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Commercial Buildings Research Infrastructure: A Sandbox For Utilities and Building Owners to Evaluate Traditional Energy Savings and Other Non-Traditional Benefits

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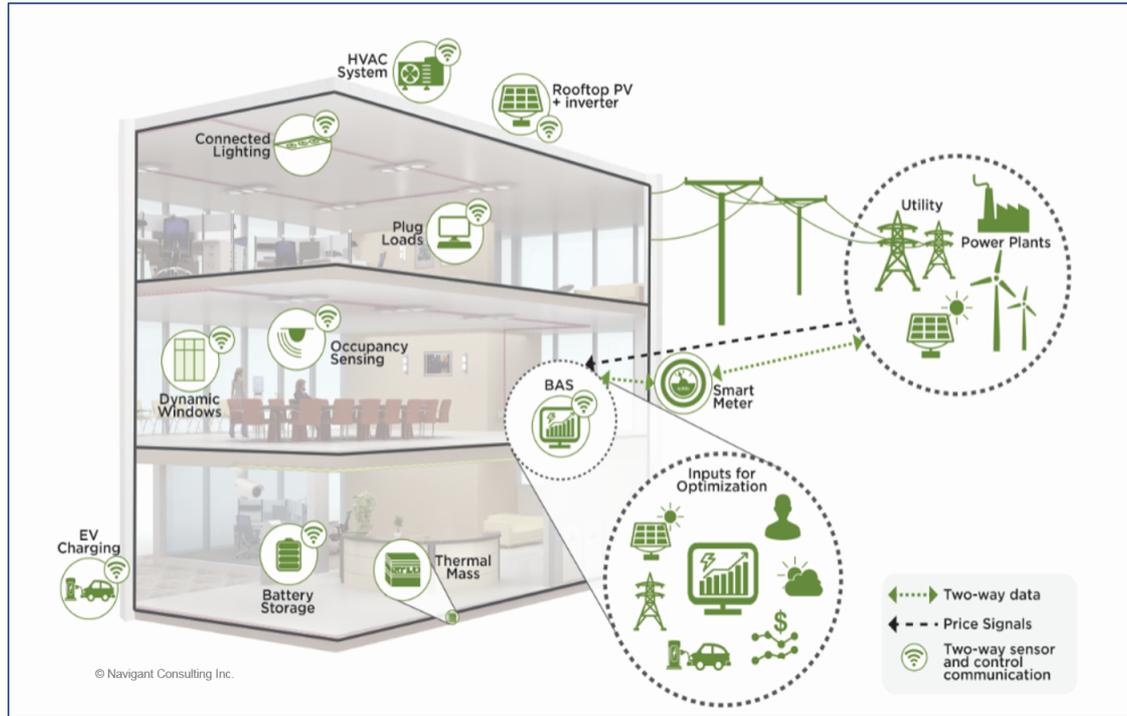
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Outline

- Grid-interactive Efficient Buildings (GEB) Overview
- Commercial Buildings Research Infrastructure (CBRI) introduction
- How CBRI helps answer GEB questions
- Upcoming projects

Grid-interactive Efficient Buildings (GEB)



Example of a Grid-interactive Efficient Building (GEB) communicating with the utility.

Why Buildings?

- 75% of electricity is consumed by buildings
- 80% of electric peak demand is due to buildings

Research Questions:

- How do we improve the technical maturity of GEB technologies?
- What will the connection between buildings and the utility look like?

Issues:

