BERKELEY LAB
BUILDING TECHNOLOGY & URBAN SYSTEMS DIVISION

System Retrofits in Commercial Buildings

Trends and Opportunities for Deeper Energy Savings

TYPES OF SYSTEM RETROFITS

1 END-USE SYSTEM RETROFIT

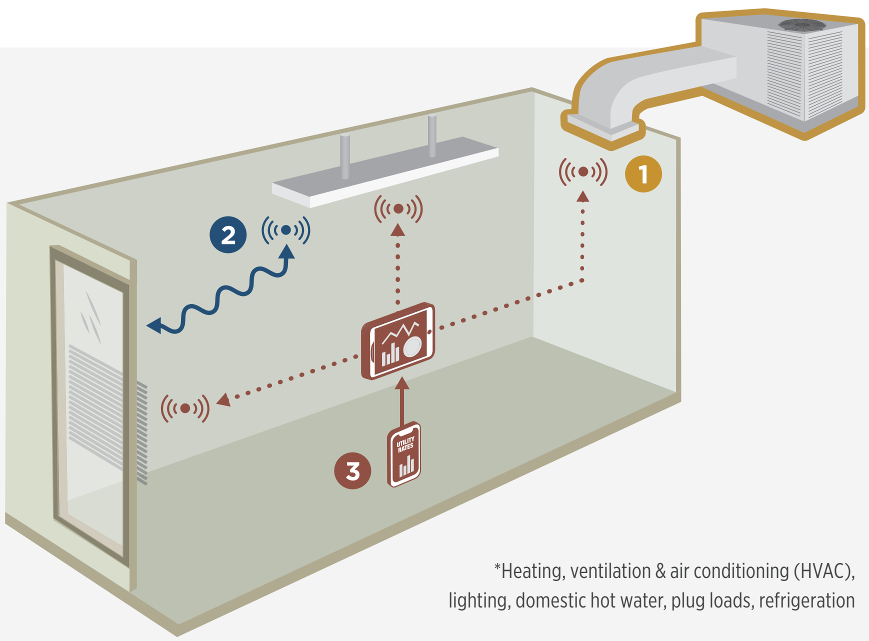
Multiple components within a single end-use* system, e.g. heat pump with heat recovery and economizer controls

2 INTERACTIVE SYSTEM RETROFIT

Passive interactions between end-use systems or other components, e.g. window retrofit to increase daylight, reducing lighting energy use via daylight sensors

3 INTEGRATED SYSTEM RETROFIT

Active control between end-use systems, e.g. automated shades responding to utility price signals and optimized to either increase daylight, thereby reducing lighting energy, or decrease solar gain, thereby reducing air conditioning energy



*Heating, ventilation & air conditioning (HVAC), lighting, domestic hot water, plug loads, refrigeration

A Comprehensive Study of 12,000 Retrofit Projects

Research has shown that savings from system retrofits far exceed savings from individual component upgrades. In one study, a lighting systems based approach saved an additional 49-82% more energy compared to a traditional component-based LED upgrade.[1] This new study by Lawrence Berkeley National Laboratory (Berkeley Lab) examined data from 12,000 retrofit projects completed within the last five years from different energy-efficiency programs, including utilities, energy service companies (ESCOs) and the federal government. The study sought to determine the extent to which different system retrofit types occur in the marketplace, to confirm whether they save more energy than component retrofits, and to identify the kinds of efficiency measures most prevalent in them.

All System Retrofits are Good, but not Equal

System Retrofits Uncommon

Across all programs, system retrofits were found in less than 20% of the projects—17% had end-use system retrofits and 6% had interactive system retrofits [*see Figure 1, 2nd page*].[2] Not one integrated system retrofit was evident from the data. System retrofits were more prevalent in federal and ESCO projects than in utility programs despite the fact that custom programs can support more complex system-based approaches.

