Model-Based Optimization for a Campus District Cooling System

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While equation-based object-oriented modeling language Modelica can evaluate practical energy improvements for district cooling systems, few have adopted Modelica for this type of large-scale thermo-fluid system. Further, to our best knowledge, district cooling modeling studies have yet to include hydraulics in piping networks alongside plant models featuring realistic mechanical systems and controls. These are critical details to include when looking to make energy and control improvements in many physical system installations.

To this study used the newly developed open-source district cooling models at the Modelica Buildings Library for a real-world case study at the University of Colorado Boulder. The site includes six buildings connected to a central chiller plant featuring a waterside economizer. We have developed detailed Modelica models for the entire system. Then the models are calibrated and validated using the measured data.

After that, several energy saving strategies are pursued based on the validated model, including control setpoint optimization, equipment modification, and pump setpoint adjustments. Results indicate that a combination of the studied measures can save the campus annually 84.6 MWh of energy, 8.9% of electricity costs, 58.0 metric tons of carbon dioxide emissions, while the waterside economizer cuts down chillers' run times by 201 days/year, reducing maintenance costs and extending chiller life.

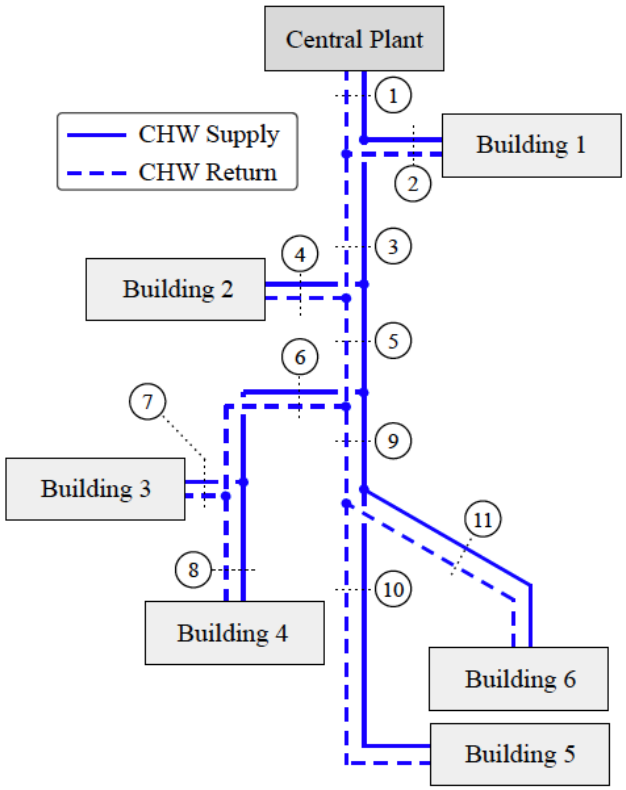

Figure 1. System schematic of the studied district cooling systems