- Interoperability
- Advanced control
- Demand-side management

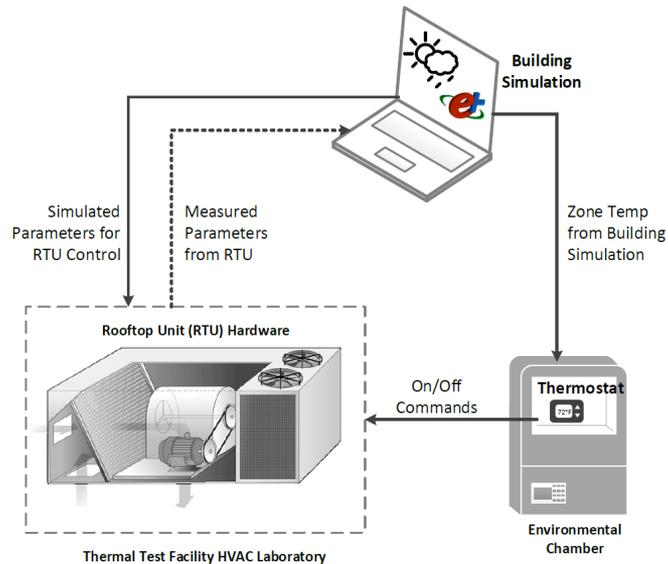
Hardware-in-the-Loop

Hardware-in-the-Loop (HIL): A technique that combines hardware and simulation in continuous feedback loop to explore complex scenarios in a controlled environment.



Credit: <https://www.altus.af.mil/News/Art/igphoto/2000940295/>

Flight Simulator: The original HIL

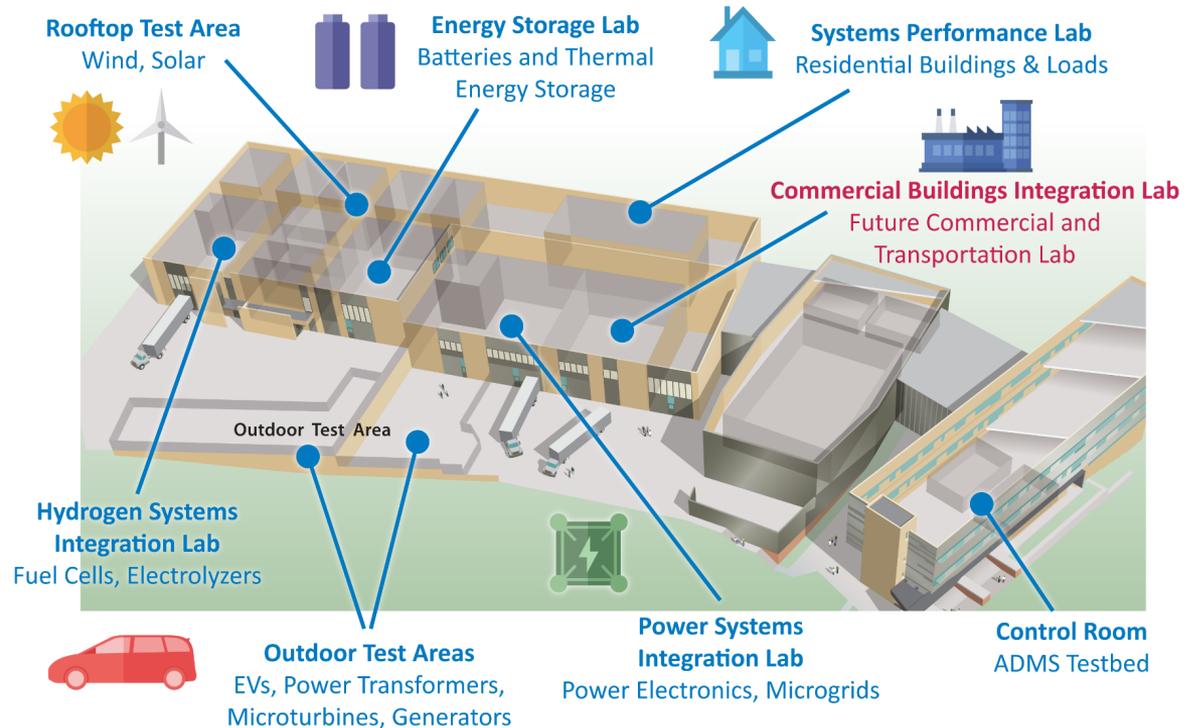


HVAC HIL: An application of HIL for buildings research.
RTU hardware operated in a realistic fashion without need for physical building and real climate.