System Retrofits Save More Energy

System-based retrofits are positively correlated with increased whole-building energy savings. Significantly more system retrofits were found in the projects with high energy savings (> 20%) than in the projects with low energy savings (< 20%) [*see Figure 2, 2nd page*]. Some non-system retrofit projects did achieve high energy savings—usually via installation of LEDs where very inefficient baseline lighting was present. Utility programs favored non-system approaches, whereas ESCOs favor systems and consequently have more projects with higher energy savings.

Lighting Retrofits Most Prevalent

Retrofit technologies varied widely by program, with utility programs favoring component-based lighting and ESCOs and federal programs focusing on HVAC. Lighting was the most common retrofit overall—found in 65% of high- and 66% of low-energy savings projects. HVAC measures had higher representation in system retrofits than in non-system retrofits.

Despite their Success, System Retrofits Lag

To better understand barriers to wider deployment of system-based approaches for existing commercial buildings, the study solicited input from 18 stakeholder organizations. What will propel these highly effective retrofits forward?

Increase Awareness

A lack of awareness of the energy-savings potential from system retrofits continues to hinder their deployment.

Make it Easy

Stakeholders cited ease of design, installation, commissioning, and operation as key factors to enable wider deployment of system retrofits. They proposed a focus on reducing the complexities involved in planning, assessing potential for energy savings, and executing such projects.

Improve the Technology

Improving the technology itself would lower barriers. System technology packages can reduce transaction costs around system specification, design, and controls integration. Industry standards and protocols for standardized controls could lower design and installation costs.

Focus on the Whole System

Some utility incentive programs require each individual energy efficiency measure (EEM) to pass a cost-effectiveness test before including them in the program, which can limit the application of system retrofits that span multiple EEMs. This barrier could be overcome by recognition that energy and cost benefits from system retrofits are greater than the sum of their parts.

Figure 1. < 20% of all Retrofit Projects had System Retrofits

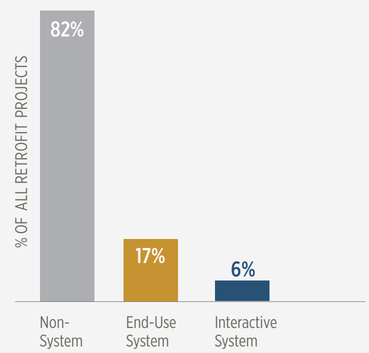
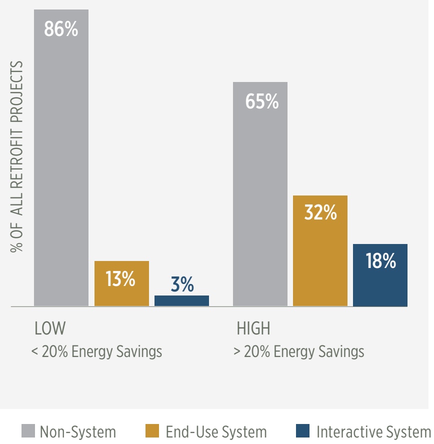


Figure 2. Projects with High Energy Savings had more System Retrofits than Projects with Low Energy Savings[2]



MOVING FORWARD

Technical, educational, policy, and regulatory advancements will all spur the application of system retrofits in commercial buildings, increasing energy savings in the built environment. Energy codes and other energy policies can continue to drive deeper levels of energy efficiency, opening system retrofits up for greater savings.

Berkeley Lab has developed several system packages to ease implementation. System specifications, validated energy and comfort performance, and simplified assessment methods can be found at buildings.lbl.gov/cbs/getting-beyond-widgets-enabling-utility-incentive

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Systems Retrofits in Commercial Buildings: Market Adoption Trends and Prospects

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[1] Regnier, C., P. Mathew, A. Robinson, P. Schwartz, J. Shackleford, and T. Walter. 2018. *Energy Cost Savings of Systems-Based Building Retrofits: A Study of Three Integrated Lighting Systems in Comparison with Component Based Retrofits*. LBNL.

[2] A project can have both an end-use system retrofit (such as a chiller, pump, and controls application) and an interactive system retrofit (such as when combined with a lighting retrofit that reduced cooling load), so the total of the system retrofits may exceed 100%.