, with detailed evaluations resulting in a total annual heat generation capacity of approximately 18,000 MWh from wastewater resources upon full implementation.

Additionally, systematic identification and evaluation of industrial waste heat potentials need to be undertaken, aided significantly by the Styrian waste heat register. Prominent local industrial entities, including e.g. Weitzer Energie, Alwera (focusing on waste heat recovery from heat pump operations), Siemens/Andritz, and Agrana, are actively involved in initial assessments and potential quantification. These waste heat resources represent valuable opportunities to further strengthen the energy portfolio of the inter-municipal district heating network, thereby contributing significantly to its efficiency and sustainability objectives.

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