DOE Controls Project: Comments from a West Coast Perspective

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It is reasonably arguable there is a "West Coast" perspective about lighting, especially energy-related technology. After all, one of the most obvious potential benefits of advanced lighting controls, demand management, would have been invaluable in helping manage California's recent energy crises. (Energy code changes were mandated under California Assembly Bill AB970 in response to the crisis, although the impact to controls was minor.) But there are also other reasons that a West Coast perspective may be helpful in evaluating the options and making recommendations for the future.

In 1978, California placed its non-residential energy code, Title 24, into effect. Since then, Title 24 and other energy codes on the West Coast, including Oregon and Washington, have been enforced and thus had profound impact on lighting design and the application of controls. The California Energy Commission (CEC) believes that change can be made through the force of code. In 1978, for example, Title 20 (the State "appliance" code) prohibited the sale of standard magnetic ballasts, making the "energy saving" magnetic ballast mandatory for fluorescent lighting systems. Another rule requiring tandem wiring gave clear preference to electronic ballasts. These successes and the maturation of the ballast industry encourage the CEC to consider future code changes to force technology. An obvious target will be controls and the directly related dimming ballasts.

Presently, Title 24 and the Oregon Energy Code provide "controls credits" for the use certain automatic controls, such as daylighting controls and lumen maintenance controls. The CEC believes that controls credits are needed to encourage the use of more expensive controls until costs fall and the use of such systems becomes common. It is important to note that as controls become

commonplace and this incentive is not needed to promote the technology, it is removed from the controls credits list and is then simply mandated.

This writer currently serves the CEC as its prime consultant for developing, investigating and justifying changes to Title 24, presently being considered for the 2003 standard that takes full effect 1/1/2005. This opportunity presents additional insight into the potential future for controls. In short, the new standards will be revised somewhat, but concerns raised by the initial report developed by the CEC and discussed below are shared by the CEC and this writer and will affect the standard as noted.

Automatic Shut off Controls

Virtually all energy codes require automatic shut off for lighting in non-residential buildings. Automatic shut off is part of ASHRAE-IESNA 90.1-1989, 90.1-1999, Title 24, the Oregon energy code, the Washington energy code and others. Originally codes only required this provision for buildings of more than 5,000 sf, but due to AB970, California recently eliminated this exemption.

In 1985, Title 24 initiated requirements for automatic shutoff controls for office buildings, extending to other building types by 1987. This played a very large role in the maturation of motion sensor technology, with two of the oldest and most significant makers (Novitas and Wattstopper) both based in California. Designers, architects, engineers, and contractors have in turn developed working familiarity with lighting controls, demonstrating practical adjustments to meet the market. Other strategies typically used for compliance include

- Building automation systems (see later) used as time switches controlling whole branch circuits with override switches in key locations
- Building automation systems with telephone override controls
- Time switches used alone or in conjunction with latching ("Sentry") switches

Current Title 24 regulations require automatic time switching systems to have manual override on and off, individual switches for each room, and programmable time functions differentiating between normal operations and days with different operation schedules, such as weekends.

What is especially important to the DOE controls project is that automatic shut-off controls are a relatively established, easy-to-apply technology that can contribute meaningful energy management as well as making lighting controls more "hands on" to building occupants.

Dimming Ballasts

Recently the CEC has considered making dimming mandatory for all fluorescent lighting systems in the state. This was one response considered under the emergency rules developed in 2000 under AB970 and has been reopened as a possibility as part of the 2003 standards revisions. However, it is unlikely to be implemented for two major reasons:

1. Because the costs of dimming ballasts is still too high to justify; and
2. Because there is no standard dimming and control protocol.

I believe that, if these two problems can be overcome, the CEC will be willing to reconsider dimming ballasts as a mandatory requirement. The intent will be to ensure that peak demand shedding capability is built into every building. Possible timing can be as early as 2008 if progress is made on these problems.

Automatic Daylighting Controls

Automatic daylighting controls have been encouraged by controls credits in Title 24 and other codes (including 90.1-89) for a long time. However, in part due to sensor problems and in part due to concerns over switching lights and the lack of standardized dimming technologies, daylighting controls are not yet required. This is expected to change with the 2003 Title 24 by requiring automatic switching or dimming for larger spaces. It is believed that the market is ready for a push and since daylighting controls tend to save energy when most desired, the benefits will outweigh any disadvantages.

This is being driven by a general trend in architecture and sustainability to provide more daylighting to buildings, especially schools. This makes the issues of compatibility and

commissioning very important in the short run. Paraphrasing, what the nation needs now is a good twenty-five dollar daylight sensor.

