Daylight Harvesting Made Simple

The Problem

Daylight harvesting systems, which automatically adjust lights in response to the amount of daylight in a space, can provide significant energy and demand savings. However, these systems are usually expensive to install, commission, and maintain. Also, they often do not perform as well as expected and are frequently deactivated by unhappy users.

The Solution

Researchers at the California Lighting Technology Center (CLTC) at the University of California, Davis developed a new approach called the Simplified Daylight Harvesting system (SDH) that is easy to install and provides automatic and continuous calibration. The system uses photosensor readings to set lights to on, off, or intermediate levels (**Figure 1**) and gives users the ability to adjust the on and off setpoints to meet their own preferences—a key element in user acceptance of daylight harvesting. The SDH has been designed for bi-level switching, but the technology can be used for multistep or continuous dimming as well. The University has signed license agreements with Watt Stopper/Legrand and Axis Technologies Inc. to commercialize the SDH and other related technologies—including photosensors that more accurately account for light approaching the sensor from all angles in its field of view, rather than just head-on, and an approach that uses dual photosensors for increased reliability.

Features and Benefits

The SDH consists of a photosensor to measure light levels, relays to switch the states of the electric lights, a controller that determines when to change lighting states, and an optional occupancy sensor. Together, these elements create a system that is reliable, user-friendly, and cost-effective.

Self-calibrating ability. The SDH control logic uses photosensor measurements to switch among the off, low-output, and high-output states in a bi-level electric lighting system (**Figure 2**).Differences in photosensor signals are automatically calculated every time the lights are switched and serve to calibrate and govern the system's response. This process accounts for changes in furniture layout and reflectance of interior surfaces, and also enables the system to adapt to the decreasing levels of electric light that are available as the lamps age. A time delay is programmed so that the system doesn't respond unnecessarily to transient changes in the daylit environment. A time delay works well for on/off systems because they are generally expected to work once in the early morning and once in the late afternoon. The system has been tested in the bi-level lighting configuration, but is also designed to be able to switch to any number of intermediate light levels.

Occupant acceptance. Several features are aimed at increasing user acceptance of the SDH system. First, the system will allow occupants to adjust the on and off setpoints to match their lighting preferences. Sufficient separation between the

Figure 1: Simplified controls enable effective daylighting

The Simplified Daylight Harvesting (SDH) system adjusts electric lights among off (A), intermediate (B), and full on (C) levels based on photosensor readings. The SDH calibrates itself by monitoring differences in photosensor data as it cycles through the different switched levels.

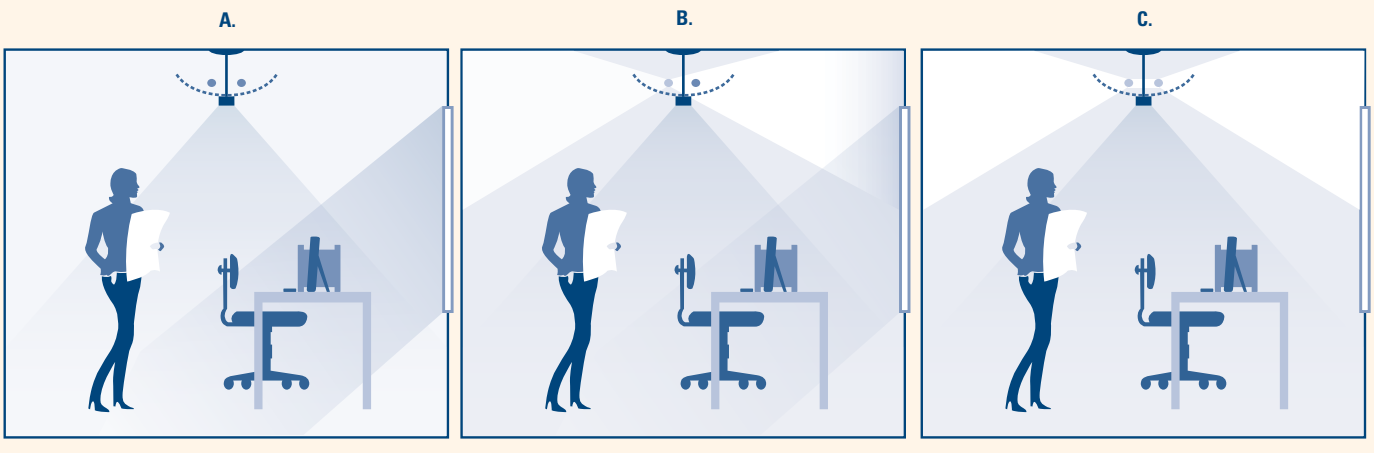
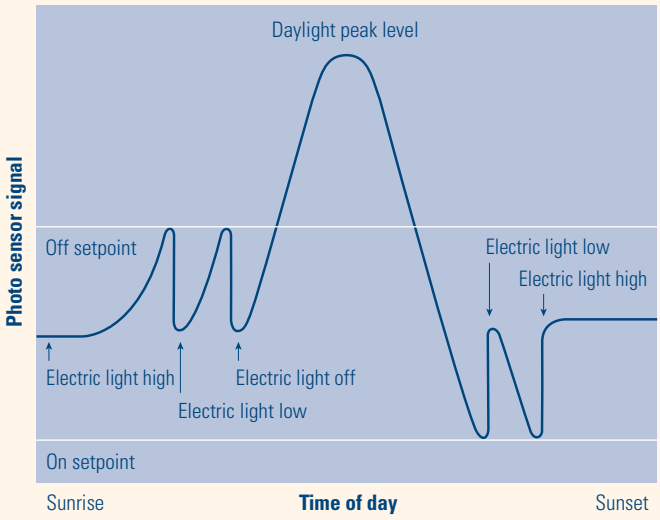


