DUAL-LOOP PHOTOSENSOR CONTROL SYSTEM

Walmart
West Sacramento, CA

The dual-loop photosensor combines open-loop and closed-loop photosensor technologies to deliver more consistent lighting control and greater energy savings.

ENERGY AND CO_2E SAVINGS

37%

CODE COMPLIANCE

2013 Title 24

ANNUAL ENERGY COST SAVINGS

$0.10/ft^2

upgrading from open-loop system *

$0.27/ft^2

upgrading from no controls or dimmable fluorescent ballasts*

** at $0.13/kWh*

CLTC collaborated with partners from the lighting industry, regulatory agencies, and California's utilities to develop a dual-loop photosensor control system that combines open-loop and closed-loop photocontrol technology. This innovation in daylight harvesting delivers more consistent, energy-efficient lighting control and features automatic recalibration for optimal, cost-effective performance.

A 12-month demonstration at the Walmart in West Sacramento, California showed the dual-loop system maintained the designed electric light level far more consistentlly than the store's incumbent open-loop system. The dual-loop device also achieved energy savings 50% greater than those achieved by the open-loop system (36.6% versus 24.4%). For stores like the demonstration site, upgrading from the open-loop to the dual-loop system could save an estimated 113.5 MWh, or $14,500, annually per site.

Energy savings from daylight harvesting are expected to rise as California's 2013 Title 24 Building Energy Efficiency Standards increase requirements for skylights in nonresidential buildings. The new standards, which take effect in 2014, also require photosensor controls for all daylight zones using 120 watts or more for lighting. The dual-loop innovation will maximize the financial benefits of compliance while improving lighting quality, increasing energy efficiency and reducing peak demand.

PROBLEM

Closed-loop and open-loop photosensor control systems are limited in terms of their accuracy and reliability. These factors diminish potential energy savings and make frequent recalibration necessary to address issues of over-dimming or under-dimming.

In an open-loop system, the photosensor is oriented so that it only responds to changes in daylight levels. For this reason, open-loop sensors do not always respond accurately to actual interior light levels. For example, if blinds are drawn to block glare on a sunny day, or reflectance is diminished within the space, an open-loop system might over-dim electric lights.

In a closed-loop system, the photosensor is oriented toward the interior space, sensing both daylight contribution and electric lighting, but closed-loop systems can be unreliable at daylight sensing. This is because the system is unable to distinguish between changes in daylight and occupant interference or changes in object reflectance within the space.

SOLUTION

Researchers at CLTC resolved these issues by integrating both open-loop and closed-loop sensors into a dual-loop system for skylight applications. The device uses an advanced control algorithm that monitors the open-loop and closed-loop photosensors and controls the electric light to maintain the designed light level. It is this control algorithm that allows the system to distinguish between true daylight changes and occupant interference.

The control algorithm also automatically recommissions the system each night, allowing it to adjust to long-term changes in the interior space (e.g., new objects or changes to flooring or wall color). These nightly automatic adjustments resolve issues of over-dimming and under-dimming. The automatic recommissioning feature also drastically reduces maintenance costs while continually optimizing performance and energy savings.

PROJECT TECHNOLOGY

LMLS-600

Dual-loop Switching & Dimming Photosensor by WattStopper, available at **wattstopper.com**

CLOSED LOOP VIEW

OPEN LOOP VIEW

PLACEMENT FOR SKYLIGHT APPLICATION

The LMLS has a 70° cone for mounting at 12–15' and a 30° cone for use when mounting the device at 16–30'.

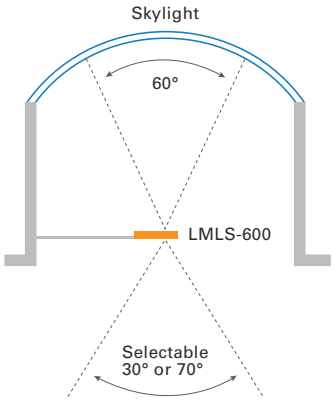
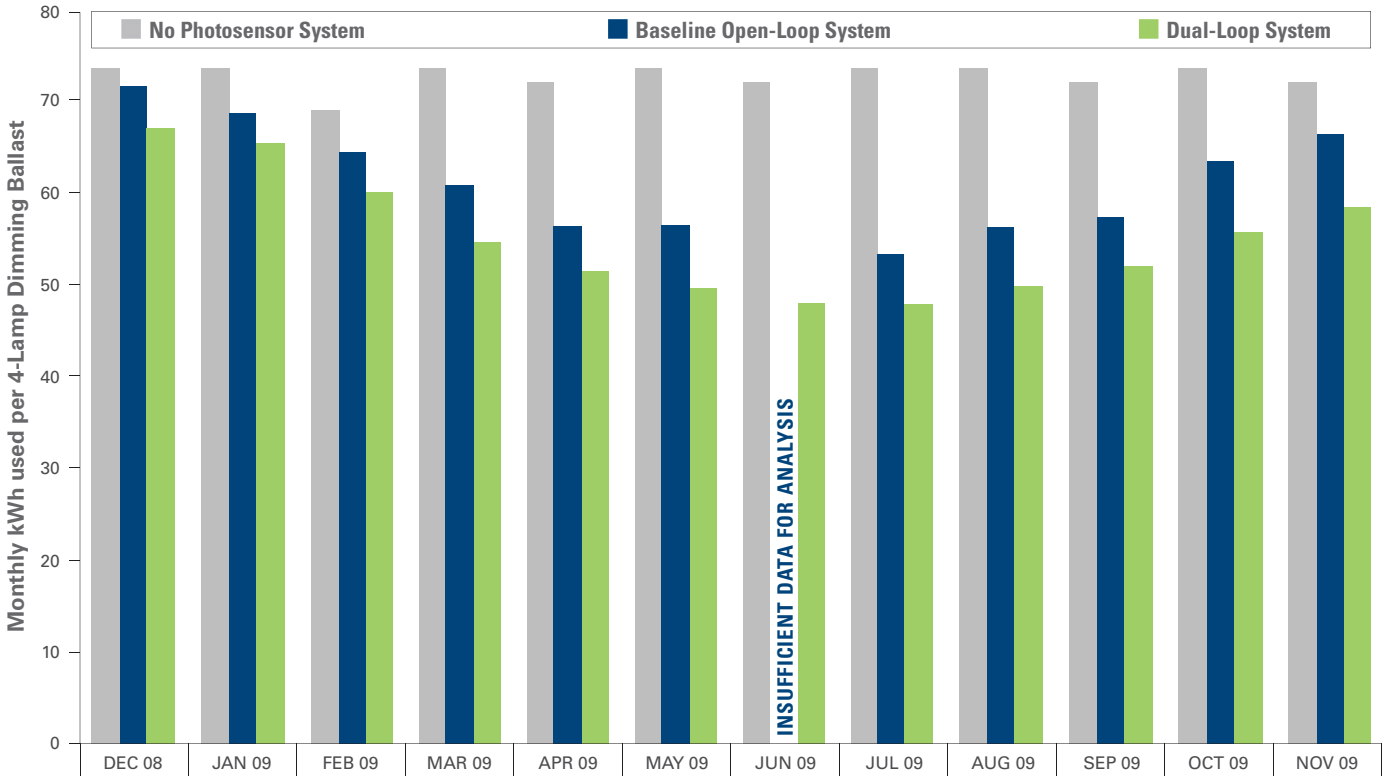


