Measure Information Template –

LED Exterior Lighting

2008 California Building Energy Efficiency Standards

PIER Program - EnergySoft, LLC

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Overview

Description	The California Lighting Technology Center (CLTC) has developed and commercialized an LED Hybrid light fixture. These fixtures use LED arrays in conjunction with traditional incandescent or fluorescent sources. The entire fixture is controlled by a photocell that keeps all lights OFF during the day. At night, the photocell turns the fixture ON. The low wattage LED array stays on for the duration of the evening and provides low level 'ambient' illumination in the area around the fixture. When the motion sensor detects motion, it turns on the incandescent or fluorescent lamp for a short duration to raise the light output of the fixture to a level equal with standard outdoor fixtures. It is expected that the primary application of this technology would be pedestrian hardscape areas, although it is quite plausible that manufacturers may develop additional applications that would benefit from the LED technology.
Type of Change	This change is proposed to be an addendum table to the Prescriptive Outdoor Lighting section of the Standards (147). An additional control credit table would be added which recognizes the type of lighting control described here, similar to the table 146-A Power Adjustment Factor table. In addition, performance criteria would be added in the mandatory measures section for the control requirements, as well as certification requirements for the controls.
Energy Benefits	The LED Hybrid Fixture uses 5 Watts of LED lighting all night long—costing only about $0.01/night—and 60 Watts of incandescent lighting during "occupied" periods. A 13-Watt compact fluorescent lamp (CFL) could be substituted for the incandescent lamp, but the low operating hours gives it a long marginal payback—nearly 10 years for residential applications and around 5 years for commercial —compared to using an incandescent lamp. Also, the light level of the CFL at start-up may lag that of an incandescent. The LED Hybrid is expected to reduce energy consumption by 53% compared to a CFL and 87% compared to a standard incandescent fixture. While this proposal does not address the Residential Standards, it could also be considered to adopt this type of technology as meeting the high efficacy requirements for residential outdoor lighting.
Non-Energy Benefits	This technology will extend lamp life considerably, given the reduced operating hours that will occur. In addition, a significant reduction in light trespass will occur due to the low light output of the LED during unoccupied periods.
Environmental Impact	There are no perceived environmental impacts with the use of LED's and motion sensors on outdoor lighting.

Technology Measures	Measure Availability and Cost All of the components involved in this fixture have been commonly available in the marketplace for at least 10 years. Shaper Lighting, a division of Cooper Lighting, commercialized this fixture in December 2004, selling it for about $200. The Watt Stopper Company is in the tooling phase for another version of the LED Hybrid concept based on the popular residential PAR lamp security light. Useful Life, Persistence and Maintenance The LED source has an expected life of 50,000 hours, more than 13 years at 10 hours on per night. No maintenance is required on the LED array, and lamp replacements on the incandescent portion will be extended considerably. The motion sensor portion of the fixture uses conventional motion senor technology, which has been in use in the industry for many years.
Performance Verification	This product is produced as a complete integrated solution. It is the recommendation that individual, component solutions not be encompassed by the revised table in section 147. If someone were to provide a component solution consisting of a motion sensor, separate LED array and conventional luminaire, there would be significant site verification and commissioning issues that would arise. Given that this product is a turnkey solution which does not require any calibration of the motion sensor, simple field verification of the installation would suffice.
Cost Effectiveness	The cost effectiveness of this fixture depends high on the amount of time the outdoor light is going to be on. However, it can be expected that in applications that require lighting all nigh, paybacks of less than five years can be expected.
Analysis Tools	This measure would not be subject to the whole building performance method. Simple calculations based upon usage patterns have been done to show the energy savings potential.
Relationship to Other Measures	Potentially, this measure could result in more low-efficacy lighting use in outdoor applications. However, the mandatory measures in the standards do permit the low efficacy uses in conjunction with motion sensors, so this technology fits well with that requirement.

Methodology

The 2005 Title 24 requires that outdoor lighting in nonresidential applications be tabulated and show compliance with a certain watt per square foot allowance. Unlike indoor lighting, however, there are no credits given for lighting controls on outdoor fixtures. While certain controls are mandatory, such as a photosensor or astronomical time clock, and in some cases multi-level switching, no credit is given to occupancy sensor based control. Based upon the outcome of the PIER study with 87% savings shown, it would be recommended that we apply a 50% lighting Power Adjustment Factor (PAF) for the use of this technology. While 87% may seem like the logical choice, it has always been past policy to reduce the control credits to account for user override, and non-operational controls. To illustrate an example, we might have two possible scenarios:

1. CFL Based design with lighting always on:
    10 lamps @ 15 watts = 150 watts.
    12 hrs operation X 365 days x 150 watts = 657 kWh/yr

2. LED / Incandescent hybrid based design:
    10 lamps @ 60 watts = 600 watts.
    10 lamps @ 5 watts = 50 watts. Adjusted by 0.50 PAF = 325 watts
    12 hrs operation x 365 days x 600 watts x 13% = 342 kWh/yr.

Analysis and Results

The CLTC research team generated ten luminaire concepts and developed four prototypes. The team then successfully built two pre-production prototypes—a Hybrid LED fixture and a PAR security light. The hybrid fixture is commercially available from Shaper Lighting.

