Title: Efficiently solving district heating network problems
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Description:
Recently, there is renewed interest in (district) heating systems, as they could make the heat supply or even the total energy supply more sustainable. For instance, waste heat of power plants can be provided to residential areas.

One tool used for designing heat networks is steady-state energy flow analysis, sometimes called load flow analysis, to determine the state variables of the heating network. Given (constant) heat power demands and outflow temperatures of loads, the pressures, water flow rates, and return and supply temperatures are determined throughout the entire network.

Generally, the steady-state energy flow model leads to a system of nonlinear equations. Multiple formulations of these model systems exist, due to both algebraic and numerical manipulation, but it is currently unclear which of these formulations is best in terms of solver efficiency, reliability or ease of use. For instance, a loop formulation is often used to describe the hydraulic part of the network. This reduces the number of equations but requires the loops of the network to be found. Furthermore, the hydraulic part and the thermal part can be modeled separately, or a combined hydraulic-thermal model can be formulated.

In this assignment some possible model system formulations are investigated to determine their advantages and disadvantages. In particular, the properties of the system of equations are of interest, as well as their effect on the efficiency and robustness of the required nonlinear solvers.
Since the solution of a nonlinear system typically involves a repeated solution of a linear system of equations, also the efficiency of the linear solvers are part of this investigation. Optionally, the effect of different solvers can be investigated as well as aspects such as scaling, preconditioning, network topology, and boundary conditions.

Approach:
1. Literature study.
2. Determining and analyzing different model formulations.
3. Setting up and analyzing numerical model(s) for the different formulations.
4. Writing the thesis.

References:
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