



HELICS Co-Simulation, and VOLTTRON

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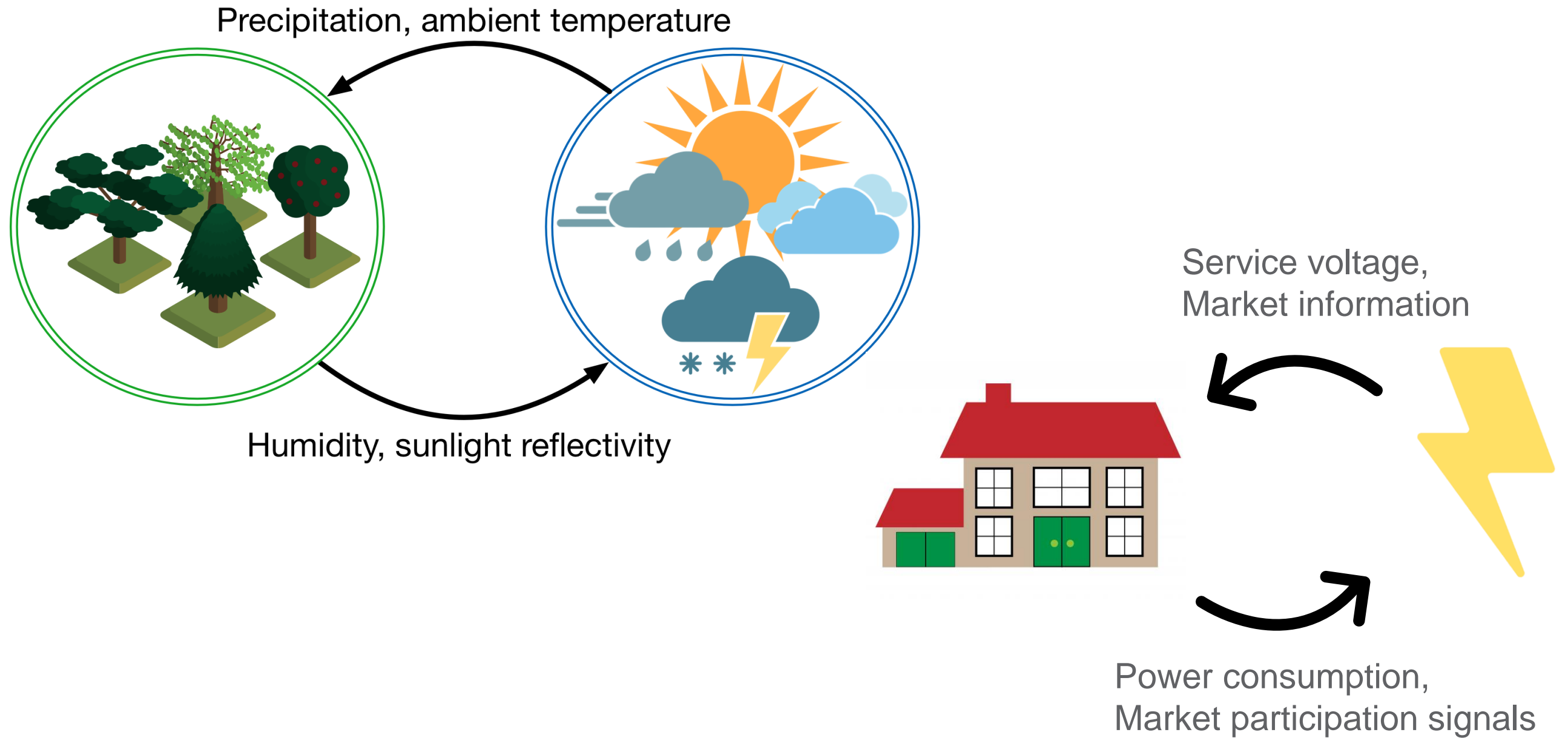
Power System Research Engineer



