Title of proposed presentation: Open Source Modelica Models for Data Center Cooling

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Body of extended abstract:

Data center cooling accounts for about 1% of electricity usage in the United States. Computer models are pivotal in designing and operating energy-efficient cooling systems. Compared to conventional building performance simulation programs, the equation-based object-oriented modeling language Modelica is an emerging approach that can enable fast prototyping and dynamic simulation of cooling systems. In this project, we introduce a newly developed open source data center package in the Modelica Buildings library to support modeling and simulation of cooling and control systems of data centers. The data center package contains major thermal and control component models, such as Computer Room Air Handler, Computer Room Air Conditioner, models of different subsystem configurations such as chillers with differently configured waterside economizers, as well as templates for different systems.

A case study is performed using the developed Modelica models. In this case study, we first modeled the cooling and control systems of an actual data center located in Massachusetts, and then calibrated a baseline model based on measurement data. The simulation of the baseline model identified several operation-related issues in the cooling and control systems, such as degraded cooling coils, improper dead band in control settings, and simultaneous cooling and heating in air handlers. Afterwards, we used a sequential search technique as well as an optimization scheme to investigate the energy saving potentials for different energy efficiency measures aiming to address the abovementioned issues. Simulation results show potential energy savings up to 24% by resolving identified control-related issues and optimizing the supply air temperature.

Figure 1 Modelica models of the cooling system for a data center in Massachusetts