

# Hardware-in-the-Loop-Simulation of a Building Energy and Control System to Investigate Circulating Pump Control Using Modelica

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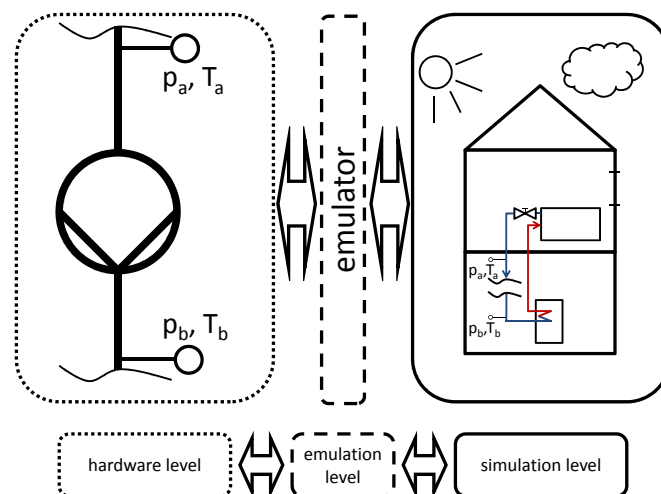
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This paper presents an application of the hardware-in-the-loop-method to a building energy and control system (BECS). We focus on investigating the interaction of a real circulating pump with the hydronic network of a virtual building energy and control system. For real-time simulation the building envelope is modelled using the Modelica-based library AixLib (<https://github.com/RWTH-EBC/AixLib>). With the presented setup model-based designed control algorithms are tested directly on real hardware.

We describe in detail the solutions found for the emulation of the hydraulic boundary conditions and a socket-based data interface. HIL-simulations are performed on an implementation of the concept. The quality of the implementation is evaluated by comparing results obtained from HIL-simulations where a constant and a variable pressure control scheme are applied to the pump. We report the root mean squared error and the relative mean error for a comparison of measured data against simulated results of the volume flow rates and pressure difference for both control schemes.

The main focus of this work is to evaluate the application of the method towards bridging the gap between model-based design and commissioning of energy efficient control for heating ventilation and air conditioning (HVAC) components.



**Figure 1.** Scheme of a three level HIL-concept of a real pump in a virtual BECS.