Analyzing Large and Complex Systems with Co-Simulation

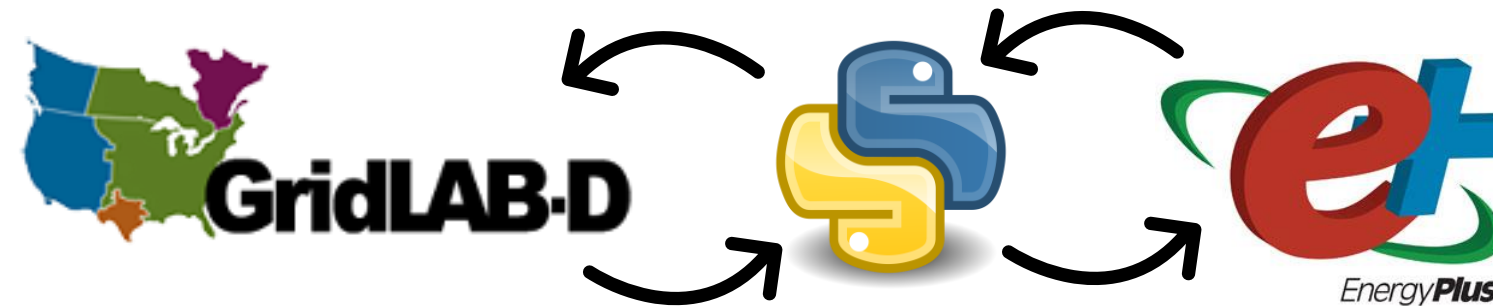
- Co-simulation is a method for unifying multiple models in a coordinated fashion.
 - Models may or may not cover similar domains
 - Models may or may not have a similar concept of time
 - Models may or may not be written in the same language
 - Simulators using models may or may not run on the same computer or operating system, or be in the same network
- Co-simulation allows models that have interactions with each other to express those interactions and influence each other's behavior.
- Co-simulation essential functionality:
 - Time synchronization
 - Data exchange

