Deeper Energy Savings with Task/Ambient Lighting and Plug Load Control

What are Task/Ambient Lighting Systems?

By installing desktop task lighting in office workspaces, it is possible to significantly reduce output from overhead light fixtures while maintaining acceptable levels of light distribution. Plug load occupancy controls may also be included, so that all non-critical equipment (including task lighting) is controlled based on occupancy. In this study Lawrence Berkeley National Lab (LBNL) focused on applying this system in interior (core) office spaces, saving 12-20% whole building energy (see Table 1[i]). Most savings come from lighting, with modest plug load savings. Even greater energy savings could be achieved in perimeter spaces by adding daylight dimming control. Several system packages are presented here, and for Package 2b, this would incur no additional cost when applied with multi-sensor light fixtures.

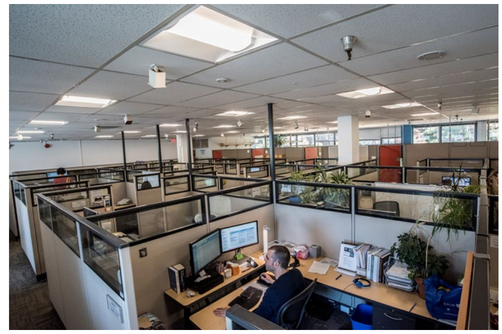

Figure 1. System 2b installed in the FLEXLAB® Occupied Testbed

System Setup

For overhead lighting, the system is applied in one of two ways: a) reducing lighting power density via lamp or fixture change-out or b) tuning existing lamps for a lower lumen output (if existing system is dimmable). Plug load control can be applied either by a) coupling the controlled receptacles to lighting system occupancy sensors or b) installing a plug load control system with dedicated occupant sensors. LBNL specified and tested one basic option (Package 1) and two more advanced systems (Packages 2a and 2b):

- Package 1: a 'basic' low intervention system, consisting of changing overhead lamp to LEDs from a fluorescent baseline, and surface mounting plug load controls on existing receptacles;
- Package 2a: a controls-only solution for overhead lighting and line voltage-wired plug load control; and
- Package 2b: light fixture replacement and plug load controls that involved more intervention, including electrical work.

Performance Validation at FLEXLAB®

Each system was tested in FLEXLAB®'s occupied testbed, a 3,000-square-foot open office space with robust load metering, to understand individual device behavior. Each technology package option was tested for two months to cover a range of occupancy conditions. Test data was collected to verify energy performance, as well as occupant comfort and system acceptance. The test results validated the performance expected in all aspects.

Overview: A Systems-based Approach

Most building retrofits are still component-based, typically addressing only one piece of equipment at a time. Case studies demonstrate that to achieve deeper whole building energy savings, integrated systems and strategies are required.[ii] However, a systems-based approach requires a more rigorous design and savings assessment effort, as well as greater resources for installation and commissioning. A main objective of developing these integrated systems packages is to simplify implementation and operation by commercial building owners and operators. These systems may also benefit from access to customer incentives from local utilities.

Cost Effectiveness[iii]

- For the retrofit case, which includes the full project cost, simple payback is estimated at 15-21 years.
- For the replace-on-burnout case, where the payback is calculated on the incremental cost of the specified technology over a "standard" lighting system replacement, simple payback is estimated at 3-9 years.
- Cost effectiveness will vary greatly based on regional utility rates and market labor rates.

Occupant Satisfaction

Light levels were measured at the desktop and floor for each package, with the aim of satisfying Illuminating Engineering Society guidelines for corridor lighting[iv] (the task-ambient lighting strategy allows for lower ambient levels, made up for as needed at the desktop with supplemental task lighting). At the conclusion of testing, occupants were surveyed to determine levels of visual comfort and satisfaction with the operation of the system; in all cases the tested systems were satisfactory and met user requirements.

Identifying Suitable Sites

Task-ambient lighting and plug load control systems are an attractive option for commercial office buildings, but candidate sites should be selected with attention to average daily occupied hours, installed office equipment, and existing lighting systems. LBNL developed a simple assessment calculator to estimate energy performance using site-specific inputs.

Table 1. Energy Savings Results for Existing Building Baseline[v]

	Energy Savings (kWh/sf/yr)	Energy Cost Savings ($/sf/yr) at $0.11/kWh	Whole Building Energy Savings (%)
Tech Package 1 - Basic	2.8 (Small) 3.16 (Large)	0.31 0.35	18% 14%
Tech Package 2(a) - Advanced	2.52 (Small) 2.82 (Large)	0.28 0.31	16% 12%
Tech Package 2(b) - Advanced	3.23 (Small) 3.61 (Large)	0.36 0.41	20% 16%

Integrated Comprehensive Implementation Support

A Systems Package Program Manual (see Figure 2) provides guidance for implementation and is comprised of a systems description, performance specification of the system components, savings and performance metrics, candidate site requirements, a site energy savings assessment calculator, an assessment of market savings potential, energy savings and performance data, implementation guidelines (including measurement and verification) and training. The Program Manual and the assessment calculator along with other systems packages and papers can be found here.

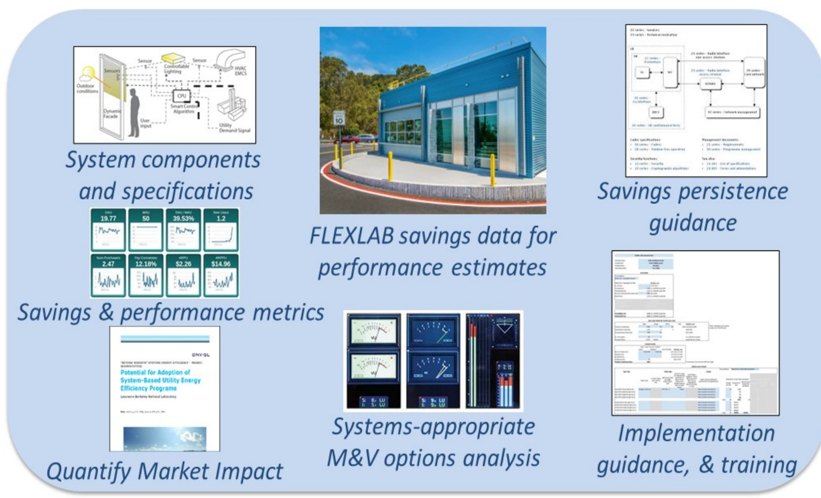

Figure 2. Key Elements of the System Package Development

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[i] Energy reductions reported are for applying the task/ambient system only in the core of an office building. Whole building savings will vary for other sites according to their proportion of core versus perimeter office space.

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

[iii] Assumes an average US electricity rate of $0.11/kWh

[iv] Average of spot measurements to achieve or exceed 200 lux.

[v] Whole building energy savings are specific to ASHRAE Climate Zone 3.