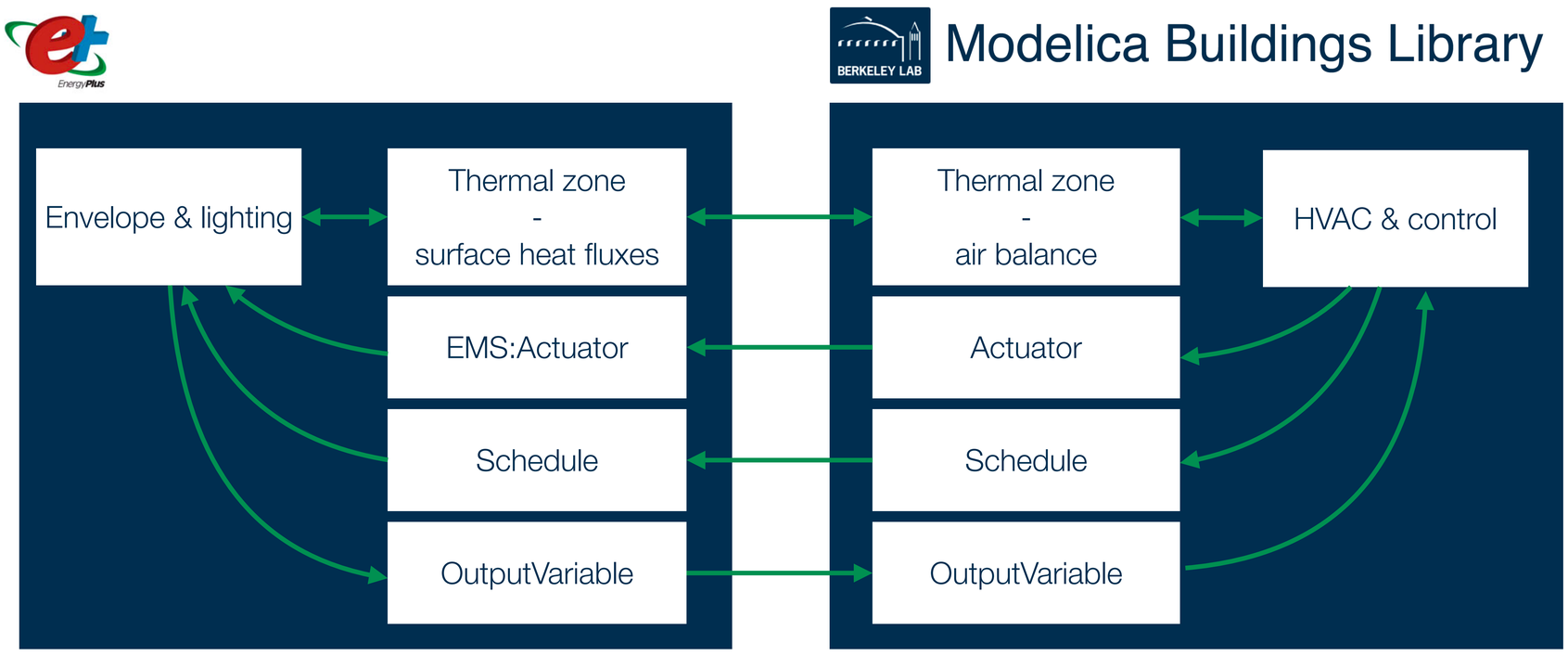
Spawn

Coupling EnergyPlus with Modelica Buildings Library to bridge BEM with controls and accelerate robust energy system decarbonization



Goal

De-risk and accelerate decarbonization through

- model-based design,
- rapid prototyping, and
- digitized control delivery.

Approach

Coupled simulation

Couple EnergyPlus envelope simulation to Modelica HVAC and control simulation, enabling realistic control simulation and digitized control delivery:

- Simulated controls takes as input measurable states and produces actuator command, rather taking loads and outputs part load ratios.
- Simulation based on fully coupled pressure, mass flow rate, temperature and control dynamics.
- Time steps are variables, from minutes to sub seconds, as needed to correctly model HVAC and control dynamics.

Separation of concerns

- Equation-based modeling language.
- Building experts develop domain-specific models.
- Numerical and software experts develop domain-neutral compilers, solvers, simulators and optimizers.

Modular and inter-operable

- Use open standards for modeling (Modelica) and simulation (FMI).
- Modular plug-and-play components.