ESIF Resources and Laboratories

ESIF Equipment:

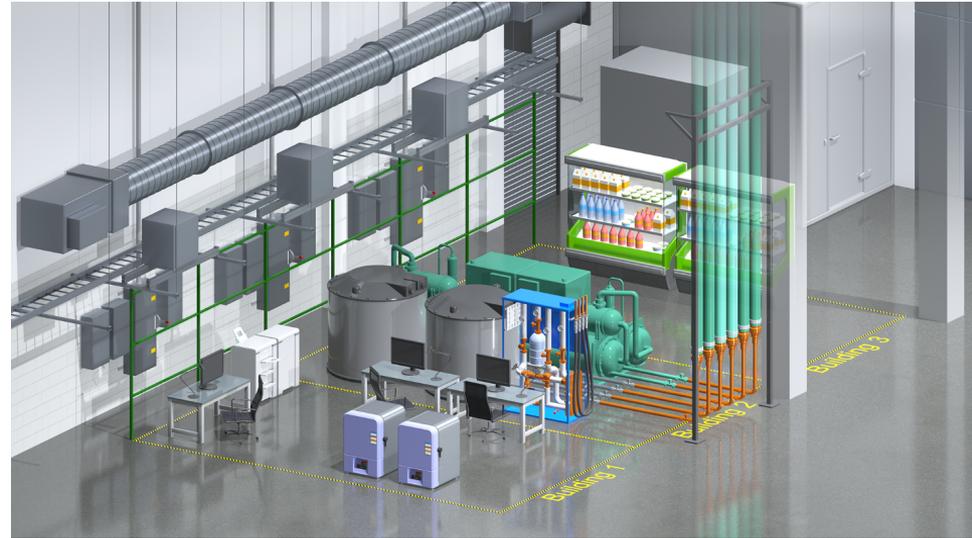
- 100 ton chiller loop
- 62.5 ton boiler loop
- 2 MW Grid simulator
- 1.5 MW DC simulator
- 1 MW load bank
- 12 EV charging stations
- Research electric distribution bus (REDB) can connect laboratories electrically



CBRI Approach

The **Commercial Buildings Research Infrastructure** will provide a flexible research platform that takes advantage of hardware-in-the-loop functionality for grid-interactive efficient buildings, specifically in these key focus areas:

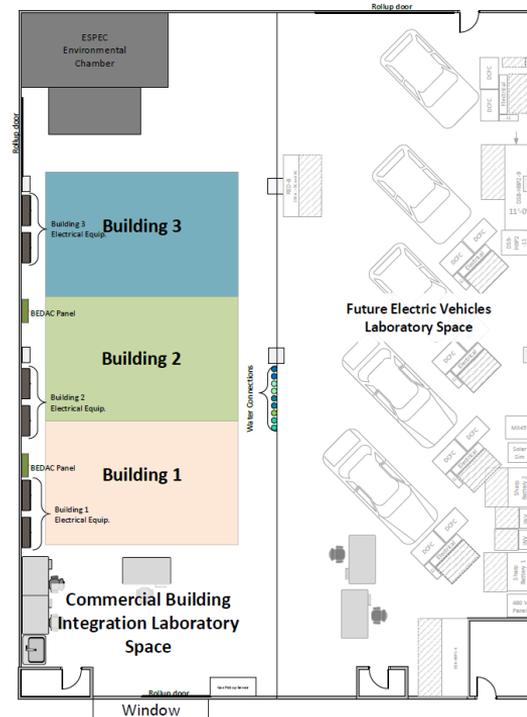
- Intelligent efficiency
- Interoperability
- Advanced controls
- Flexibility of demand-side management



CBRI Capabilities

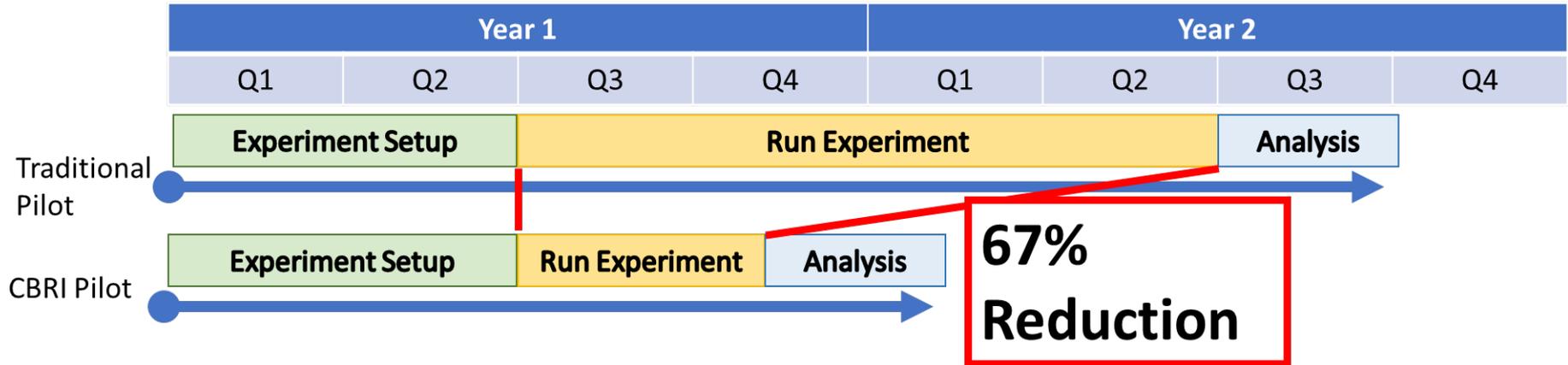
Features of the CBRI:

