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DEVELOPING HIGH-EFFICIENT BIOMASS-BASED DISTRICT HEATING SYSTEMS FOR RENEWABLE HEAT SUPPLY

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SUMMARY

The transformation of existing biomass-based district heating systems into high-efficient systems requires holistic retrofitting and modernization concepts as well as a portfolio expansion. Within BM Retrofit, the corresponding technological and non-technical measures as well as the system-wide steps, are being developed and tested. The solutions are subsequently implemented and realized in biomass-based district heating networks in Austria at different locations with accompanied data evaluation as well as holistic system validations including life cycle and value chain analysis. Identified optimization potentials and experiences from the whole innovation process will be summarized in guidelines including lessons learned and best practices, that show technical, economic, and ecological benefits and impacts. Moreover, scaling scenarios to generate and assess the market potential and to determine benefits and impacts on the energy system are addressed.
Key words: biomass, district heating, retrofitting, efficiency improvement

INTRODUCTION

Biomass-based district heating systems are crucial for sustainable heat supply in Austria, with approximately 2,400 heating plants and about 150 CHP plants, often with oil and/or natural gas boilers for covering peak load and as a backup [ÖBMV, 2023]. A growing need exists for retrofitting and modernizing these systems to meet future challenges and realise high-efficient biomass-based DH system, both technical and non-technical. Technical improvements include optimizing biomass boilers, integrating storage, enhancing efficiency, and adopting digitalization through sensor technology and control concepts. Non-technical measures involve strategic grid expansion, coupling with energy planning, integrating new energy sources, and considering economic factors like production costs and billing models. Currently, the development of modernization concepts often lacks a systemic and holistic approach. This is addressed in the “BM Retrofit" research project, by creating and demonstrating such an approach for the necessary transformation process. BM Retrofit is part of the Green Energy Lab, a research initiative for sustainable energy solutions and part of the Austrian innovation programme "Vorzeigeregion Energie" of the Climate and Energy Fund.

THE BM RETROFIT APPROACH

Since late 2022, an interdisciplinary team led by AEE INTEC has been working on this three-year project. Their goal is to develop and demonstrate comprehensive modernization concepts for heating networks, focusing on three key objectives: a) adapting existing systems to future requirements, b) contributing to climate targets, and c) enhancing economic benefits and local value creation. The project uses a methodology built on three pillars: technical measures (e.g. flue gas condensation units, heat pump systems, storage technologies, sector coupling), non-technical/organizational measures (e.g. stakeholder analyses and actor integration, new business models), and systemic approaches (e.g. energy management systems to optimise operation strategies, storage management, modelling of DH networks for expansion planning). The "BM retrofit" approach aims to create a sustainable energy system with high efficiency, increased use of locally available renewable energy, maximized

infrastructure synergies, and enhanced resilience, resulting in reduced emissions, resource consumption, and increased supply security and economic efficiency.

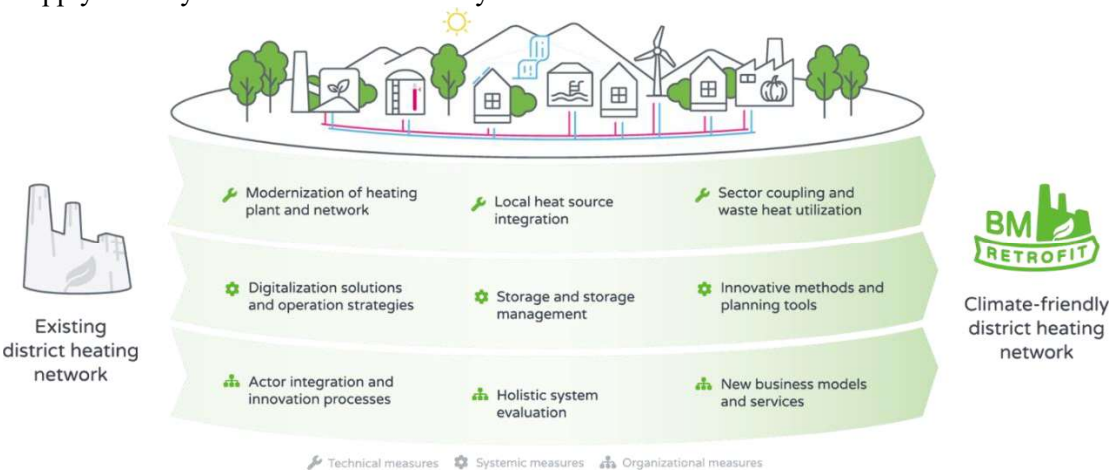

Fig. 1: Methodology for the development of the modernisation concepts, source: Green Energy Lab

ELEMENTS AND SOLUTIONS TESTED IN REAL ENVIRONMENTS

The developed elements and solutions are implemented in different biomass-based district heating networks, so-called demonstrators. These demonstrators are analysed comprehensively, with data evaluation and holistic system validations, including life cycle and value chain assessments. BM Retrofit aims to identify optimization opportunities and compile these findings into a guide of best practices, quantifying technical, economic, and ecological benefits. Furthermore, scaling scenarios for generating and evaluating the market potential and the benefits and impacts for the energy system are identified.

The heating network in Wald im Pinzgau was identified as a suitable demonstrator in the first project phase. A two-stage process is used for the modernisation. In the first phase, summer operation is optimized by incorporating local waste heat and enhancing flexibility. This involves an innovative heat pump concept, tapping waste heat from the cooling cycle of a nearby hydropower plant. A thermal storage tank is introduced for improved flexibility, and the heat pump is powered by on-site renewable electricity. The second phase includes measures for optimizing biomass boiler operation and an intelligent energy management system for efficient heating network operation and grid control. This transformation will allow for 100% renewable and local heat sources, substantially reducing the need for fossil oil boilers, resulting in significant annual savings in oil consumption and CO2 emissions.

Another heating network in Kreuzstetten, Lower Austria, serves around 150 heat consumers, including a drying plant for agricultural products. For the development and evaluation of relevant modernisation measures, corresponding evaluations and assessments of the actual situation as well as a thermal-hydraulic network simulation were carried out on the basis of the available operating data. From this, an optimised control integration of the drying plant as well as a survey of its waste heat potential and an expansion of the storage capacities were derived as possible initial measures. In addition, targeted network expansion and densification potentials are to be investigated with the support of spatial energy planning. Thus, further potentials for increasing the heat supply with renewable energy and for increasing energy efficiency are being determined.

REFERENCES

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CONFERENCE TOPIC

- Primary topic: Future District Heating and Cooling Technologies
- Secondary topic: Renewable heating and cooling, including high temperature applications