FLEXIBLE ENERGY SYSTEM INTEGRATION USING CONCEPT DEVELOPMENT AND DEMONSTRATION FOR RURAL DISTRICT HEATING NETWORKS IN AUSTRIA

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Overview

Ambitious decarbonization targets at international level, and specifically within Austria the 2030 target of achieving a 100% renewables-based electricity supply require a massive increase of PV and wind generation, increase fluctuations on the electricity grid and on corresponding markets. This poses challenges to provide the required system flexibility. On the other hand, there are more than 2400 rural biomass-based district heating networks (DHN) in Austria, many of these plants are old with a low efficiency and requiring retrofitting. The integration of power-to-heat (p-t-h) units can unlock the flexibility of DHN and thus increase the local hosting capacity for PV and wind; further on, biomass combined heat and power (CHP) units can support the renewable electricity supply during times of no PV and wind generation. However, there are currently no clear business models for this integration, i.e. only 3% of the rural DHN have CHP plants, and there are very few heat pumps integrated. Aim of the Flexi-Sync [1] project is to strengthen local and regional energy systems by optimizing the flexibility of the heating/cooling sector in order to enable district energy systems to act as a component in balancing the electricity grid. This contribution describes results of the Austrian part of the project, i.e. the application of the Flexi-Sync methodology to the district heating network (DHN) of Maria Laach am Jauerling located in the federal state of Lower Austria.

Methods

The project has following methodological stages:

First, the potential of DHN participation on electricity markets is assessed using a mathematical programming approach to analyse the operation of a rural DHN of Maria Laach in Lower Austria in detail. The network is mainly supplied by biomass using heat only boilers and, in the future, a combined heat and power plant, i.e., a situation quite representative for many rural networks in Austria. The model represents i) generation technologies present in the network, e.g., heat only boilers or heat pumps, ii) flexibility options, i.e., thermal storages or thermal mass of buildings used as storage, and iii) different electricity markets, i.e., day-ahead and balancing market. Measured historical heat demand data together with input data for electricity markets are used. Different scenarios, e.g., with or without buildings-as-storage, a heat pump or a larger central storage tank, are being considered.

Second, this result is represented by considering flexibility potential of demand side management (DSM) for heating in building sector in the HLA-Times (Heat Lower Austria Times Energy Model), which is developed under Times/Markal energy modelling framework. The aim of this modelling work is to assess the energy transition and decarbonization of the heat demand and production in the residential and service sector of Lower Austria for urban and rural areas up to 2050 by also incorporating the contribution of flexibility options, i.e., sector coupling, DSM and storage technologies. In addition, electricity prices for Austria are calculated in accurate way through a specific model for this purpose created under Balmorel [2] tool and interlinked to HLA-Times. These prices are also used in the simulation to assess the future impact of flexibility measures in Maria Laach. Figure 1 shows the modelling framework of this work.

Third, at the demo site Maria Laach, the operational solution from combining supply optimization (i.e. potential utilization of CHP) and DSM and control (building-side) is tested and evaluated in near operational environments.

Finally, the above investigated flexibility options of the heating network are evaluated economically. For this, a cost-benefit-analysis (CBA) is conducted using dynamic investment calculation. In a next step, derived technical and economic results are combined with stakeholder feedback in order to derive general business models for rural heating networks based on biomass.

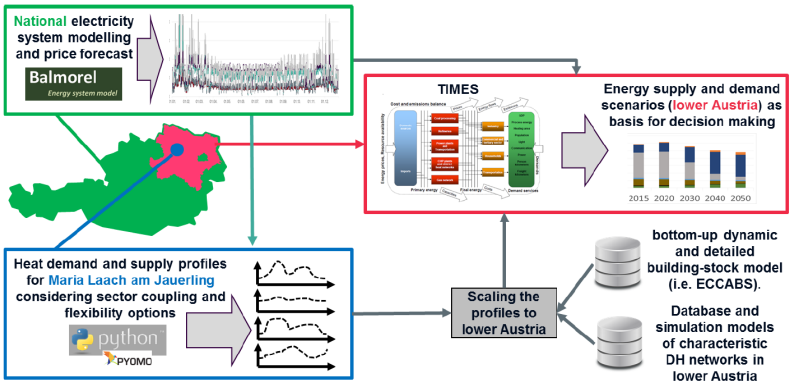

Figure 1: Approach

Results

The results are currently being processed. Preliminary results related to the potential of DHN participation on electricity markets show that trading power on the day-ahead market is the most financially viable option for the CHP as well the HP options.

For the assessment of the energy transition and decarbonization of heat supply for buildings in Lower Austria two future scenarios by 2050 are analysed: 100% Renewable (100% RES) scenario and Maximized Flexibility (MF) scenario. Both scenarios follow visions of local developments in Lower Austria: high decarbonization of the heating sector, high relevance of district heating with a predominant use of renewable energy sources and use of flexibility options. The fundamental difference between these scenarios is that while 100% RES scenario projects increased utilization of renewable energy sources, mainly biomass and district heating expansion, MF scenario considers additionally further expansion of flexibility measures (i.e., sector coupling, DSM and storage technologies).

Conclusions

Flexibility provision by buildings can be a valuable asset in existing rural DHN, however, a detailed assessment of the overall system and a comparison to other flexibility options is needed due to the expectedly high investment costs of implementing demand response schemes.

References

[1] https://www.ivl.se/projektwebbar/flexi-sync.html
[2] http://www.balmorel.com/

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