Modelling of the Central Heating Station within a District Heating System with Variable Temperatures

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Within this paper, the concept of developing a detailed model for an existing district heating system (DHS) with variable temperatures is described. This DHS uses central heat generators as well as distributed heat pumps (HPs) at the consumers' substations. This work focusses on the central heating station with multiple different supply units. In the present case, the model is implemented with a close-to- reality-control and will be used for testing new control strategies for the DHS. Therefore, a model with both realistic behavior as well as control interfaces similar to the real control is necessary. Within the NATAR research project (Local heating grids with lowered temperature as provider of balancing power), different targets for the improvement of the control will be investigated. One major target is an intelligent linking between the heat and electrical sector to demonstrate the opportunities of heating grids, as the investigated one, to balance the power grid.

This work uses the free and open-source programming language *Modelica* and the commercial software tool *Dymola* with the *Modelica Standard Library* (MSL) and libraries based on the common core library IBPSA *(International Building Performance Simulation Association*). A new, more specialized library is created for the simulation of the DHS with variable temperatures. Main purpose of this library is the use for this application, but the library will be created object-orientated and flexible to ensure that the library can be easily used and adjusted for further simulations of low-temperature district heating systems (LTDHS). In this way, the library may constitute the basis for a district heating library at the Institute of New Energy Systems (InES).

The requirement for entire model and the different component models is on one hand the capability of simulating periods up to one year, within a reasonable time, to evaluate the systems performance for new operation approaches. One the other hand temperature changes as well as shut-on and shut-off behavior in minute resolution needs to be provided to balance the electrical grid on this scale.

The component models of the heating station are validated with measurement data from the actual operation mode. Temperatures, heat flow rates as well as electrical power and energy sums are used for the validation. The heat generators within the heating central are a combined heat and power plant (CHP), a HP, a peak boiler and a solar thermal system. Two heat storages with different temperature levels complete the central heating station.

The simulation results and the measurement data for the different components match well for the most components and periods, but also show some weaknesses that need to be improved. The simulation of the boiler model shows that supply temperature, heat flow rate as well as the generated heat match the measurement data very well. The electricity demand of the HP is also close to the measured one, but this model needs adjustment with respect to the heat generation. The simulated temperatures of heat storage meet the measured data with different accuracy depending on the height within the heat storage.

To model the entire system, a model of the heating grid including the consumers needs to be added. This model extension is necessary to improve the entire control system including the control of the circulator pumps and the use of the distributed HPs.

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