New Use Cases

Innovative system design: Rapid prototype and de-risk new system-level solution for decarbonized energy systems.

Controls: Connect energy simulation with control design, optimization, and implementation (https://obc.lbl.gov).

Fault detection and diagnostics: Quickly insert faults into models and assess fault signature in presence of control that may compensate for faults.

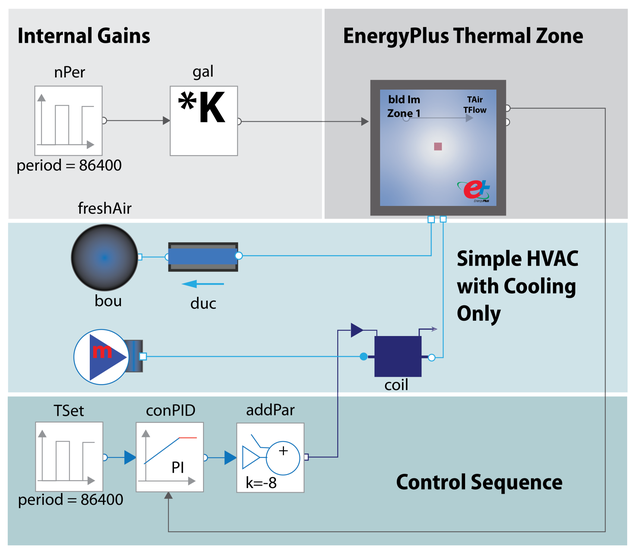
District energy: Model 5th generation combined district heating and cooling networks that reduce costs of decarbonization.

Data-driven modeling: Combine physics- and data-driven models.

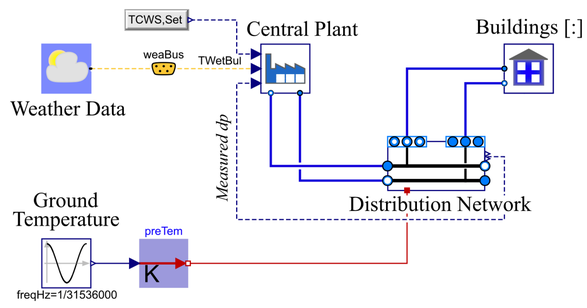
Status

Modelica Buildings Library

- 2000+ models and functions for HVAC, controls and electrical systems.
- Include ASHRAE Guideline 36 sequences, preconfigured HVAC systems and district energy systems.
- Developed in collaboration with IBPSA Project 1 and IBPSA Modelica Working Group.
- Works with open-source OpenModelica environment, with Modelon IMPACT and with Dassault Systemes Dymola.



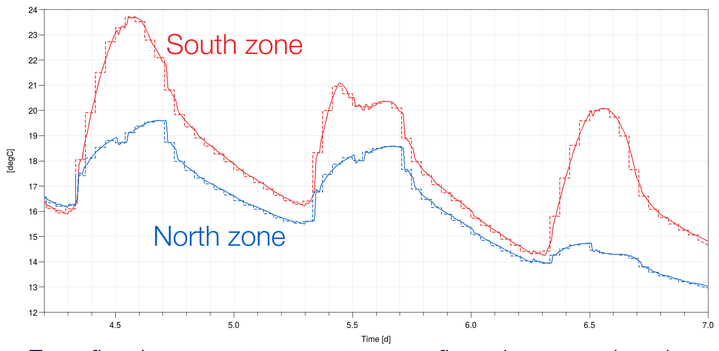
Graphically connect EnergyPlus load modeling with Modelica HVAC and control models.



Model coupled controls, HVAC equipment, buildings and whole district energy systems.
Simulate time scales from sub-seconds for fast control to slow dynamics of buildings and geothermal fields, including all heat flow, mass flow and pressure distribution in duct and pipe networks.

EnergyPlus Envelope Model

- Exchanges data during simulation with Modelica Buildings Library.
- Uses EnergyPlus input format for building envelope and loads model.
- Bypasses EnergyPlus HVAC calculations.



Free-floating zone temperatures reflect the same heating and cooling loads in Spawn (solid lines) and in EnergyPlus (dashed lines).

Resources

Project site at https://lbl-srg.github.io/soep/
Download at https://simulationresearch.lbl.gov/modelica
Principal investigator: Michael Wetter, Berkeley Lab