FLEXLAB®

GETTING BEYOND WIDGETS

Enabling systems-based utility incentive programs for commercial buildings

THE CHALLENGE

Component upgrades are commonplace, and miss deeper energy savings opportunities

Current utility incentive programs for energy efficiency aim largely at components such as lightbulbs and air conditioner units. This widget-based approach misses the deeper savings possible with systems-level upgrades. Integrated lighting, HVAC and façade solutions, for example, can be designed to operate at higher overall efficiencies, maximizing energy savings across multiple end-use systems. A highly integrated, whole-building retrofit can deliver up to 80% energy savings, compared with about 30% for a components-based approach[1].

Why, then, aren't these integrated systems more prevalent? Implementing such retrofits can be complex and disruptive, but they also require more rigorous assessment through modeling in order to identify effective systems strategies. The added costs and complexity of this process makes them difficult to scale through utility incentive programs. At the same time, many building operators remain unaware of how much energy some integrated building systems can save.

[1] Regnier, C., T. Hong, K. Sun, M.A. Piette. 2017. Quantifying the benefits of a building retrofit using an integrated system approach: A case study. Energy and Buildings 159, 332–345.

THE SOLUTION

Researchers at the U.S. Department of Energy's FLEXLAB® facility at Lawrence Berkeley National Laboratory (Berkeley Lab) collaborated with utilities to develop and validate options for systems-level incentive programs. They evaluated three sets of technology packages in real-world conditions at FLEXLAB's highly instrumented test facilities. Recognizing many utility customers start with looking for savings with LED lamp replacements, the three sets focused on a system package that incorporated lighting strategies, each integrated with another building system or element. The results provided utilities and their customers with the information, tools and proven savings data needed to implement systems-level projects, avoiding the cost and complexity of custom solutions. Streamlining the adoption of these technologies can deliver large, sector-wide energy savings.

> **Thanks to the capabilities of FLEXLAB®, we were able to quickly and accurately assess the benefits associated with an integrated systems approach. Bringing together multiple technologies under the same controlled environment is a truly unique and valuable tool for us as a utility seeking to provide unbiased and well-proven solutions to customers. FLEXLAB is a key strategic asset for the U.S. in adopting more of these integrated approaches.**

Andrew Quirk, Xcel Energy, Team Lead - Customer Solutions

THE BOTTOM LINE

FLEXLAB delivered crucial performance validation and data that utilities can use to design deep-saving energy efficiency incentive programs for integrated building systems.

The opportunity for increased energy savings through adoption of integrated buildings systems is clear. Meanwhile, with increasingly stringent energy codes, the number of cost-effective component-based solutions that achieve significant savings is dwindling. The test data provided by FLEXLAB® enabled the development of new simplified methods for utilities to evaluate and promote integrated systems, while ensuring visual comfort and achieving new levels of energy savings with known levels of accuracy. With test chambers that enable highly granular thermal, visual and power data measurements in a real-world setting, FLEXLAB fosters insights that can ultimately help homes, schools, and businesses.

THE EXPERIMENT

Researchers evaluated three integrated systems packages over a period of a year:

- Automated shading combined with daylighting dimming controls.
- Task-ambient lighting retrofit with task lighting and plug load occupancy controls.
- Workstation-specific lighting with daylight dimming controls.

Each package was tested under a range of conditions typical of retrofits, such as differing existing lighting types, varying building window to wall ratios, solar orientation and the depth of daylit controls zone. Descriptions of each test is provided in the following bullet points.

- Automated shading integrated with tuned LED lighting and daylight controls was compared with a baseline case of manually operated venetian blinds and tuned LED lighting with no daylight-based dimming. The two were evaluated at the same time under identical conditions using both cells of the FLEXLAB rotating testbed to test south and west facing conditions. Testing for Illinois utility ComEd approximated Chicago climate conditions.
- FLEXLAB evaluated task-ambient lighting with task lights and plug load occupancy controls in four different test conditions for California Publicly Owned Utilities. The system was tested in FLEXLAB's Occupied Lighting and Plug Loads Testbed, which consists of a permanently occupied commercial office environment, with power measurement and controls capabilities at the device level.
- A workstation-specific lighting system retrofit combined with daylight dimming controls was evaluated for Xcel Energy markets in Colorado and Minnesota. The test case of workstation-specific LED lighting system and the base case of T8 zonal lighting, recessed fluorescent troffers and no daylight-based dimming were tested simultaneously under identical conditions using two FLEXLAB testbed cells.

THE RESULTS

- About 82% annual lighting energy savings in the south-façade daylit zone for workstation specific lighting systems with daylight dimming (including lighting retrofit and task tuning).
- About 20% annual lighting energy savings for south facing automated shading combined with daylight dimming, not including light fixture retrofit savings.
- 30-46% annual lighting and plug load energy savings for task-ambient lighting systems combined with plug load occupancy controls in a core space application, depending on base case lighting system and office building size (no daylight dimming impacts).
- FLEXLAB test data demonstrated substantial savings, which were used to generate annual energy savings and create simple assessment methods for utilities to apply to their customer's buildings. All three systems illustrated acceptable levels of daylight glare probability for the occupants.
- Test data translates to annual whole building savings of 5-8% (large-medium commercial office), 3-5% (medium-large commercial), and 12-28% (large-small commercial) for these systems respectively, using a U.S. Department of Energy (DOE) reference building model (DOE 2018).
  - Systems were applied in south facing perimeter (first two systems) and interior core zones respectively.
  - Savings may be higher when applied to larger perimeter or core areas than as occurs in the reference models.
- All systems achieved 30 to 50% more energy savings than a traditional LED retrofit, with competitive paybacks.

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