Integrated Office Lighting System

Mrak Hall, UC Davis
Davis, CA

The Problem

Office lighting has traditionally been provided by overhead recessed or pendant mounted flourescent luminaires, with additional task lighting supplied by fluorescent undercabinet fixtures and desk lamps. Some fluorescent systems can be energy-intensive, and they often lack lighting controls such as daylighting controls or personal occupancy sensors. California's 2008 Building Energy Efficiency Standards (which took effect January 1, 2010) reduced the allowed lighting power density by 25% to 0.85 W/ft^2. Meeting these standards requires significantly reducing both general lighting and task lighting loads without sacrificing occupant satisfaction and visual comfort.

The Solution

The California Lighting Technology Center (CLTC) partnered with Finelite, Inc. and Adura Technologies to develop and demonstrate a unique, wireless task/ambient office lighting solution ideally suited for the retrofit market. The system consists of two key elements: a task/ambient lighting system and advanced, wireless lighting controls. The combination provides substantially reduced energy use, improved lighting quality, and personal lighting control for individual work spaces, without the need for any additional wiring or rewiring of existing luminaires or lighting circuits.

The system has three specific components: adaptive ambient lighting, LED task lighting, and wireless controls. Ambient lighting retrofits consist of step-dimming recessed or suspended luminaires. Task lighting is provided by the Finelite Personal Lighting System (PLS), a suite of desk lamps and undercabinet luminaires available in 3W, 6W and 9W that can be combined to create custom systems. These task lights utilize a personal occupancy sensor, which can be commissioned to communicate with the Wireless Photosensor and Motion sensor (WIPAM) system offered by Adura Technologies. Wireless occupancy sensors and switches were also included to create custom lighting zones throughout the space. This unique combination of technologies may be customized to suit the needs of any retrofit lighting project.

FIGURE 1: INTEGRATED OFFICE LIGHTING SYSTEM WITH LIGHTPOINT CONTROL SYSTEM
Mrak Hall, University of California, Davis

Features and Benefits

- High-quality ambient and task lighting, providing an aesthetically pleasing office environment
- Energy-efficient LED task light components can be customized to the individual workspace
- Personal occupancy sensors control task and ambient lights
- High user satisfaction for IOLS retrofit
- Significant energy savings, typically 40–50%
- Ability to control lighting remotely via the Adura LightPoint control system

FIGURE 2: MRAK HALL OPEN OFFICE AREA
Each occupant of the open office area was provided LED task and undercabinet lighting.

Technology Costs and Incentives

An IOLS retrofit will generally cost twice as much as a lamp-and-ballast retrofit, yet the IOLS yields twice the energy savings. Increased first costs are attributed to the addition of high-quality LED task lighting systems, advanced lighting controls, and, often, replacement of existing luminaires with direct / indirect pendants.

Energy-efficient lighting retrofits can expect utility incentives of $100 per kW demand saved and $0.05 per kWh saved. These incentives can sometimes be combined with incentives associated with T12 or T8 lamp replacements, the addition of occupancy sensors, and LED light source retrofits. Facility managers can contact their utilities to determine applicable incentives.

Payback periods for IOLS retrofits are typically between three and seven years. These payback periods depend primarily on incumbent task and ambient lighting systems. The payback period for this demonstration was 12 years due to the additional cost of the WIPAM wireless lighting control system. Larger installations deliver much shorter paybacks because certain wireless communication components included in this system can service much larger lighting zones. This increases energy savings with no increase in system cost, thus reducing payback periods.

Demonstration Results

University Communications Office Mrak Hall, University of California, Davis

CLTC partnered with the University of California and Adura Technologies to retrofit existing office lighting with a WIPAM-controlled IOLS demonstration at the University Communications office on the third floor of Mrak Hall on the UC Davis campus.