Co-Simulation Examples

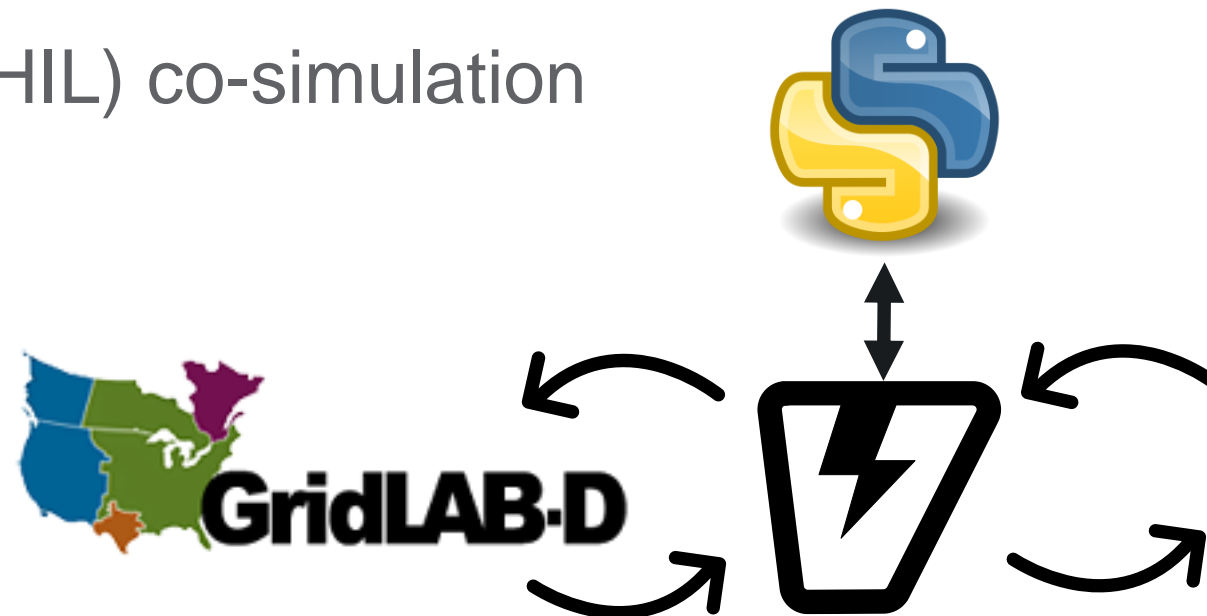


Co-Simulation with Buildings

- Software-only co-simulation



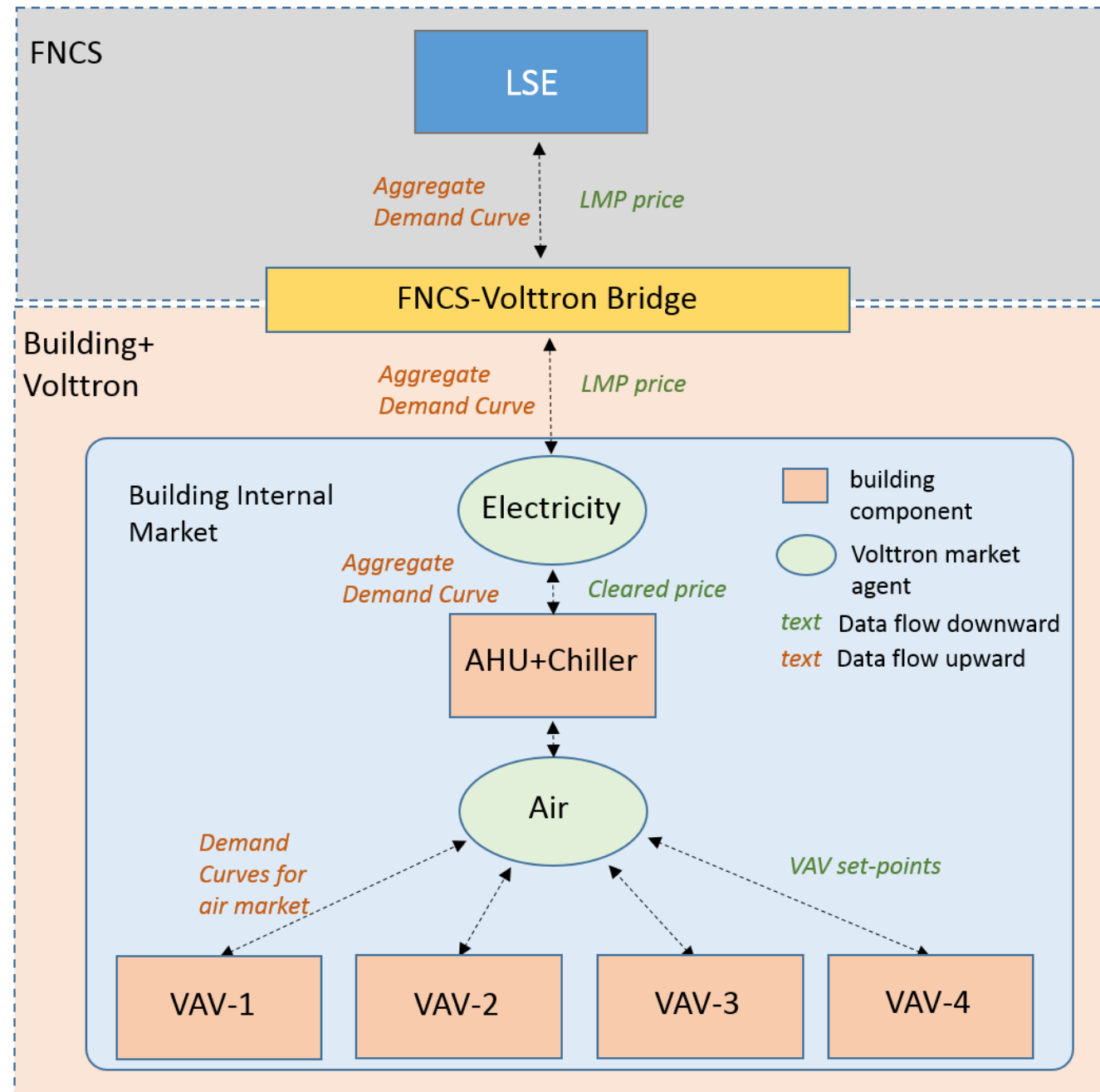
- Hardware-in-the-loop (HIL) co-simulation