- Electrical infrastructure for 3 buildings
- Integrated data acquisition system – collects data, controls equipment, real-time visualization
- Connections to grid and PV simulators and other distributed energy resources (DER) for grid interactivity research
- Communication/control link to HVAC Lab enables hardware-in-the-loop testing of HVAC equipment
- Building Automation System Testbed
- Connection to building energy simulations platform
- Integration with other ESIF labs and resources



ComEd/CLEAResult & DOE

- 5-8 commercial building technologies evaluated for energy efficiency in 2 years
 - Goal of 67% reduction in experiment time per technology
- Additional funding from DOE to evaluate GEB potential of some of the technologies



ComEd/CLEAResult & DOE Technology Selections

ComEd/CLEAResult Research Question: How much energy will be saved by replacing traditional induction motors on conveyors with advanced, high efficiency motors?



ComEd/CLEAResult Research Question: How much energy will be saved by replacing traditional refrigerated cases with alternative refrigerant cases?

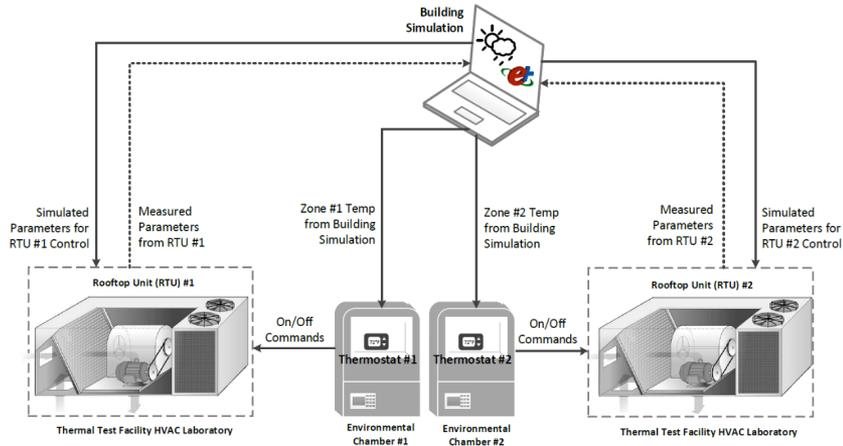


DOE Research Question: Are customers willing to reduce load of conveyors in response to a utility request?

DOE Research Question: How can a building owner coordinate control of multiple cases to respond to a utility request?

