Automated model generation and simplification for district heating and cooling networks

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Abstract

The current operation of district heating networks often relies on static analyses and control parameters. In the future, possible integration of renewable energy sources like solar or geothermal energy are getting more and more important. To investigate the impact of these new energy sources in combination with new control strategies, dynamic simulation models for district heating and cooling systems are getting more important. However, these models are often large and therefore have large computation times and require manual effort to create and optimize them. Thus, this paper investigates in the simulation of a large and meshed district heating network, presenting a workflow for automated generation and model simplification of simulation models based on GIS data. Therefore, we use Modelica models from the *modelica- ibpsa* (van der Heijde et al., 2017) library as well as the *AixLib* (Müller et al., 2016). The validity of the model simplification is proven and the usability of the model is demonstrated by a Use Case with two different control strategies.

Starting with a GIS dataset, the graph framework for urban energy systems *uesgraphs* (Fuchs et al., 2016) is used to transfer the GIS data into a graph for more efficient data handling. This graph is used to store additional information about the district heating and cooling system, like pipe diameters and insulation thicknesses. These information are used to automatically generate a simulation model in Modelica, taking all available information regarding the thermo-hydraulic network behavior into account. Tackling the problem of large DHC networks and their huge complexity as a simulation model, the presented paper describes two steps to reduce the DHC network for a more efficient simulation.

The first step is a complexity reduction regarding the network layout. Therefore, *uesgraphs* is able to simplify the graph network to contain less pipe network representations by nodes and edges. This is mainly done by a weighted reduction of the existing pipes between nodes which represent junctions, substations or supplies. Figure 1 shows an exemplary cutout of the presented use case before the simplification process.

The second step is a simulation model reduction by replacing the used plug-flow pipe model with a static pipe model for short pipe segments. This leads to a reduction in simulation times by 45 % and a more stable simulation in terms of *bad allocation errors*.

Concluding, the presented paper shows the usability of the modeling language Modelica for DHC applications. Future work will include a comparison of the used models with even more simplified models to elaborate which model detail is necessary for the evaluation of top level control strategies. Nevertheless, the paper present possible network simplifications and their results of an Modelica user oriented view.

Keywords: District Heating and Cooling Networks, Model Simplification, Control Strategies

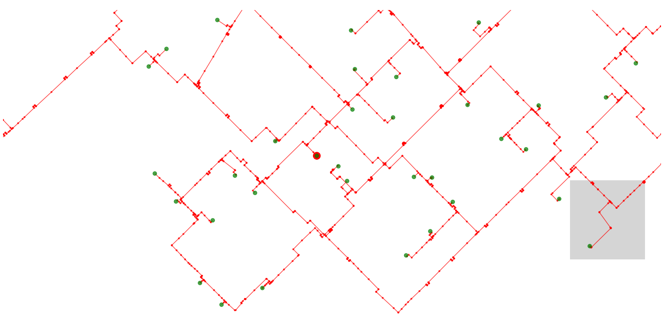

Figure 1. Original model cutout of an exemplary district heating grid

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