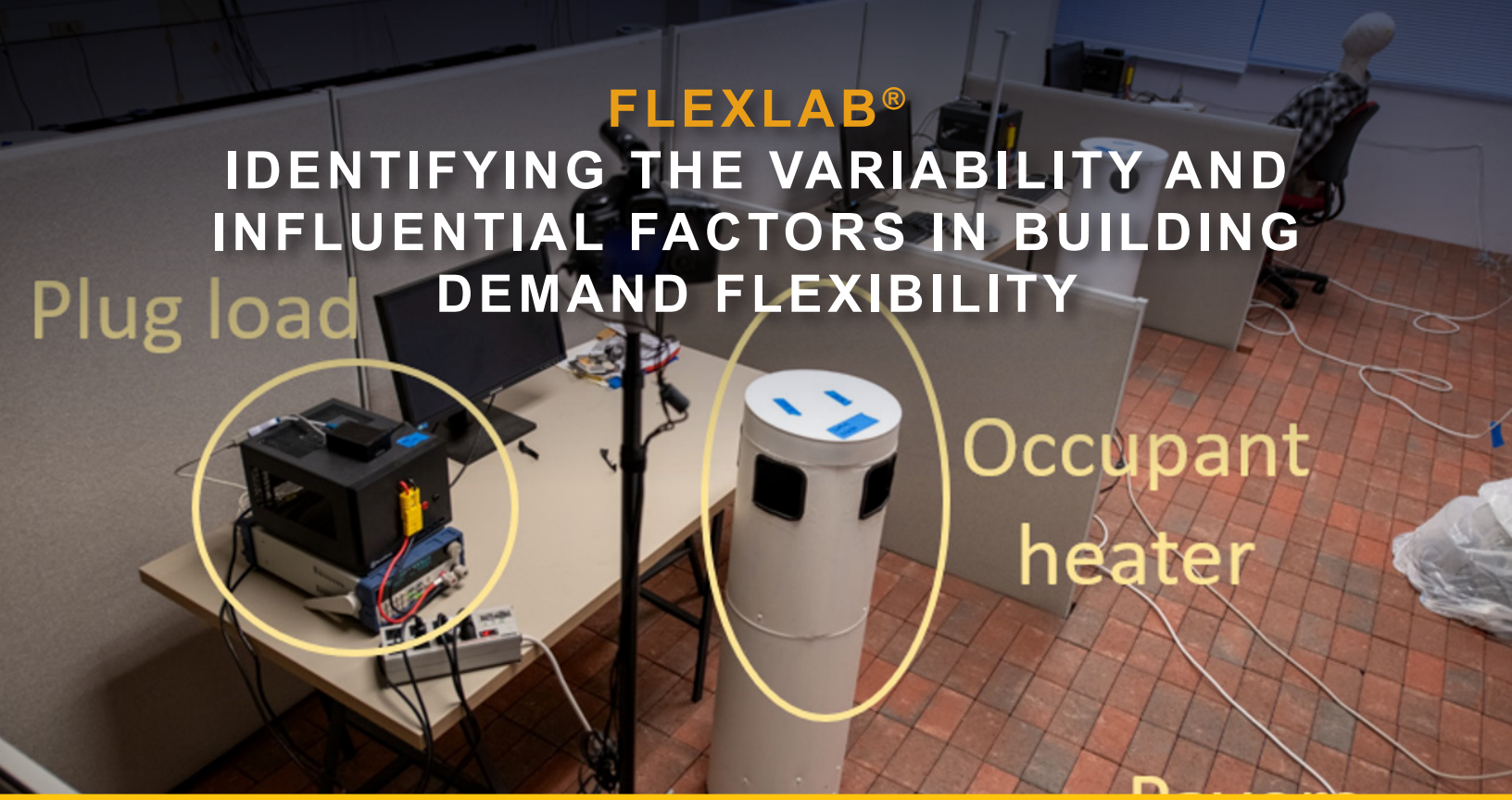


FLEXLAB®
IDENTIFYING THE VARIABILITY AND INFLUENTIAL FACTORS IN BUILDING DEMAND FLEXIBILITY

FLEXLAB testing helps reveal key factors influencing building demand flexibility

THE CHALLENGE

Understanding key influences in predicting and optimizing building demand flexibility performance

Building demand flexibility (DF) can help to decarbonize the buildings sector, improve grid reliability, and meet environmental and economic goals for buildings. In fact, building DF can be a more economical resource than other strategies, such as behind-the-meter batteries. However, building DF performance is subject to many factors that cannot be realistically isolated for analysis in the field. An improved understanding of these influential factors is critical for helping building owners identify optimal DF strategies and anticipate DF performance.

