

# Flexible, Multipurpose Laboratory Advances Building and Thermal Energy Systems

## Expanding Evaluation and Development of Grid-Interactive Buildings

Photo by Warren Grez, NREL 4117

### Market Challenge: Precise Measurement and Rigorous Evaluation of Building Technologies and Thermal Systems

Robust hardware and controls are necessary to ensure results match intent before systems can be used broadly. However, rigorous evaluation often requires multiple field experiments in a variety of climate zones. In the field, it is difficult to obtain information on other important factors, such as thermal, grid, and occupant interaction.

Gaps also exist in understanding the performance degradation and life cycle of thermal energy systems as they relate to buildings. There is a lack of robust, high-quality performance data for projects at scale; these data can be expensive to produce and often remain proprietary.

### Solution: Measuring the Grid-Interactive Performance of Technologies at Scale

NREL's Thermal Technology Facility is a flexible multipurpose laboratory that enables detailed evaluation and development of building and thermal energy systems. The recently upgraded facility is designed to measure the grid-interactive performance of technologies—from metascale (e.g., one-tenth scale) devices, up to systems that are 10 refrigeration tons (or 35 kilowatts-thermal).

The Thermal Technology Facility is addressing current R&D needs through two key lab spaces within the facility: the HVAC Systems Laboratory and the Thermal Cycling Laboratory.

### R&D Growth: Flexible, Hardware-in-the-Loop HVAC Simulations

The HVAC Systems Laboratory has been renovated to include state-of-the-art features that assist in developing hardware and controls for grid-interactive efficient building HVAC technologies, including residential and commercial air-conditioning and heat pump equipment,

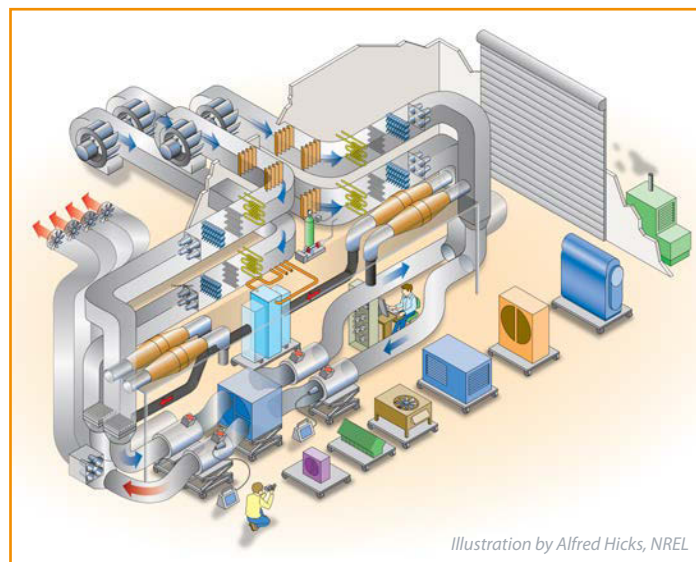


Illustration by Alfred Hicks, NREL

**HVAC Systems Laboratory:** In the HVAC Systems Laboratory, four inlet air streams are conditioned to follow real-time weather. Air is delivered to evaluate particles, and four outlet air streams measure the performance.

heat pump water heaters, and heat exchangers. Experiments supporting grid-interactive efficient buildings can be connected to real-time co-simulations of buildings using hardware-in-the-loop (HIL) infrastructure. This enables researchers to construct flexible experimental designs that answer questions about dynamic performance and grid interactivity, minimizing expensive in-situ development and corrective actions.

### R&D Growth: Thermal Energy Storage and Dynamic Building Fenestrations

Thermal energy storage cycling experiments are used to characterize the performance of composite energy storage materials (e.g., paraffin wax embedded in a graphite matrix), develop tools to understand