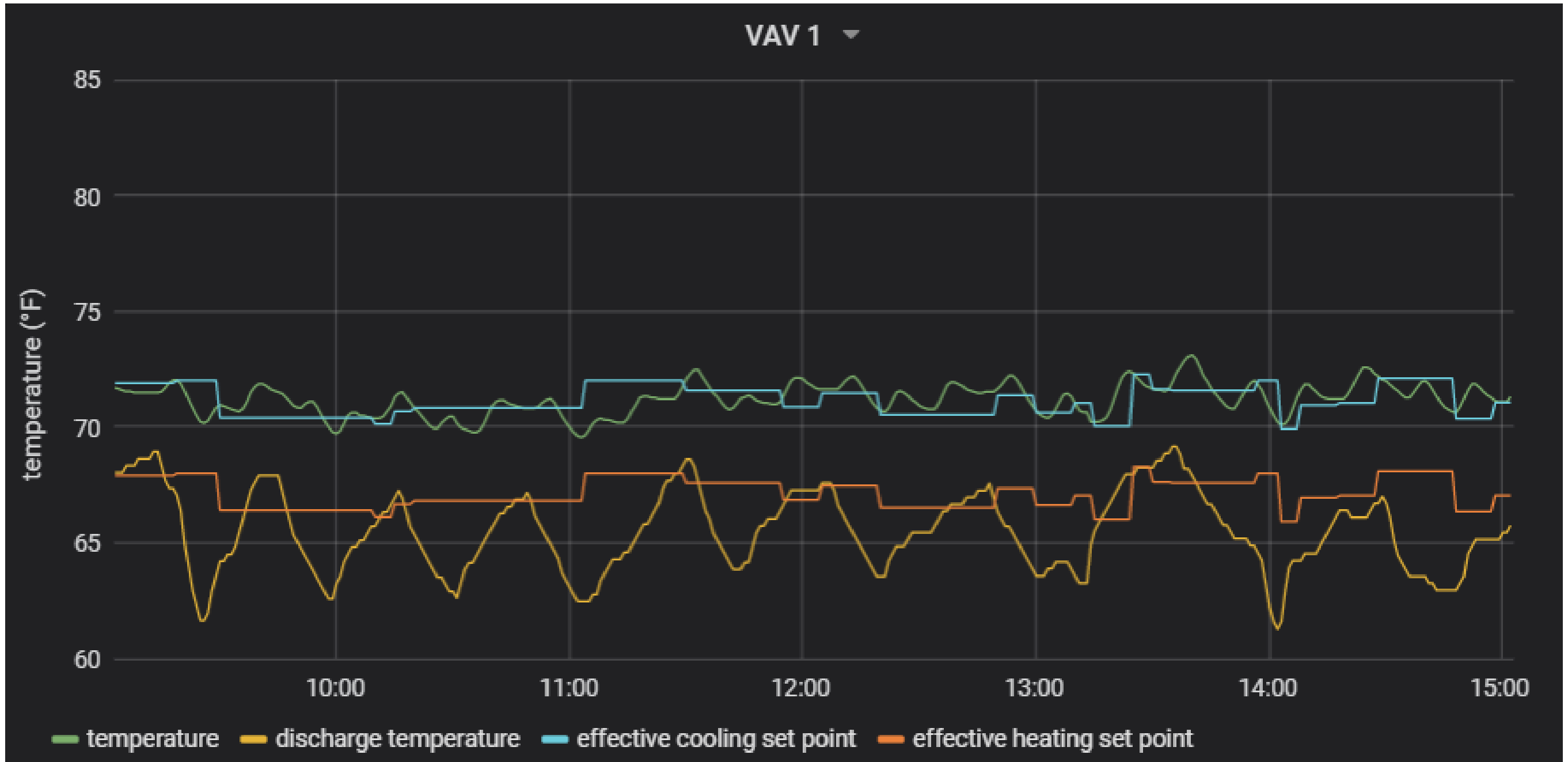
PNNL HIL Co-Simulation Demonstration

- Market-based control technique (transactive energy)
 - Loads in the system bid for energy
 - A central market clears all bids from generators and loads
 - Prices are distributed to all loads in system
 - Loads adjust energy consumption based on price (HVAC setpoints)
- Modeling choices
 - Power system: software only
 - Markets: software only
 - Loads: mostly software with one PNNL building HIL-connected with VOLTTRON

PNNL HIL Co-Simulation Demonstration



PNNL HIL Co-Simulation Demonstration



HELICS: Multi-Lab DOE-Sponsored Co-Simulation Platform



HELICS co-simulation platform is composed of:

- Libraries and language bindings to use for integrating a simulator
 - C
 - C++
 - Python
 - MATLAB
 - Java
 - ...
- Executables for running co-simulations and assisting in co-simulation development and testing
 - Data exchange and synchronization services



