STATE OF THE ART **LIGHTING CONTROL** TECHNOLOGY FOR SCHOOL OFFICE SPACE

Lighting currently accounts for 30–40% of electricity use in California non-residential buildings, such as school classrooms, libraries and office facilities. Due to the relative importance of lighting design, it is not surprising that lighting products and lighting controls are among the most rapidly evolving technology systems for use in commercial and institutional buildings.

Improved lighting efficiency has been a significant energy reduction strategy for decades. While the very stringent 2013 California Energy Code (Code) does not specify the use of efficient luminaire types for schools, it does place limits on maximum installed watts either by area occupancy type or whole building. This effectively restricts the designer's choice to the most efficient types of lighting using prescriptive methods. High-efficient fluorescent lights with electronic ballasts (Super T-8 and T-5) and light-emitting diode lighting (LED) are examples of advanced luminaire systems that are becoming more common for new and retrofit office projects.

Another trend is that automatic lighting controls are now standard design. For example, dimmable lighting, occupancy sensors, daylight sensors (in daylight zones), and computer controlled lighting management systems are examples of lighting control devices that are typically required by Code. While these baseline lighting controls installations have greatly improved lighting efficiency, there remain inherent design limitations which prevent a building from reaching its full potential. For example, "baseline" lighting controls (i.e. Code-mandated) are not fully integrated and may have less than ideal "granularity." These controlled zones include daylighting zones, offices, or even entire floors and buildings. Conventional installations of lighting control devices are less flexible because they cannot "talk" to each other or respond to individual occupants. Flexibility is limited when control devices serve larger than ideal interior zones.

There are common misconceptions related to the potential to improve lighting performance beyond Code. For example, one false perception is that once a building is designed and constructed the lighting performance is relatively set. Another false perception is that it is almost impossible to exceed the "Code baseline" through best practices in the lighting performance area. These misconceptions are belied by the documented lighting performance of some of California's best high performance buildings which can achieve deep lighting reductions up to 40% better than Code baseline.

ADVANCED INTEGRATED LIGHTING CONTROLS (ALC)

LED lighting is now available with integrated advanced lighting controls using onboard occupancy and daylight sensors. These systems can connect directly to wiring used by legacy recessed fluorescent lighting to minimize retrofit installation costs. LED fixtures with integrated advanced controls are easily programed and can talk to each other wirelessly. Fixtures with advanced controls can operate both as members of the group and independently. For example fixtures in a zone might operate at minimum background level, but fixtures that sense occupancy will brighten to full output. At the same time fixtures within a zone can be tuned to individual needs. The easy programming feature ("plug and play") of these systems can eliminate the need for maintenance intensive adjustments and commissioning.

LUMINAIRE LEVEL LIGHTING CONTROL (LLLC)

LLLC strategy can offer several advantages over Code baseline lighting control technology.

Granularity–LLLC reduces the lighting control area to an area served by a single luminaire, which typically would be 80 to 120 square feet of open office space. Each LLLC is not only "addressable," it features an integrated sensor that is network connected and can be programmed, monitored and modified through a lighting control computer interface. (Since today's office workers spend less than half of their time at the desk, it is easy to see how occupancy sensors at the luminaire level can achieve significant savings.) Lighting levels can be individually tuned to match the lighting needs of each occupant at their work station.

Control Strategy Layering–LLLC features control strategy layering through the use of integrated networked control devices. Control strategies include institutional tuning, scheduling, daylight harvesting, occupancy response, temporary demand control, and personal tuning control. By comparison, traditional lighting controls are less integrated, are difficult to maintain and are sometimes confusing at the user level. Many LLLC systems have simplified their outward facing devices—using point and click remotes, computer software programs and manual controllers with visuals that mimic other familiar tools.

Monitoring–Data collection informs the energy manager and provides occupancy patterns over time for better energy savings.

RETROFIT STUDIES

Currently most LLLC installations are retrofits. A 2013 study in the Pacific Northwest found that total costs were from $1.71/SF to $3.11/SF. This amounts to $185—$292 per fixture. Control costs for LED lighting with integrated ALCs were less than half of the cost of LED lighting without ALCs. Setup costs for LED lights with ALCs are minimal.

Cost Factors

- **Decreasing Costs**–Wireless digital network costs are decreasing rapidly and sensors and controls are more available.
- **OEM Integration for New Construction**–LLLC are being specified in fixture design which provides integration efficiency and lower costs.
- **Baseline Controls In Code**–Going to fixture-level LLLC will be a much lower cost over the cost of retrofit studies cited above.
- **Extended Lamp and Ballast Life**–LLLC reduction in hours of usage results in corresponding extension of life.

Buildings with advanced lighting controls will play a key role in the path to ZNE buildings in California. These buildings will feature LED lamps, LLLC layering and optimal integration of advanced lighting control technologies.

DSA DIVISION OF THE STATE ARCHITECT
DEPARTMENT OF GENERAL SERVICES

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