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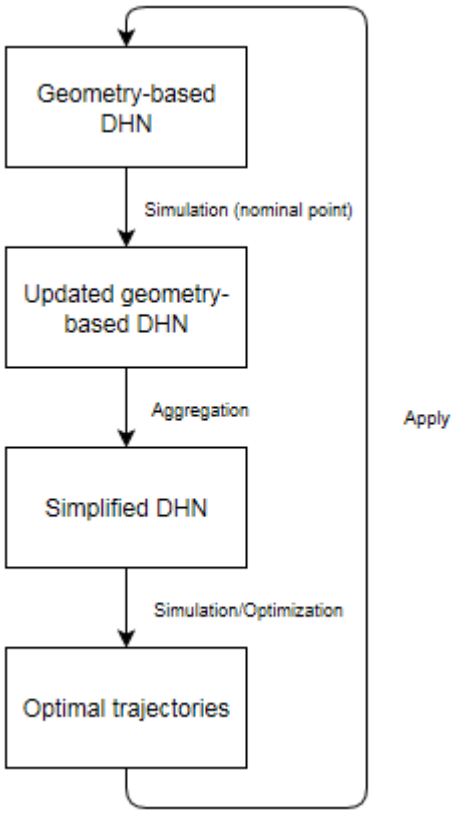
Optimization framework for district heating networks

A flexible optimization framework for district heating networks could provide researchers a tool to test different system configurations and suppliers to improve their existing systems.

By introducing pressure in the system, the mass flows are distributed along the nodes, which determines the amount of heat delivered to each customer. The network representation of the district heating area can be created, simulated and optimized in different software programs.



The developed framework has been used on the Austrian city of Graz, which suggests that it is possible to be used on real cases. Based on geometries and load predictions for each customer, provided from the University of TU-Graz, the network was represented, simulated and optimized successfully. JModelica.org is a platform which easily allows to set constraints on the dynamic systems. By limiting for example the supply temperature in of the customers, the solver compensates this by increasing and decreasing different flows to fulfill the requirements.

Setting up proper values on pipes and supply temperatures are vital in order for the solver in the optimization to find solutions. Preferably, the geometries and load profiles should be used from real cases and not made up since values cannot be too unrealistic. If for example the lengths of the pipes are increased with a factor of 10, the furthest distance in the Graz-case between producer and customer is 10 km. The supply temperature for the customer furthest away will be lower than it requires, which makes it a problem impossible to solve.

According to SETIS (Strategic Energy Technologies Information System) in terms of utilizing essential resources such as industrial surplus heat, waste and biomass, recent studies show that district heating has the potential to be a key factor. This imposes a significant challenge in terms of optimization and further development of technologies to increase the efficiency. In this project, the objective was to develop a framework for a flexible and compact network representation for different types of pipes, producers and consumer models. By introducing pressure in the framework, a realistic dynamic complex system could be obtained.

A real district heating network could consist of thousands of customers. The size of such a network cannot be optimized due to the large computational time and memory consumption. Therefore, the Fraunhofer Institute developed a method for aggregating district heating networks to a smaller size and still keeps its main dynamics, with a small

error. This simplified network can then be used for optimization. For more details about the method, see the thesis.

The overall methodology of the framework is to first set up a network based on geometries of the pipes and limits on supply temperatures to customers. Thereafter, the network is updated with dynamic behavior such as mass flows, loads and heat losses based on simulations in Dymola. The updated network is then simplified using the “German method”. This simplified network can then be optimized which give optimal trajectories for different flows. The trajectories are then to be used in the original, complex network. If all the customers receive their load demand, the framework is complete. An illustration of this is in the figure above.