Other HELICS applications

- PNNL's Transactive Energy Simulation Platform (TESP) (in-development)
 - Transactive energy simulation in a box
 - Goal is to enable easy testing of transactive energy controllers and mechanisms
 - Models transmission and distribution power system, generators, and residential and commercial loads
- DOE's North American Energy Resilience Model (NAERM)
 - Increased interdependency between electricity and natural gas systems introduces new vulnerabilities
 - NAERM is developing nationwide electrical system and natural gas system models to evaluate the vulnerabilities
 - Future work will add in other system interactions such as communications and transportation

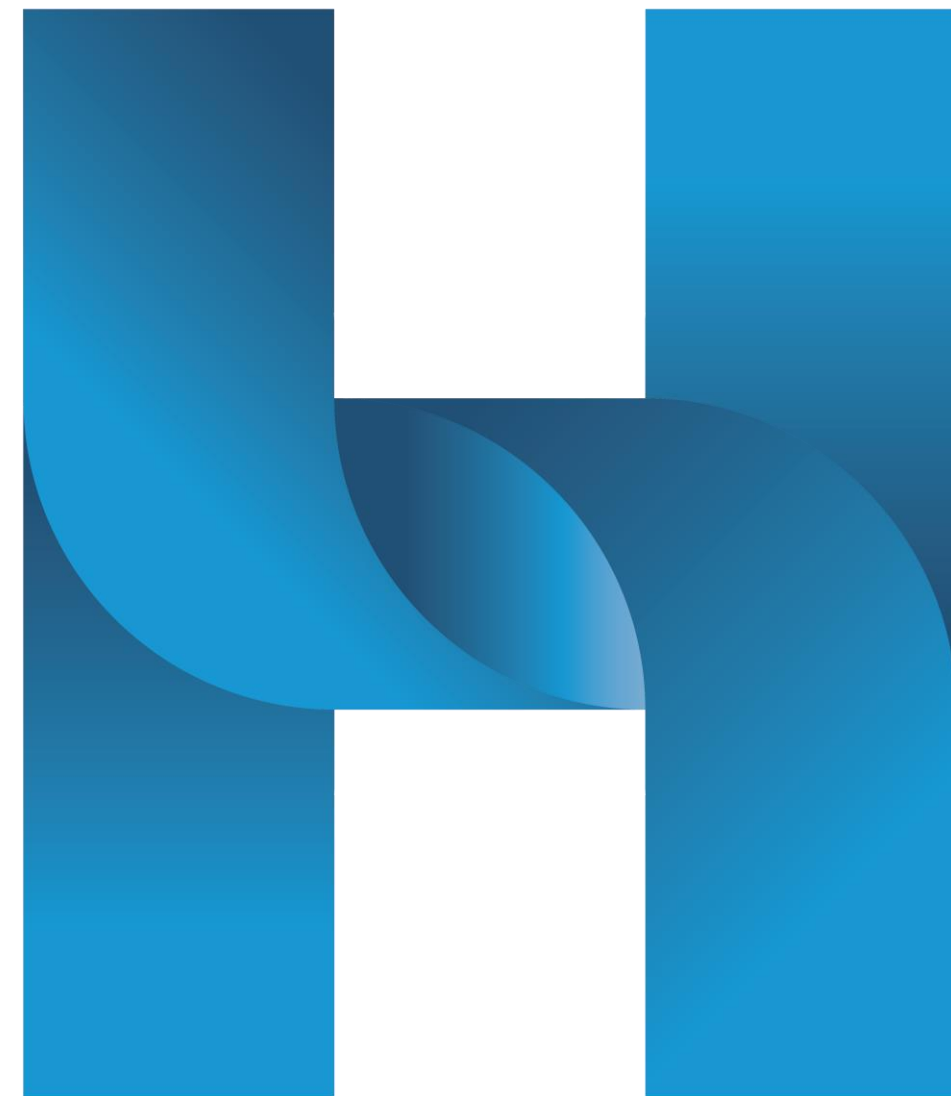
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<https://www.helics.org>

<https://github.com/GMLC-TDC/>

<https://helics.readthedocs.io>

<https://helics.readthedocs.io/en/latest/user-guide/index.html>



HELICS