Building Automation Systems and Digital Controls

Given twenty-five years and a huge business base, one might wonder why the building automation industry has failed to make significant inroads to dominating the lighting controls industry. The draft report cites several possible reasons; I believe that there are others, in descending order of priority:

- High per point of control cost using DDC, Echelon, BACNET, etc.
- Cost of wiring and communications
- Minimal need of initiation of control signal from remote location
- Substantial commissioning and management complexity
- Non standard control hardware and wiring protocols

The trend towards digital communications and control for individual ballasts should be carefully considered before leaping into this technology. In a room with more than one luminaire (and especially more than one ballast), seldom do the luminaires operate differently unless the room is large enough to have more than one zone. For instance, in a typical school classroom, there might be 20 ballasts on two zones, each having different daylighting characteristics. The costs of digital control would have to be very low to justify communicating with, addressing, and commissioning 20 ballasts when there are only two zones of control. A "master box" (such as the Lutron "Microwatt" or "Digital Microwatt") can be wired to control all the ballasts in its zone by carrying only one additional #12 wire to each ballast, contained in the same conduit as other power wiring and easily installed by an ordinary electrician without special training.

The 0-10 volt ballast should not be discarded, but the issues identified in the draft report and meeting are truly problematic. Perhaps one reason why the 0-10 volt ballast appears to be an obstacle is the lack of "system" responsibility – there is an implicit suggestion that any 0-10 volt ballast will work correctly with any 0-10 volt controls. A plug-and-play wiring protocol might be considered as a partial solution to the problems of field wiring problems. But otherwise, there are

many side benefits of an analog system, including low cost, currently available products and a potential universality that lends itself to low cost plug and play lighting control systems, both digital and analog.

Regulatory Issues – Carrot or Stick?

The preliminary report observes the capability of dimming systems in load management for energy cost savings, but seems to conclude that the demand for such features will be hard to muster. The "carrot" of energy cost savings is not enough to warrant use of current products and systems, based on the cost of energy (even assuming normal inflation). This is because of the chicken or egg issue in which advanced controls are expensive because of the lack of product volume which is caused by the lack of demand due to expensive controls. A market transformation "carrot" or a regulatory "stick" would change this by increasing demand.

However, the realization that real time pricing and load management are future strategies to better control load growth are real considerations in the west and Northeast, where sensitivity to power plant construction and the environment is expected to be an issue in deliberating future utility rates. (At least one noteworthy trend is towards consumers willing to pay higher prices for "green" power.) So, if the nation's public service commissions were to encourage power management and load shedding as a long term strategy, the ability to dim electric lights will quickly become the cheapest way to shed load that has a minimal impact on productivity and profitability. Dimming fluorescent lighting systems to 50% power results in an apparent 29% reduction in light (the "square law"), which is tolerable, especially compared to the inability to dim computers and appliances at all.

Considering that commercial and industrial lighting systems constitute 12-15% of the electric load of the nation, active management of this load could be a very simple and effective part of future supply and demand planning. Widespread demand management systems could be easily retrofit into buildings as well as built into new ones, using existing technology and a modest investment in developing a new generation of products. I believe that DOE and industry need to promote fluorescent dimming controls as a significant and smart opportunity, and if successful, various states' Public Service Commissions will envision and implement advanced rate structures that

encourage demand management as much as building more power plants. Somewhat regardless of the extent to which unregulated, almost all states and utility customers would benefit.

Preliminary Recommendations

While I agree to a large extent with many points in the draft project report, I disagree with the preliminary recommendations quite a bit. I firmly believe that advanced lighting controls suffer from a bit of a "chicken or egg" dilemma – manufacturers are reluctant to make an investment in an untested and future market, and government is unwilling to demand use of a future technology, despite its relative simplicity and obvious benefits, because there is currently very little product and no standard.

Assuming that at least one mission of DOE is to resolve this dilemma, I suggest the following recommendations:

1. Through research, develop accurate values of expected energy savings when lighting controls of all kinds are employed.
2. Also through research, determine the extent to which dimming and other controls contribute to productivity and other human factors.
3. Develop standards of performance and control protocols (both analog and digital if warranted) for dimming systems.
4. Develop standards of installation and commissioning of dimming and daylighting systems.
5. Develop a standard system for signaling buildings to undertake load management.
6. Install pilot programs to demonstrate the effectiveness of load management using lighting and other building systems.
7. Measure and verify system performance.

I believe that a major advance in controls applications and functionality is just around the corner. However, due to the chicken-or-egg situation that restricts investment in lighting controls development, it will take funding and leadership from organizations such as DOE to expedite these beneficial results. End