

Successful Modernisation Measures in Biomass-Based District Heating Networks in Austria

Joachim Kelz, Stefan Retschitzegger

At both the national and EU levels, there is broad consensus that the use of renewable energy sources must be further intensified in order to reduce greenhouse gas emissions. Across Europe, targets for emission reduction and energy system transformation have been defined within frameworks such as the European Green Deal and the “Fit für 55” package (*engl. Fit for 55*). Achieving these goals requires particular attention to the long-term planning and sustainability of heat supply systems.

In Austria, approximately half of total final energy consumption is used for heating purposes, including space heating and cooling, domestic hot water, and process heat. In 2023/24, around 40 % of total heat demand was covered by renewable sources. In the district heating sector, the renewable share amounts to roughly 50 %, primarily supplied by biomass. Beyond climate considerations, current geopolitical and energy policy developments underscore the urgency of reducing dependence on fuel imports and fossil energy carriers. Rapid and comprehensive diversification and defossilisation of the heating sector therefore constitute a central challenge. In addition to appropriate policy and regulatory frameworks, targeted projects operating between research and demonstration such as “BM Retrofit” are essential to support this transition.

The Role of Biomass-Based District Heating Networks in Austria

While 50 to 70 years ago urban heat supply in Austria was largely based on fossil fuels and fossil-fired CHP plants, rural regions began implementing local district heating networks based on solid biomass from around 1990 onwards. Currently, approximately 2,500 biomass-based district heating plants



*Opening ceremony in Wald im Pinzgau with representatives of the project team and relevant stakeholders and local actors.
Source: Klimafonds / Krobath*

and around 150 biomass CHP plants are in operation across Austria. Oil and/or natural gas boilers are typically used for peak load coverage and backup purposes. Biomass-based district heating networks thus represent an efficient and flexible pillar of the energy transition.

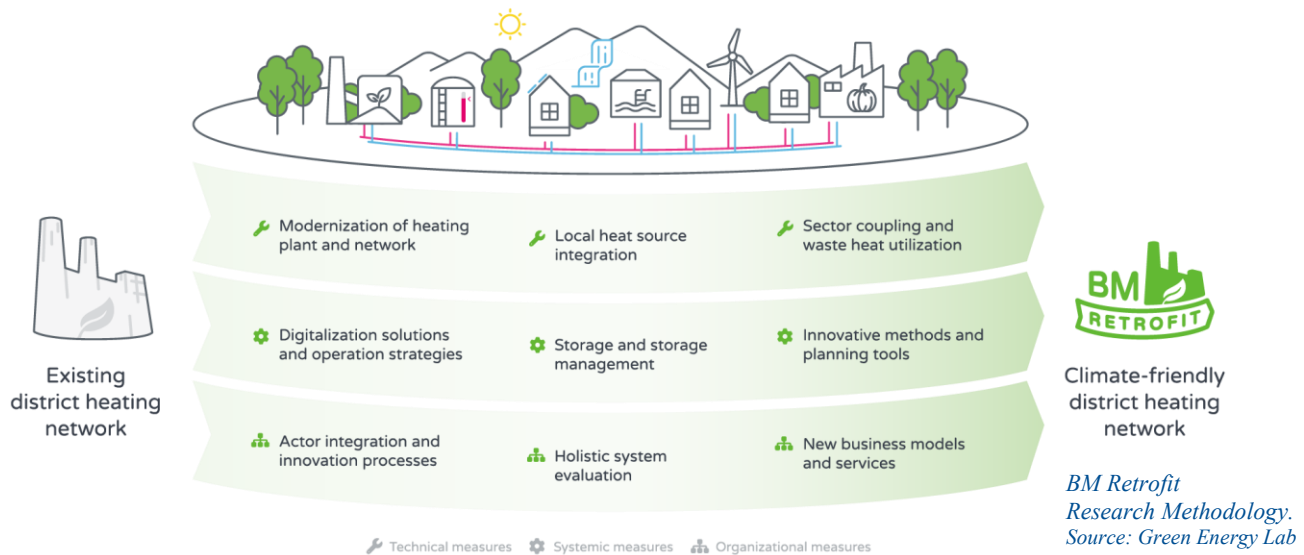
However, older district heating networks in particular face increasing needs for retrofitting and modernisation to meet current and future technical, economic, and regulatory requirements and to enable the sustainable strategic expansion of the DH network. In practice, a systemic and holistic approach within the concept development is often lacking, and measures tend to be implemented in isolation rather than as coordinated packages. As a result, existing optimisation potential frequently remains underutilised.

