**Lehrstuhl für Wirtschaftliche Staatswissenschaften,
insbesondere Energiewirtschaftslehre**

Master Thesis

How can district heating grids transition cost-efficiently to climate neutrality?

District heating is a system that delivers thermal energy in the form of hot water or steam through insulated pipes to provide heating and hot water to residential, commercial, and industrial buildings from a central source. Historically, district heating grids were operated at high supply temperatures provided by centralized combined heat and power (CHP) plants or waste heat. The ongoing energy transition necessitates new heat generators that can provide climate-neutral heat, such as heat pumps or geothermal energy sources. However, these energy sources can only supply limited temperature levels. Additionally, lower supply temperatures enhance the energy efficiency of heat pumps and reduce heat losses. As a result, future heating grids may operate with lower supply temperatures and incorporate a higher number of heat generators, supplying heat decentrally at different locations of the grid. Decreasing the supply temperature is a challenge because consumers have different temperature requirements, and existing grids were designed for higher supply temperatures. Additionally, the temperature level determines the range of the heating grid, as the temperature decreases over the length of the pipes due to heat losses. Therefore, decreasing heating grid temperatures is a major challenge of the heat transition.

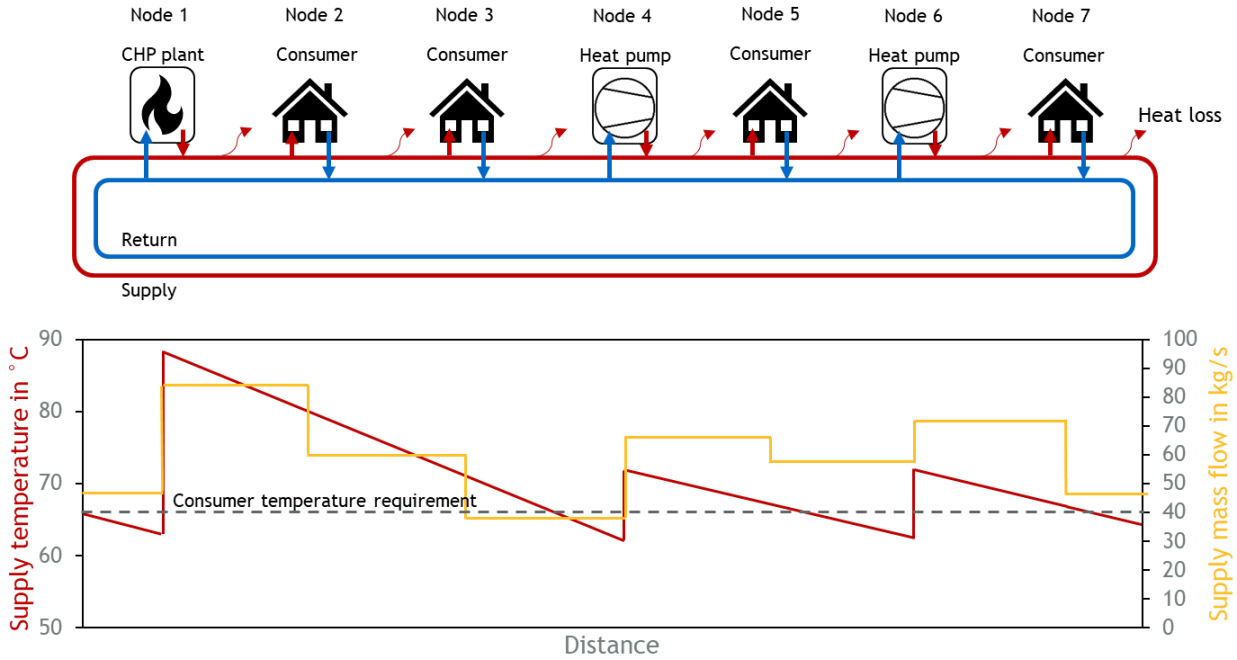

Figure 1: Exemplary illustration of consumers and heat generators at different model nodes, their connection to the supply and return pipes, and the temperature and mass flow in the supply pipe at the respective model nodes

Key tasks and objectives of the thesis

In your thesis, investigate how existing heating grids can be transitioned or how newly built heating grids can be set up to provide climate-neutral heat at the lowest cost. To that end, you should develop an optimization model (preferably a mixed-integer linear problem) that optimizes the investment and operational decisions and locations of heat generators in a heating grid, enabling decentralized heat generation. The model should capture important economic features, such as scale effects and efficiencies of heat generators, as well as technical necessities, including temperature levels and mass flows within the grid. Your investigation should contain two exemplary grids: an existing grid and a newly constructed grid. For both grids, you should determine cost-optimal setups for sensitivities regarding cost scenarios. You should discuss results for the specific grids modeled and, based on these results, derive general implications for the cost-efficient transition of heating grids and recommendations for decision-makers.

Your profile

Student of economics, best with a focus on energy and with coding experience

Literature

Averfalk H. et al; edited by Kristina Lygnerud and Sven Werner (2021): Low-Temperature District Heating Implementation Guidebook. IEA DHC Report.

Blesl, Markus; Burkhardt, Alexander; Wendel, Frank (2023): Transformation und Rolle der Wärmenetze. Ariadne-Analyse.

Contact

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Topics

- District heating grid
- Optimization

Methods

- Mixed-integer linear programming
- Case-study
