

Lighting Research Center

Overcoming Barriers to Widespread Use of Lighting Controls in Commercial/Industrial Applications Part 1: Automatic Shut-off Controls

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Background

Under funding from the US Department of Energy, the Lighting Research Center (LRC) is identifying barriers to the widespread penetration of lighting controls in commercial and industrial (C/I) applications and making recommendations to overcome these barriers. Since fluorescent lamps are the predominant technology in C/I applications, the focus of this project is the control of fluorescent lighting systems.

The LRC reviewed existing research, technology, patents, and market data related to lighting controls, interviewed control manufacturers, surveyed control installers, and conducted a peer group review to improve and validate a set of preliminary recommendations. Two distinct categories of controls were identified, each with their own set of barriers: dimming controls (architectural dimming, load shed dimming, and photosensor-activated daylight dimming) and automatic shut-off controls (occupancy sensors and timers). Dimming controls still have substantial technical barriers and are dependent upon changes in electricity pricing systems to be cost-effective in many applications. Automatic shut-off controls, however, are technologically robust, less expensive, and ready for widespread installation.

Because these differences between dimming controls and automatic shut-off controls need to be addressed by different stakeholders, the peer group review recommended a bifurcation of the project. **This paper and roundtable only addresses the barriers to the widespread penetration of automatic shut-off controls.** A parallel effort is being made to reduce the barriers to widespread use of dimming controls.

Penetration of automatic shut-off controls for fluorescent lighting systems into C/I applications can be increased, particularly if market transformations groups, specifiers, government agencies, and manufacturers collaborate to help reduce the remaining barriers to the use of this robust control technology.

Automatic shut-off controls

Automatic shut-off controls turn off lamps when a signal is received from an occupancy sensor (“unpredictable scheduling”) or from a time-of-day scheduling device (“predictable scheduling”). There are several different ways this can be accomplished, including the use of building automation systems, energy management systems, individual time clocks, wallbox mounted devices, and various combinations of relays, sensors and control panels. Since lamps are not dimmed the increased cost of the dimming ballast and controller is avoided. There are several issues relevant to widespread deployment of automatic shut-off controls:

Market Penetration: Retrofit vs. New Construction

Automatic shut-off controls are becoming commonplace in new construction; some estimates indicate that 60% of commercial projects now utilize them. Current and planned energy-code provisions, the ease of installation in new construction, and the potential energy savings will continue to increase the penetration of automatic shut-off controls in new construction. To capture additional penetration of automatic shut-off controls in new construction, the most effective approach to widespread penetration includes specifier education and more pervasive code requirements and/or enforcement.

However, according to the Energy Information Agency,¹ during the 1990s, new construction represented less than 10% of both buildings and floor space in the 1995 buildings stock. Penetration of automatic shut-off controls in existing buildings is poor.

Retrofitting existing buildings with automatic shut-off controls presents several barriers not present in new construction:

- Wiring is usually more difficult and expensive in a completed building compared to wiring while a building is under construction;
- In new construction, automatic controls can be purchased instead of manual controls; in retrofit construction, the manual controls they are replacing have already been purchased;
- Lighting and electrical plans are drawn for new construction, providing an opportunity where automatic controls can be easily considered and integrated into the plans. Electrical or lighting plans for renovations in existing buildings are seldom redrawn, especially for minor alterations.
- Energy code provisions often do not apply to existing buildings unless they are undergoing major renovations;

¹ Energy Information Administration (EIA). 1995. The Commercial Buildings Energy Consumption Survey (CBECS). Internet: http://www.eia.doe.gov/emeu/cbecs/char95/ex_sum.html

- “Hassle factor” is perhaps the greatest barrier. Building owners and tenants are focused on their businesses and seldom have the time or interest to consider redoing their lighting or control systems.

The overwhelming sentiment among the installers of automatic shut-off controls is that they can make controls work, but there is a small market demand in existing buildings. They believe that some agency needs to repeatedly and effectively communicate the value of lighting controls to building owners and facility managers. Partnerships between manufacturers and public benefit market transformation parties need to be formed to develop programs to retrofit buildings with automatic shut-off controls. These partnerships are necessary to reap the large untapped, energy savings potential in existing buildings.

Lamp/Ballast System Reliability

As a consequence of the energy crisis of the 1970s, significant improvements in the efficacy of fluorescent systems were achieved in the last two decades of the 20th century. The physical, electrical, and photometric properties of fluorescent lamps and ballasts were continually optimized during this era to improve not only efficacy, but also to give them smaller size, better maintenance (lumen depreciation and life), lower mercury content, and higher visual quality (better color rendering and reduced flicker). This evolving sophistication has led to higher and higher expectations for fluorescent system performance in terms of energy efficiency, maintenance, visual satisfaction and, of course, low initial cost. One down side of this sophistication, however, has been the proliferation of products that provide poor system reliability. Lamps operated on ballasts that do not have optimized starting and operating electrical properties for those lamps will fail prematurely, leading to dissatisfaction among specifiers, owners, and facility managers. This was a common situation in the 1980s and early 1990s as the electronic ballast manufacturers learned how to operate lamps produced by the “big three” global manufacturers: GE, Philips and OSRAM, but those days are essentially over for C/I on-off fluorescent lighting systems, largely because the global manufacturers have taken control of the specifications for ballasts that operate their lamps. Today, the stories of poor reliability mostly refer to fluorescent systems operated with dimmers and/or residential-grade products.