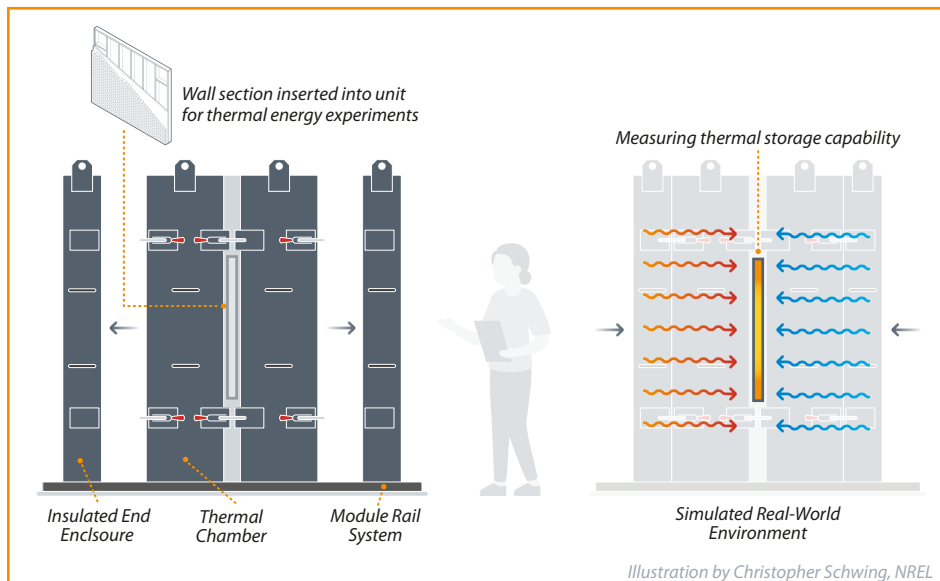
the mechanisms that impact thermal performance, and assess the lifetime of thermal energy storage devices. The Thermal Cycling Laboratory, through multiple cycles of melting and freezing of stored energy, can assess degradation, heat transfer rates, and thermal conductivity.

Dynamic building fenestrations and wall assemblies affect a building's electricity use by managing thermal loads. The dynamic thermal cycling test stand applies indoor and outdoor weather conditions to measure durability and thermal performance. Real-time and accelerated thermal and humidity cycles are applied to the assemblies to determine failure modes.

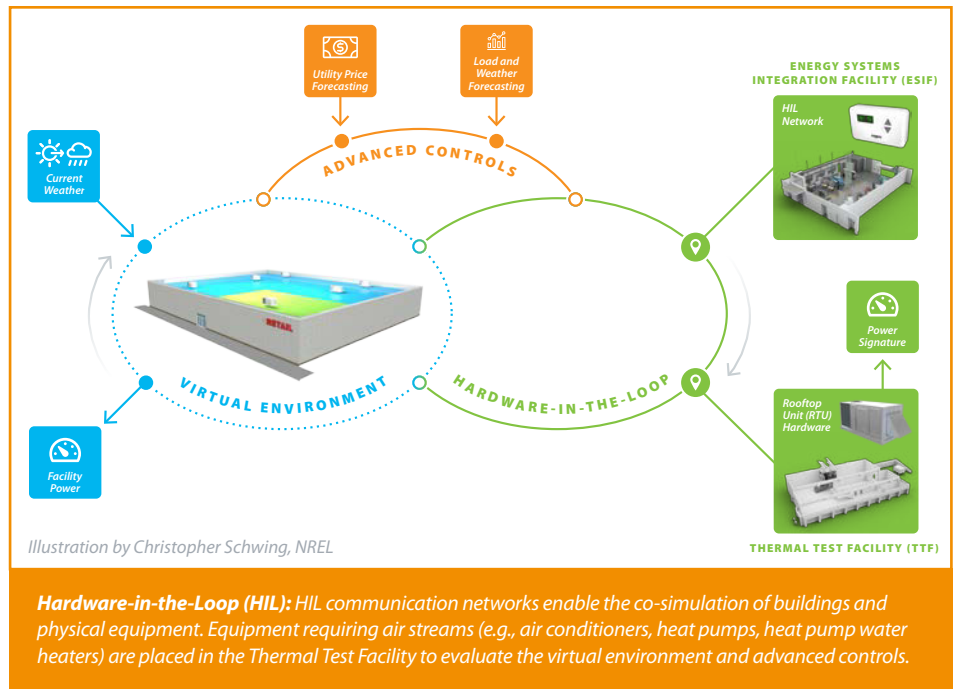
### Why NREL?

NREL's world-class researchers and facilities enable us to catalyze cutting-edge innovations while lowering industry risk for new technology investment. We enable industry, government, research, and nonprofit partners to conceive innovative ideas and develop concepts into prototypes. NREL can help you bring your idea to market. Here's why:

**We are results-driven:** Backed by 42 years of achievement, NREL leads the way in helping to meet the growing demand for energy innovation. NREL is a neutral, trusted technical resource.



**Thermal Energy Storage Cycling:** The dynamic thermal cycling test stand consists of a "clam-shell" dual chamber that can assess prototype fenestrations and wall assemblies of various sizes.



**We are relevant:** With more than 750 active partnership agreements, including small and large businesses; nonprofits; educational institutions; and local, state, and federal government, NREL is helping partners solve energy challenges.

**We are focused:** NREL is America's only federal laboratory entirely dedicated to research, development, commercialization, and deployment of renewable energy and energy efficiency technologies.

**We have the resources:** NREL's distinctive expertise, state-of-the-art laboratories, and testing and partnering facilities for developing commercially viable products can help you.

**We have the track record:** We have a strong history of conducting industry partner-driven R&D and transitioning technology to market.

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