TABLE 1: ILLUMINANCE LEVELS
Mrak Hall, University of California, Davis

SCENARIO	AVERAGE	MIN	MAX	UNIFORMITY
PRE-RETROFIT	30.1	5	53	6.0
POST-RETROFIT	42.2	38	48	1.1

Private offices in Mrak Hall were partitioned from the main open office area with semi-permanent walls. These partitions did not allow for wired lighting controls, and, as a result, no occupants in the facility had personal control of the lighting in their offices. All lighting, for private and open offices, was controlled by a single bank of switches.

The pre-existing lighting consisted of delamped 4-lamp T8 fluorescent troffers of various color temperatures. Each troffer consumed 77 W of power. Incumbent task lighting consisted of a mix of undercabinet T12 fixtures and desktop incandescents controlled by manual switches.

The IOLS retrofit consisted of a PLS task light replacement and a lamp-and-ballast retrofit which changed the color temperature of the luminaires to a consistent 4100 K and changed all ballasts to step-dimming ballasts. While UC Davis facilities personnel were carrying out the lamp and ballast retrofit, they also installed light controllers (LC) in the troffers. LCs serve as links between the luminaires and the wireless control infrastructure, receiving commands from wireless switches and sensors then controlling luminaire output accordingly. When used in concert with the rest of the Adura Lightpoint System, these LCs allowed flexible dynamic control of the lighting in the office.

CLTC monitored pre- and post-retofit energy consumption. The new system consumed approximately 45% less energy than the existing systems, for a total life-cycle savings of more than $20,000. It is estimated that a building-wide retrofit would result in savings of approximately $400,000. Energy and maintenance costs and savings for this demonstration are detailed in Table 2.

Photometric measurements were also taken before and after the retrofit to ensure that illuminance levels were maintained in the office after the IOLS demonstration (Table 1). Post-retrofit illuminance levels exceeded those of the incumbent system while improving lighting uniformity.

Product Availability

Bi-level and 0 – 10V dimming ballasts are offered by major fluorescent ballast manufacturers such as Philips and Osram Sylvania. PLS customizable task lighting systems are available from Finelite. WIPAM controls systems are available from Adura Technologies.

FIGURE 3: DEMONSTRATION COMPONENTS
Personal Lighting System (left) and wireless wall switch (right).

What's Next

The CLTC continues to develop demonstrations of energy-efficient office lighting technologies through the State Partnership for Energy Efficient Demonstrations (SPEED) program. This program is aimed at achieving widespread implementation of these and other energy-efficient lighting and controls technologies.

Collaborators

This demonstration was the result of collaboration among CLTC and UC Davis, as well as manufacturing partners Adura Technologies, and Finelite. It was sponsored by the CEC-PIER SPEED program, which is coordinated by the California Institute for Energy & Environment (CIEE).

For More Information

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TABLE 2: ENERGY AND MAINTENANCE COSTS AND SAVINGS

TECHNOLOGY	SYSTEM SIZE (WATTS)	ANNUAL ENERGY CONSUMPTION (kWh)	ANNUAL ENERGY COST	ANNUAL MAINTENANCE COST	TOTAL ANNUAL COST	LIFECYCLE ENERGY COST	LIFECYCLE MAINTENANCE COST	TOTAL LIFECYCLE COST
AMBIENT 4-LAMP RECESSED FLUORESCENT	5,914	23,319	$2,985	$0	$3,010	$35,048	$0	$35,048
RETROFIT 2-LAMP RECESSED FLUORESCENT	4,312	10,383	$1,329	$0	$1,329	$15,606	$0	$15,606
SAVINGS	**1,602**	**12,936**	**$1,656**	**$0**	**$1,681**	**$19,442**	**$0**	**$19,442**
FLUORESCENT TASK LIGHTING	475	2,289	$293	$4	$1,569	$3,040	$488	$3,528
PLS	255	1,229	$157	$0	$757	$1,632	$0	$1,632
SAVINGS	**220**	**1,060**	**$136**	**$4**	**$812**	**$1,408**	**$488**	**$1,896**

Annual hrs of incumbent use: 39,433 Annual hrs of retrofit use: 2,190 Cost of labor: $50/hour Time to replace lamp: 0.25 hrs Energy cost: $0.128/kWh

About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) Program. PIER supports public interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.