THE SOLUTION

The U.S. Department of Energy's FLEXLAB® facility at Lawrence Berkeley National Laboratory sought to close this knowledge gap by conducting lab testing and research to develop a validated understanding of how key factors such as weather, building thermal mass, and HVAC system type may influence DF in real building systems as measured in predefined metrics.

> **Building Energy Demand Management is increasingly urgent and critical for grid stability, utility cost savings, and decarbonization efforts. Yet there is limited research on the operational strategies and behavioral implications supporting demand flexibility. This study offers real measurement based analysis that informs operational strategies and challenges of demand flexibility for facility managers and building operators.**

Peter Crabtree, BEST Center Principal Investigator

U.S. DEPARTMENT OF ENERGY

THE BOTTOM LINE

FLEXLAB® tests were able to identify key factors influencing building DF.

Testing conducted at FLEXLAB not only validated some of the researchers' hypotheses but also revealed new findings such as how HVAC system type and thermal mass may influence building DF. The testing also provided a valuable calibration data source for simulation models and supported the building demand flexibility benchmarking framework, which can accommodate varying grid needs across geographic and time dimensions. Building aggregators, building portfolio owners, and utility program design professionals can use this research to support their business decisions.

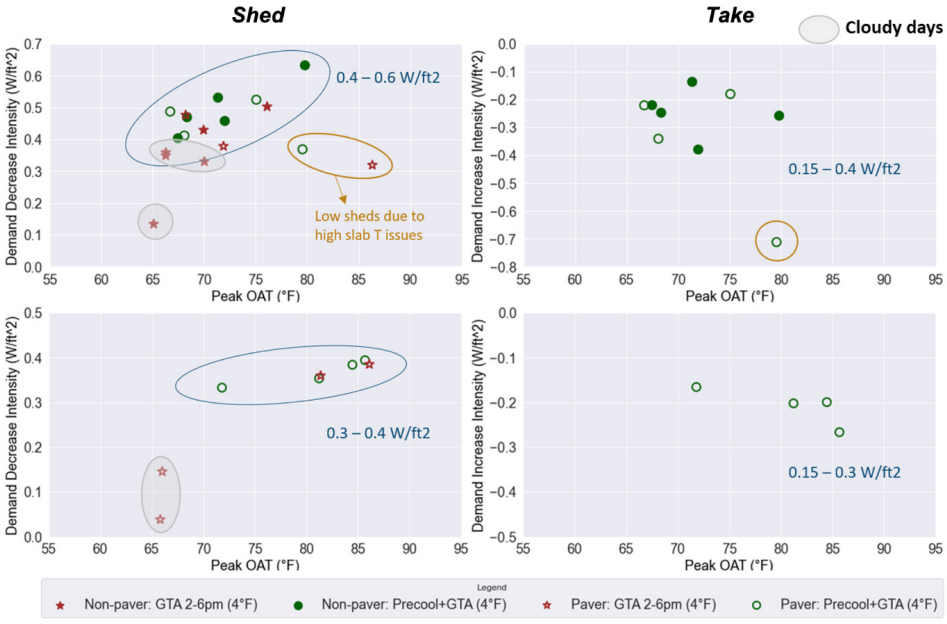
THE EXPERIMENT

- FLEXLAB's testbed cell was set up to represent a small/medium office building constructed between 1980 and 2004 with single-pane window glass and T8 fluorescent lighting. The same setup was tested with two different HVAC system types: a three-zone variable air volume (VAV) system representing a thermal zone of a medium office building and a single-zone constant-volume heat pump rooftop unit (RTU) system representing a small office building.
- The test considered three scenarios—Baseline, Global Temperature Adjustment (GTA) Only, and Precool with GTA—for buildings with normal level vs higher level floor thermal mass (emulated with pavers). During GTA shed events, zone temperature setpoint(s) were raised from a normal setpoint (e.g., 74°F) to an acceptable higher setpoint (e.g., below 80°F).
- The team evaluated FLEXLAB test results with a full set of DF metrics, compared test results with Energy Plus simulation, and compared between the VAV test and the RTU test.

THE RESULTS

The lab testing resulted in key insights which inform building owners on how they may anticipate demand flexibility performance before an event based on influential factors:

- There was a positive correlation between load shed and daily peak temperature (but with significant variability) and no clear correlation with humidity was found. Cloudy conditions reduced shed significantly.
- Shed decreases significantly for longer events, and evening DF events yield lower shed compared to afternoon events.
- Single-zone RTU systems tend to yield higher load shed on a Watt per square-foot basis compared to multi-zone VAV systems.
- Load shift with pre-cooling can be energy efficient and improves comfort, but it may not significantly increase shed. Warm room temperatures overnight may reduce the next-day shed significantly.



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