Using LEDs together with occupancy sensors is an excellent application for outdoor lighting. This combination provides low-level ambient lighting all night long, switching to full light level only when needed. The LEDs use only about 0.06 kWh per night, costing less than $0.01 per night. Because of the low usage, incandescent lamps are more cost effective than compact fluorescent for full light level, with the marginal payback for the CFLs at about 10 years. Not only do CFLs have a long marginal payback because of such low usage, but intermittent use of CFLs is not a good application because their warm-up time causes dim conditions and reduces user satisfaction for the very short illumination need.

Recommendations

It is recommended that a new table be added to section 147 of the standards.

Table 147-D LIGHTING POWER ADJUSTMENT FACTORS

TYPE OF CONTROL	TYPE OF APPLICATION	FACTOR
Occupant sensor controlled primary light source with secondary “Always-On” LED light source integrated with photosensor.	Pedestrian Hardscape	0.50

Additional language in Section 147 would include:

(b) Calculation of Actual Lighting Power. The actual lighting power of outdoor lighting is the total watts of all lighting systems (including ballast or transformer loss).

1. Reduction of wattage through controls. The controlled watts of any luminaire may be reduced by the number of controlled watts times the applicable factor from TABLE 147-D if:

   A. The control complies with Section 119; and
   B. At least 50 percent of the light output of the luminaire is within the applicable application listed in TABLE 147-D; and
   C. Except as noted in TABLE 147-D, only one power adjustment factor is used for the luminaire.

In the mandatory measures section 132 of the standards, under the controls for outdoor lighting, the following additional exceptions would be added to exempt this type of lighting from the 50% switching requirement.

EXCEPTIONS to Section 132 (c) 2:
1. Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.
2. Lighting for steps or stairs that require illumination during daylight hours.
3. Lighting that is controlled by a motion sensor and photocontrol.
4. Lighting for facilities that have equal lighting requirements at all hours and are designed to operate continuously.
5. Temporary outdoor lighting.
6. Internally illuminated, externally illuminated, and unfiltered signs.
7. Lighting that is controlled by an motion sensor and photocontrol that includes a secondary "Always-ON" LED light source, provided the LED light source is less than 10 watts.

Material for Compliance Manuals

Chapter 8 changes to the Nonresidential Manual are listed below.

Installed Power

§130 (c)

The installed power for outdoor lighting applications shall be determined in accordance with §130 (c). Luminaire power for pin-based and high intensity discharge lighting system types that are listed in ACM Manual Appendix NB may be used as an alternative to determine the wattage of outdoor luminaires. However, luminaires with screw-base sockets, and lighting systems which allow the addition or relocation of luminaires without altering the wiring of the system must be determined in accordance with §130 (c). Please see Chapter 5.4.3 of the Nonresidential Manual, Determining Luminaire Wattage, for additional discussion on installed power~~. Unlike indoor lighting, no power credits are offered for automatic controls~~. ***Actual lighting power (adjusted)*** is based on total design wattage of lighting, less adjustments for any qualifying automatic lighting controls. ~~However,~~ Some automatic controls are required by the mandatory measures.

1.7 Automatic Lighting Control Credits

§147(b)1

The controlled watts of connected lighting outside the building may be adjusted to take credit for the benefits of certain types of automatic lighting controls. A list of the controls that qualify for these credits is shown in Table147-D in the Standards.

The lighting control credits set out "Power Adjustment Factors." These are multipliers that allow the actual lighting power to be reduced, giving a lower adjusted lighting power. This makes it easier to meet the allowed lighting power requirement. A credit is only permitted when the control types indicated in Table147-D are used.

In order to qualify for the power savings adjustment, the control system or device must be certified (see Section 5.2.1 **Error! Reference source not found.**), and must control all of the fixtures for which credit is claimed; only controlled luminaires are eligible for lighting control credit.

Table 6-7 – Standards Table 147-D Lighting Power Adjustment Factors

TYPE OF CONTROL	TYPE OF APPLICATION	FACTOR
Occupant sensor controlled primary light source with secondary "Always-On" LED light source integrated with photosensor.	Pedestrian Hardscape	0.50

OLTG-5-C: Lighting Controls Credit Worksheet

1. OLTG-5-C is used to report the control credits for outdoor applications. When certain types of automatic lighting controls listed in Table 147-D in the Standards are used, a credit is permitted. This table also lists some restrictions that must be met in order to take credit for the controls.
   - Lighting control credits are documented on form OLTG-5-C. This requires a specific listing of each device that is used for credit and listing those luminaires controlled by that device.
   - APPLICATION – List the area where the control device is controlling luminaires.
   - DESCRIPTION – List a description of that device.
   - PLANS – Indicate where on the plan set the controls are shown.

2. WATTS OF CONTROL LIGHTING – The total watts of controlled lighting in each application.
3. POWER ADJUSTMENT FACTOR – Indicate the power adjustment factor for that specific control device from Table 147-D in the Standards.
4. CONTROL CREDIT – The product of COLUMN G (Watts of Control Lighting) and COLUMN H (Power Adjustment Factor).
5. The total control credit watts (entered on OLTG-5-C) is the sum of the control credit watts in COLUMN J. This credit is subtracted from the total installed watts to determine the actual lighting power (adjusted).

Bibliography and Other Research

Information for this measure template has been taken from the PIER research project number 500-01-041-A2 report. This PIER report is available from the California Energy Commission's PIER group as an Adobe Acrobat file, and includes the detailed background and research related to this measure template proposal.

The hyperlink for this project is as follows:

http://www.archenergy.com/lrp/lightingperf_standards/project_5_3.htm