Lighting the Way to Demand Response

The Issue

Demand-response (DR) programs, in which facilities reduce their electric loads in response to a utility signal, represent a powerful tool for cutting peak demand and reducing stress on the electric power grid. It is also an effective strategy for customers to control energy costs. Lighting reductions can be a significant element of DR programs because lighting use coincides with periods of peak demand, and light levels can be reduced significantly for short periods with little impact on a building's occupants. Commercially available advanced lighting-control systems can be used today to reduce demand, but the cost, the potential savings, and the best way to implement these systems have not been adequately defined.

The Solution

Researchers from Southern California Edison (SCE) and the California Lighting Technology Center (CLTC) identified communications and lighting-control technologies as the two most critical areas for further study. They evaluated communications alternatives and concluded that the Internet is the best medium for a lighting DR program. They then looked at controls alternatives and installed and tested three commercially available systems in an SCE office building. All three of the installed systems worked well with four different DR scenarios and significant energy savings were measured, but the systems proved costly and difficult to implement.

Since the test, however, the participating vendors and other companies that make lighting controls have lowered product costs and reconfigured these types of products for easier installation. This project also served as a catalyst for the creation of the California Advanced Lighting Controls Training Program, which developed new training programs for electricians to learn how to install advanced lighting controls.

Features and Benefits

Analysis and testing of advanced lighting-control configurations yielded a number of insights into how to use the technology for DR applications.

Communications. Based on a combination of speed, cost, availability and reliability, researchers chose the Internet as the communications technology with the most promise. The widespread availability of personal computers with Internet connections can enable the establishment of an automated DR network in the fastest, most cost-effective manner. Other technologies considered included land-line phones, text messaging, commercial and dedicated radio, pagers, powerline communications, TV cable, and satellite.

Lighting-control technologies. Researchers investigated three categories of controls based on the medium used for communicating with the lamps: wired, wireless, and powerline carrier. Within each category, there are also competing approaches. CLTC researchers evaluated a variety of lighting-control systems ranging from research prototypes with limited field trials to commercial products with proven installations. No single approach stood out as having the best potential for a majority of situations, but three commercially available systems were chosen for field testing: wired systems from Convia and Lutron, and a powerline communications system from Universal Lighting Technologies.

System elements. All three systems offered remote control capability that enabled tuning, scheduling, and DR. Elements included occupancy sensors, photosensors, and dimmable ballasts, and the lights could be controlled individually and by zones.

DR testing. The three systems were installed in separate zones in a large SCE office space, and their energy and lighting performance were monitored during both normal operation and simulated DR events (**Figure 1**). The testing covered four

Figure 1: Saving with new fixtures and controls

New lighting fixtures and controls were installed in a Southern California Edison office space and served to reduce both energy use and demand.

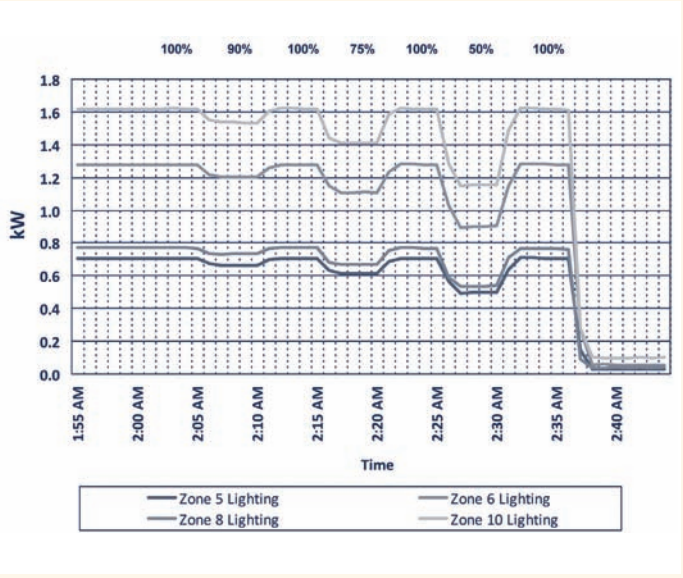
scenarios typically employed in DR programs: shed load right now, in the next hour, later the same day, and the next day.

All three systems operated adequately once installed and correctly commissioned, providing demand reductions of up to 35 percent compared to normal operation (**Figure 2**). However, the installation and commissioning of several of these systems required unplanned repeat visits by the installers. This suggests that the level of complexity of advanced lighting-control systems and insufficient training of electricians could pose significant barriers to market adoption. Also, the cost of the systems was higher than that of conventional lighting systems.

No effect on occupants. All three systems reduced light levels slowly, to as low as 50 percent of full power, over a one-minute period. Occupants did not notice the reduction in light levels.

Figure 2: Lighting controls reduce demand

All three of the lighting systems tested reduced lighting demand in a Southern California Edison office space. Demand-response signals controlled the lights to 90 percent, 75 percent, and 50 percent of peak power demand.



Applications

Reducing light levels for DR is appropriate for all commercial buildings. However, the current commercialization potential for advanced lighting-control systems with DR capability comes mainly from the appeal of other benefits that the system provides, such as scene-control capabilities and individual control of light levels. With more widespread implementation of utility pricing schemes that increase the price of electricity at times of higher demand, the appeal of advanced lighting-control systems that provide DR capability is likely to increase.

California Codes and Standards

California's DR infrastructure is not fully defined, so the question of how these systems are going to interface with statewide utility DR infrastructures has not been fully answered. The implementation of this type of system would be accelerated if Title 24 required some of the capabilities that the systems provide.

Collaborators

The project team included Southern California Edison and California Lighting Technology Center.

For More Information

A report documenting this project and providing more details may be downloaded from www.energy.ca.gov/2011publications/CEC-500-2011-012/CEC-500-2011-012.PDF.

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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.

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