Figure 2: Controlling electric lighting levels

The Simplified Daylight Harvesting system automatically switches the electric lights among high, low, and off states based on the light levels detected by the photosensor and user-adjustable setpoints.



setpoints will also help to minimize the on/off cycling that sometimes annoys occupants under conventional daylight-harvesting systems. Second, an optional occupancy sensor is available for switching only when the space is unoccupied so that occupants do not experience a sudden drop in light level—it can take time for the eyes to adjust to sudden changes. In addition, if sudden changes are a concern, conventional bi-level ballasts can be replaced by ramping ballasts that gradually adjust lights from one level to the next.

Cost effectiveness. The initial cost of the SDH system should be low because it uses a small number of simple components and does not require the more expensive dimming ballasts that dimming daylighting systems use. In addition, thanks to the automatic calibration capabilities and the ability of the user to adjust setpoints, the system never needs to be calibrated or recalibrated by a technician, thus eliminating the most expensive element in current daylight-harvesting approaches.

All of these features will enable users of the SDH to reliably reap the financial benefits of daylight harvesting—significant energy-cost savings and reductions in peak demand charges because peak daylight availability typically coincides with peak electricity demand.

Applications

The SDH system can be installed by original equipment manufacturers as part of a new fixture or provided as a retrofit kit for an existing fixture. The fixtures can be used in any daylit spaces in commercial buildings.

California Codes and Standards

The SDH system operates as a multilevel lighting-control system and is suitable for the bi-level control requirements of Title 24.

What's Next

The researchers at the CLTC have tested the SDH system and filed for a patent. Watt Stopper and Axis technologies have licensed the SDH system and are working with CLTC to develop commercial products. Researchers are also working on concepts that employ the dual-sensor and photosensor angular sensitivity capabilities developed at the lab.

Collaborators

The California Lighting Technology Center (CLTC) at the University of California, Davis spearheaded this research with support from the PIER program.

For More Information

For more information on this project, please contact the California Energy Commission researcher listed below.

More PIER Technical Briefs can be found at www.energy.ca.gov/research/techbriefs.html.

Contacts

California Energy Commission,
Michael Seaman, mseaman@energy.state.ca.us,
or visit www.energy.ca.gov/research/buildings

California Lighting Technology Center,
University of California, Davis, Konstantinos Papamichael,
530-754-7613, kpapamichael@ucdavis.edu,
http://cltc.ucdavis.edu

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.

Arnold Schwarzenegger, *Governor*

California Energy Commission

For more information see www.energy.ca.gov/research

Chairman: Jackalyne Pfannenstiel *Vice Chair:* James D. Boyd
Commissioners: Arthur H. Rosenfeld, Jeffrey Byron, Karen Douglas

PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

CEC-500-2008-067-FS
September 2008