Research Approach and Innovation Methodology

Within BM Retrofit, a holistic methodological approach was developed, combining technical, organisational, and systemic measures. This integrated strategy enabled existing district heating networks to be adapted and further developed to meet future requirements. The resulting concepts were demonstrated at three pilot sites, so called demonstrators, Wald im Pinzgau, Saalfelden, and Kreuzstetten and in specific use-cases, including the integration of absorption heat pumps, thermo-hydraulic simulation tools, and predictive control strategies.

The entire process was accompanied from the identification of site-specific challenges through concept development, detailed planning, and implementation to data monitoring and optimisation.

BM Retrofit – Development and demonstration of holistic retrofitting concepts for biomass-based district heating networks



Core Elements of the Demonstrators

The technical components and innovative elements (e.g. integration and optimisation of thermal storage systems; implementation of efficiency-enhancing measures such as flue gas condensation units and (absorption) heat pump systems, etc.) incorporated into the holistic concepts were further developed for efficient system integration and tested, validated, and optimised under real operating conditions at the demonstration sites. They serve as prototypical model solutions for broader replication.

- **Wald im Pinzgau:** Utilisation of low-temperature waste heat from a nearby hydropower plant (cooling circuit) via a 250 kW heat pump; installation of a power-to-heat unit to ensure operational redundancy; 30,000-litre buffer storage tank to enhance flexibility and cover load fluctuations.
- **Saalfelden:** Modernisation of the biomass boiler system; integration of a cascading heat pump concept (3 x 250 kW) into the flue gas condensation process to increase efficiency; innovative control strategy using CO lambda sensors to optimise biomass boiler operation; upgrade of flue gas cleaning (electrostatic precipitator); 150,000-litre buffer storage tank; installation of a new supply line to increase transmission capacity.
- **Kreuzstetten:** Targeted network densification based on network simulations; modernisation

and improvement of boiler control systems; optimisation of buffer storage management to reduce unnecessary load fluctuations; reduction of return temperatures through secondary-side measures; implementation of a new operational and business model to enhance economic performance.

Holistic Assessment and Accompanying Processes

Based on detailed data monitoring, the technical, economic, and environmental impacts of the implemented measures were systematically analysed.

- **Wald im Pinzgau:** The integration of the heat pump and thermal storage allows the biomass boiler to be shut down during the summer months. This results in annual savings of up to 10,000 litres of oil and 1,000 bulk cubic metres of biomass.
- **Saalfelden:** The combined measures lead to annual savings of approximately 1,000 MWh of natural gas, while generating around 4,000 MWh of additional yield from the biomass boiler system, including heat pump integration. This enabled the connection of 15 new heat customers without expanding generation capacity.
- **Kreuzstetten:** Return temperatures were reduced by up to 20°C through secondary-side optimisation measures, leading to a reduction in network heat losses of approximately 15%. Optimisation of buffer storage operation and boiler

control reduced boiler start-ups by more than 60 %, thereby increasing overall system efficiency and extending boiler lifetime.

Lifecycle assessments and value chain analyses were conducted to evaluate impacts on greenhouse gas emissions, primary energy consumption, and domestic value creation. Scaling scenarios were developed to assess market potential and energy system impacts. These comprehensive evaluations generated valuable insights for further development and transfer to the broader sector of district network-based heat supply.

Stakeholder and actor identification and engagement constituted another key success factor. Active involvement included workshops, information materials, and public events such as open days to present innovations at the demonstration sites. These activities facilitated dialogue between operators and citizens, improved transparency, strengthened public trust, and provided valuable feedback that proved crucial for acceptance.

Summary and Outlook

BM Retrofit has demonstrated that large-scale implementations can be realised within comparatively short timeframes. A system-level integrated

perspective is as essential as the application of innovative methods, permanently embedded within a long-term development strategy.

The research approach enabled the implementation of intelligent energy systems that enhance overall efficiency and flexibility while reducing emissions. It supports optimal use of locally available energy sources, leverages synergies within existing infrastructure, and establishes future-proof, sustainable, and economically viable systems.

The systemic solutions lead to a pioneering role at national and European level in this field, with high scalability potential.

To further advance the heat transition in the district heating sector, additional challenges must be addressed, including integration of large-scale thermal storage and deep geothermal energy, phase-out of large gas-fired CHP plants, and intelligent sector coupling through the use of regional surplus electricity for heating applications. There is also an urgent need to develop new business models and transparent tariff structures to ensure long-term economic sustainability.

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Dipl.-Ing. (FH) Joachim Kelz is a researcher in the “Cities and Networks” department at AEE INTEC. j.kelz@aee.at

Dr. Stefan Retschitzegger is a researcher in the “Cities and Networks” division at AEE INTEC. s.retschitzegger@aee.at

Sources and further information

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The Transformation of District Heating Networks



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