FIGURE 2: LIGHTING ENERGY USE

Compared to a skylit area lacking any daylight harvesting controls, the open-loop system reduced energy use 24.4%. The dual-loop system reduced energy use 36.6%, a 50% improvement upon the energy savings of the baseline technology.



DEMONSTRATION RESULTS

CLTC installed a dual-loop prototype in the skylight well of a 24-hour Walmart store in West Sacramento, California. The dual-loop system and a pre-existing open-loop system were monitored for 12 months (November 2008–October 2009). During the demonstration period, product displays below the skylight changed, altering the geometry and reflectance of the products in the skylit space. The automatic commissioning feature accounted for these changes and adjusted electric lights for the space accordingly, maintaining light levels within 10% of the designed electric light level nearly 64% of the time.

This improved accuracy and consistency also increased energy savings. Compared to a store lacking any daylight harvesting controls, the open-loop system yielded an average energy savings of 24.4% while savings from the dual-loop system averaged 36.6%—a 50% improvement.

COSTS & SAVINGS

The Walmart location where the dual-loop photosensor was demonstrated has 1,000 ballasts and an area of 150,000 square feet. Based on these dimensions and the systems' demonstrated energy savings, the dual-loop system could save 113.5 MWh and $14,500 more than the open-loop system over a 12-month period. Assuming the dual-loop system retrofit costs $1,000 in materials and $1,000 in labor, the simple payback would be 1 month, 20 days. There are approximately 3,500 Walmart stores and supercenters in the U.S. Assuming half of Walmart's existing store base is similar to the store in this study, Wal-Mart could save 198.5 GWh, or $25.4 million, annually by switching to the dual-loop system.

COLLABORATORS

This project was made possible through the collaborative efforts and support of the California Energy Commission, the PIER program, CLTC, the Building Energy Research Grant Program, Walmart, WattStopper, SDG&E, SMUD, and Southern California Edison.

NEXT STEPS

CLTC is exploring the use of multiple photosensors for sidelit applications. The dual-loop photosensor functions well for windows without window treatments, but research is ongoing to develop a photosensor system that performs well with windows that do utilize treatments.

TABLE 1: DUAL-LOOP SAVINGS—UPGRADE SCENARIO

Upgrading from an open-loop system to a dual-loop system yields the following savings

	Monthly	Annual
Energy Savings / Ballast	9.5 kWh	114 kWh
Energy Savings / Store	9.5 MWh	114 MWh
Average Cost Savings / Ballast	$1.21	$15.52
Cost Savings / Store	$1,210	$14,529
Energy Savings		0.76 kW/ft^2
Cost Savings		$0.10 per ft^2

TABLE 2: DUAL-LOOP SAVINGS—FULL RETROFIT SCENARIO

Installing dimmable ballasts and the dual-loop system at a site that lacked photocontrols or dimmable ballasts yields these results

	Monthly	Annual
Energy Savings / Ballast	26.3 kWh	315.7 kWh
Energy Savings / Store	26.3 MWh	315.7 MWh
Average Cost Savings / Ballast	$3.37	$40.44
Cost Savings / Store	$3,370	$40,440
Energy Savings		2.11 kW/ft^2
Cost Savings		$0.27 per ft^2

Store Floor Area *150,000 ft2* ***Ballasts / Store*** *1,000 ft^2*
Average Energy Cost *$0.128/kWh*

ABOUT CLTC: The California Lighting Technology Center is part of the University of California, Davis. CLTC is a not-for-profit research, development and demonstration facility dedicated to advancing energy-efficient lighting and daylighting strategies and technologies.

For questions about this project contact:

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