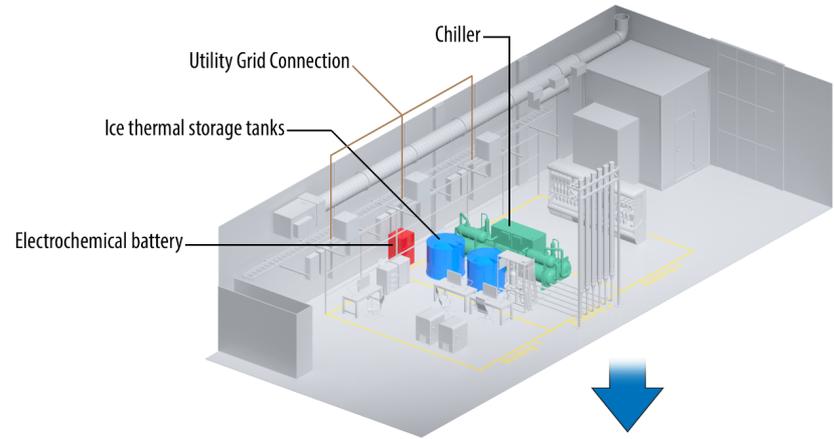
Other Funded Projects

- RTU Coordination



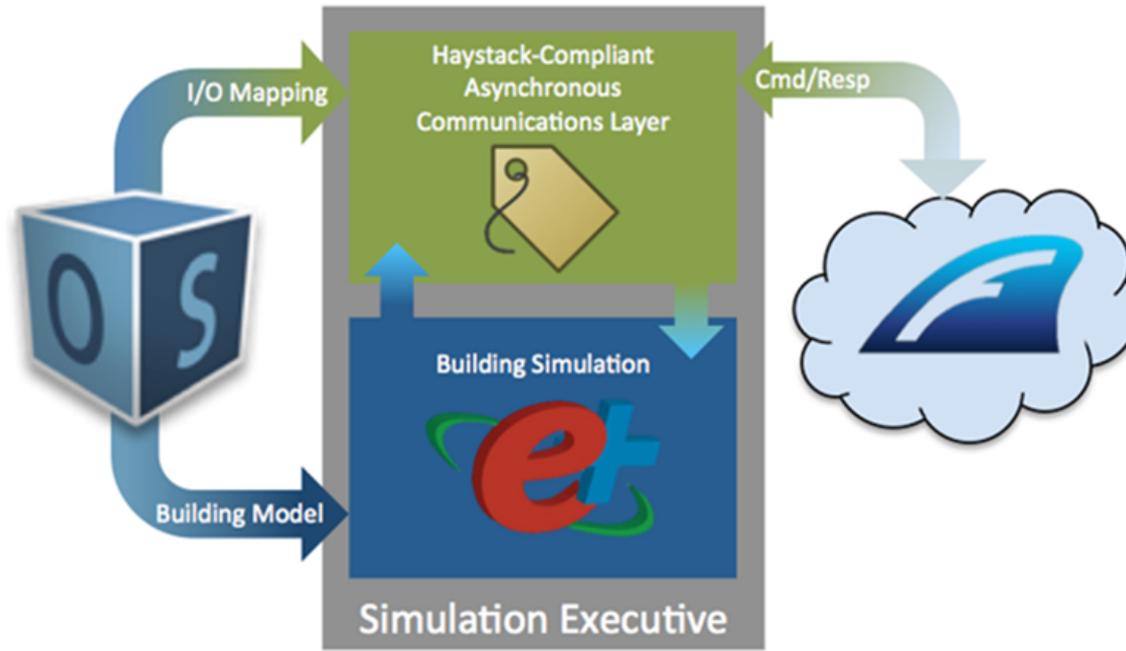
Research Question: What energy savings are possible by coordinating rooftop units?

- Behind-the-meter Storage

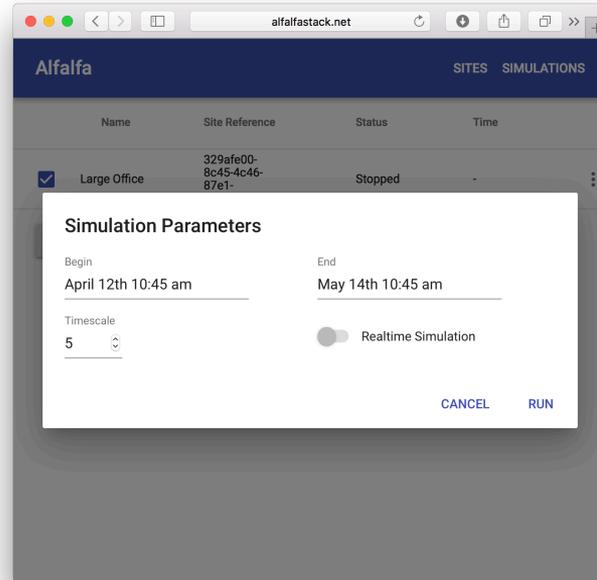
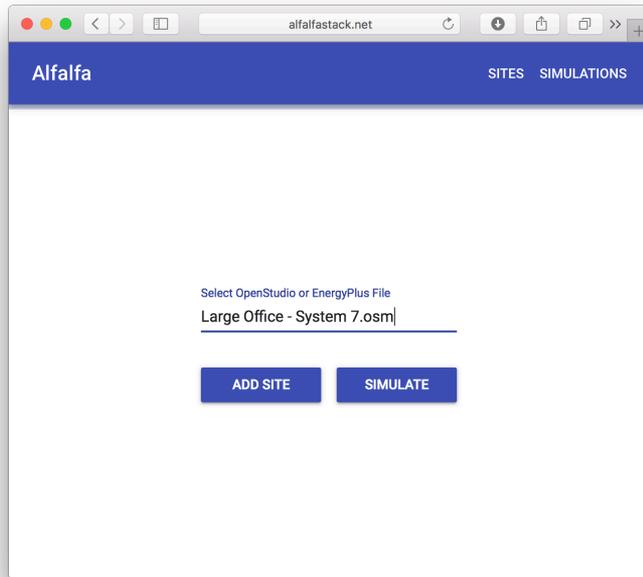