The remaining lamp/ballast compatibility issue for automatic shut-off controls is the effect of frequent switching on lamp life. BAS, panel controls, and timers are usually not configured so that the lamps are frequently switched. On the other hand, occupancy sensors set for short time delays and located in frequently used locations such as stairways, large restrooms, and hallways could cause frequent switching and therefore, shortened lamp life. Premature lamp failures in these instances could create a generalized barrier to the use of automatic shut-off controls.

The Human Element: Manual On and Overrides

Some important principles for automatic shut-off controls have emerged from research into lighting controls. The goal of automatic shut-off controls is to turn lights off when no one is in the space. This strategy will not annoy the occupant or compromise the worker's productivity in the space because the space is unoccupied. In general, manual controls should be used to turn lights on when needed; automatic controls should be used to turn them off when no one occupies the space. This manual on/automatic off approach reduces false triggering of occupancy sensors and prevents lights from being turned on needlessly when daylight is sufficient for the occupants or when the lights are not otherwise needed in the space.

Because no technology is completely foolproof, however, it is essential that there be a local, manual override to any automatic strategy. For example, if a worker is working late one evening and the automatic time clock initiates an "off" command, the worker must be able to manually override the automatic command in the work space and in areas needed for exiting the work space. However, engineers and facility managers seem hesitant to provide manual override, because it is assumed that people will use them too often and energy savings will be lost. To address their concern, manual overrides capabilities should be designed to automatically reset to automatic shut-off mode after each use.

Programs to Overcome Barriers

First cost remains a barrier for lighting controls. Often the person or department that pays for the installation of lighting equipment does not receive the benefit from the reduced electrical bills. Also, in existing buildings, managers do not want the "hassle factor" of implementing a change. First cost and hassle factor have been overcome for other energy-efficient lighting technologies with demand-side management (DSM) incentive programs, market transformation procurement programs, shared-savings marketing by energy service companies (ESCOs), and new code requirements. Combinations of these approaches increase market demand for energy-efficient lighting products, leading to lower product cost and market transformation. Products such as T8 lamps, electronic ballasts, and LED exit signs are examples of successful lighting market transformations. Lighting controls, however, have yet to benefit substantially from these market forces, at least in part, because of the difficulty in predicting the energy savings resulting from control use.

DSM program developers and evaluators, code developers, and ESCOs do not have adequate information to predict expected savings by control measures. They need to know, for example, when and for how long the control switches off the lights. There are case study examples, but robust control use factors need to be developed that will afford the program developers confidence that a specific control installation will deliver a specific energy savings. With this confidence, controls will more likely find their way into lighting incentive programs, code provisions, and ESCO strategies.

Again, there are no technical or human barriers to turning the lights off in unoccupied spaces to achieve energy savings. There is simply “a failure to communicate” that *automatic shut-off lighting controls that turn lights off in unoccupied spaces are reliable and cost effective*. These principles consistently meet the demands for occupant satisfaction and energy savings.

Preliminary Recommendations

Aggressively encourage the widespread deployment of automatic shut-off lighting controls in existing and new C/I buildings.

The following actions, listed in descending order of priority, overcome the identified barriers to the penetration of lighting controls into C/I markets. They are focused on existing, automatic shut-off lighting controls that have been demonstrated to be cost effective and reliable. These recommendations can be implemented immediately.

1. Bring together various stakeholders interested in increased penetration of automatic shut-off lighting controls (manufacturers, specifiers, government, public benefit energy efficiency groups, building owners) to prioritize approaches and form implementation partnerships that overcome the hassle factor and/or first cost barriers to automatic shut-off lighting controls in existing buildings, such as:
 - a. campaigns for specifiers and customers
 - b. education/training of qualified technicians
 - c. rebate programs
 - d. procurement programs for large real estate
 - e. labeling programs that will assure quality of the products
 - f. model specifications and standards.
2. Support data collection that provides fixed numbers for expected energy savings and load reductions for various automatic shut-off lighting control technologies in various applications. Develop simple guidelines for setting time delays on occupancy sensors used in spaces that frequently change from occupied to unoccupied.
 - a. research and development
 - b. demonstrations and evaluations.
3. Encourage use of automatic shut-off controls that:
 - a. have manual on/automatic off capabilities
 - b. reset to automatic off mode after each manual override
 - c. for retrofit occupancy sensors, can be installed without power wiring in a switch run and operate fluorescent lighting systems.
4. Encourage more stringent code provisions requiring automatic shut-off lighting controls for new construction and substantial renovations.