Deeper Energy Savings with Workstation-specific Lighting and Daylight Dimming

What is Workstation-specific Lighting with Daylight Dimming?

By designing lighting systems with one overhead light fixture per workstation and sensors and dimming control at the fixture level, illumination is provided when and where it is needed. Lighting energy is significantly reduced by the reduction in lighting fixture density and by fixture operation over time. This design approach recognizes that light levels in corridors and egress pathways need not be as high as the task plane, per the Illuminating Engineering Society's (IES) recommended practice.[i] Additional savings are possible in perimeter zones using daylight harvesting controls, with total annual energy savings estimated up to 93%.[ii]

Figure 1. System installed in FLEXLAB® Testbed

System Setup

The lighting system locates fixtures where they are needed over the workstation, and implements two main strategies to deliver energy savings to perimeter zones: a) lighting power is tuned to deliver a desired task plane light level and b) daylight dimming is enabled for each fixture in the daylit zone[iii] so that electric lighting power lowers with daylight availability. Lights nearest the window will dim the most (or switch off entirely), with lights deeper in the daylit zone dimming progressively less. Manually operated venetian blinds – essential to manage glare from low sun angles – are also installed and are operated by occupants according to lighting conditions in the space.

Performance Validation at FLEXLAB®

Each system was tested in FLEXLAB, a heavily instrumented and metered test facility that supports side-by-side comparisons of baseline and test conditions. Testing was conducted in a south-facing perimeter zone for a total of six months to cover multiple fixture configurations, and a range of daylight conditions and sun angles. Test data was collected to verify energy performance and to analyze the workstation light levels and incidence of glare to quantify occupant visual comfort conditions.

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.[iv] 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

Simple payback was calculated with energy savings valued at an average US electricity rate of $0.11/kWh

- Simple payback for the retrofit case, including the full project cost of the workstation-specific lighting and daylight dimming, is estimated at approximately 16 years.
- For the replace-on-burnout case, only the incremental cost of the specified technology over a "standard" lighting system replacement is included. Simple payback in this case is estimated at just over 5 years.
- Cost effectiveness will vary greatly based on regional utility rates and market labor rates.

Table 1. Energy Savings Results for Existing Building Baseline

Energy Savings (kWh/sf/yr)	Energy Cost Savings ($/sf/yr) at $0.11/kWh	Lighting Energy Savings (%)
3.84	0.41	93%

Occupant Comfort

Target workstation light levels were maintained by the lighting system, per IES-recommended practice. Daylight Glare Probability was similar for baseline and test cases. It was maintained within acceptable levels during some of the testing period but reached intolerable levels at times; this occurred particularly during the winter season when sun angles are lowest. Incidences of glare were higher closer to the windows, as expected. In these circumstances, manual or automated shades are required; they would be installed and operated according to the preferences of occupants.

Identifying Suitable Sites

Workstation-specific lighting and daylight dimming are an attractive option for commercial office buildings, but due to the daylight access aspect of the system, candidate sites should be selected with attention to window-to-wall ratio, cubicle partition heights, and existing fluorescent lighting. A simple assessment calculator is available to estimate energy performance using site-specific inputs.

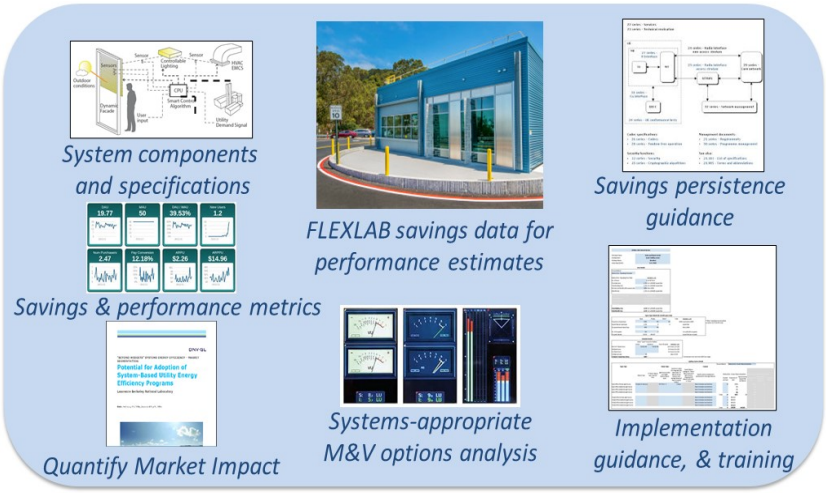

Figure 2. Key Elements of the System Package Development

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, and 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.

[i] Illuminating Engineering Society (IES), 2011, The Lighting Handbook, 10th Edition.
[ii] Florescent base case, assuming 500 lux at the workplane
[iii] Generally assumed to be twice the window head height
[iv] 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.