Research Question: When should the thermal energy storage be charged and when should electrochemical battery be charged to minimize overall costs and energy usage?

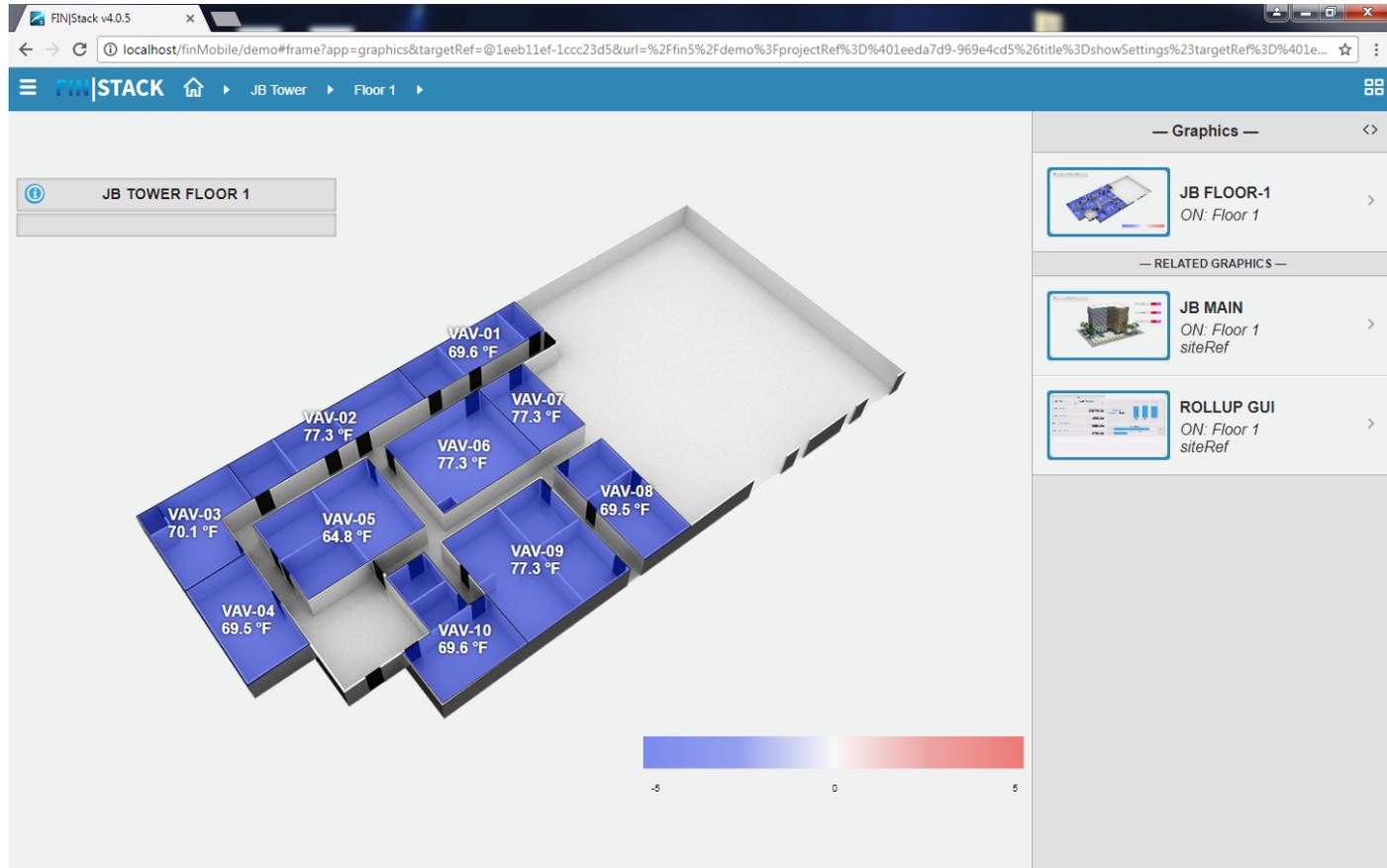
Controls effectiveness evaluation



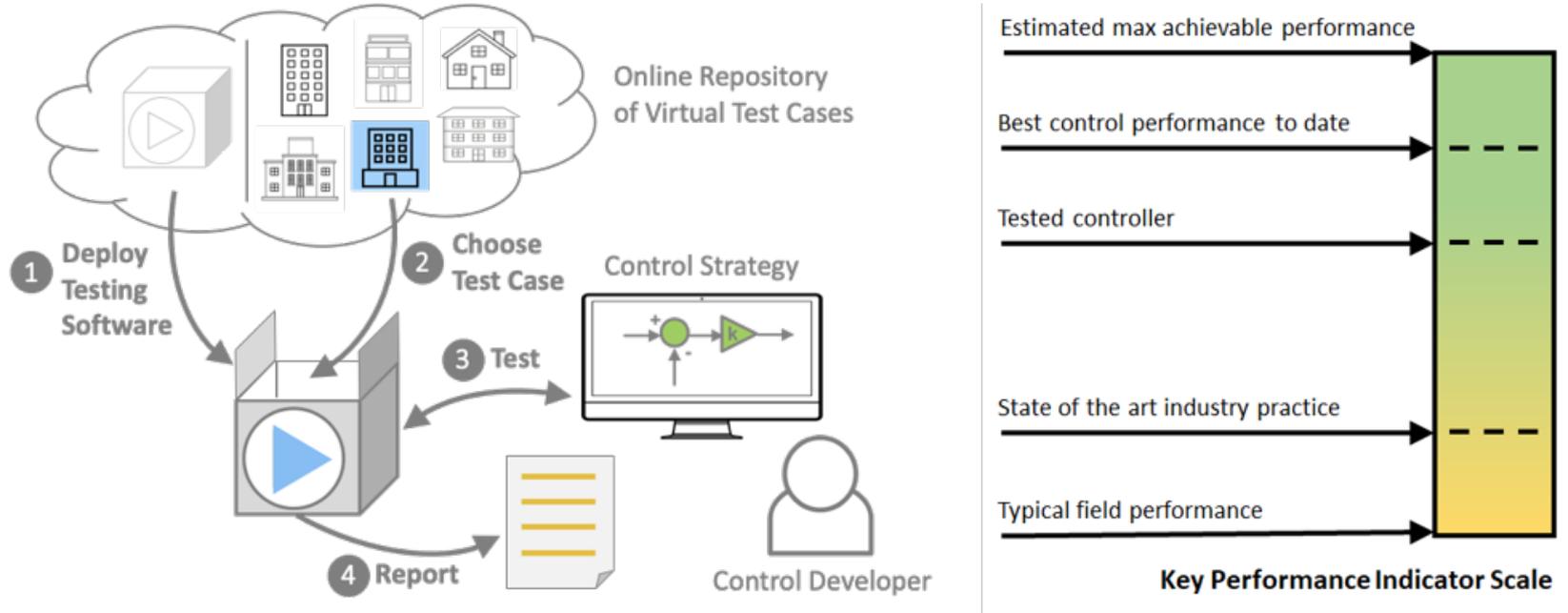
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Real or Simulated?



BOPTTEST (Building Operations Testing) Framework



The BOPTTEST (Building Operations Testing) Framework is a set of simulated buildings and a standard API for manipulating their sensor and actuator "control points" for comparing and benchmarking the performance of control and FDD algorithms.

Questions?

CBRI Related Questions

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DOE Related Questions

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