Proposal Information Template for: **NIGHTLIGHTS**

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Please note: all savings estimates and information in this document are preliminary and are based on data available to the authors at the time of the report. If the CEC moves forward with this topic, we anticipate updating our estimates and recommendations based upon additional input from stakeholders.

Proposal Information Template – Nightlights

2011 Appliance Efficiency Standards

Prepared for: Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Edison, Southern California Gas Company

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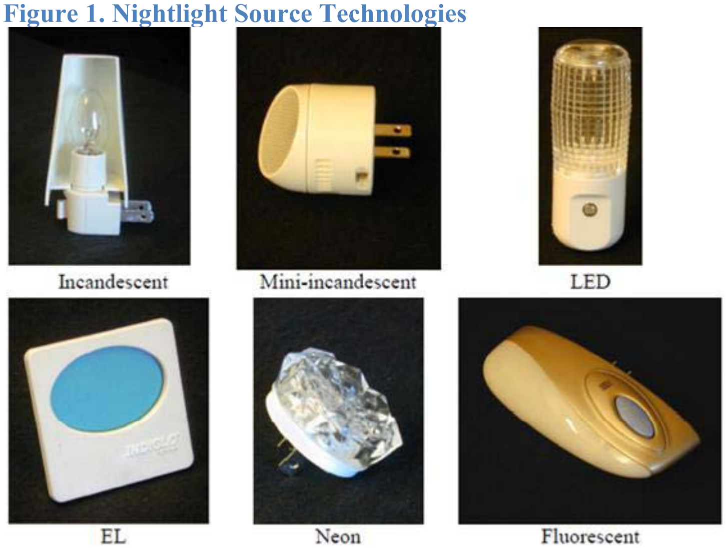
Purpose

This document is a report template to be used by researchers who are evaluating proposed changes to the California Energy Commission's (Commission) appliance efficiency regulations (Title 20, Cal. Code Regulations, §§ 1601 – 1608) This report specifically covers Nightlights.

Background

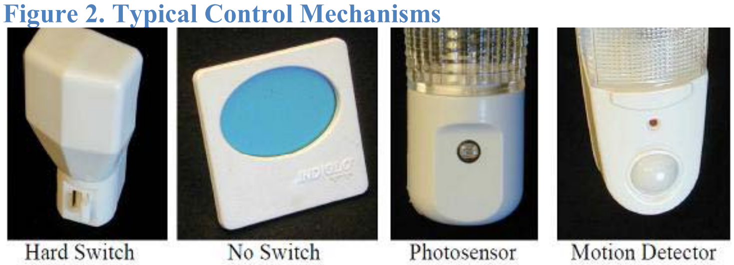
Nightlights are small, plug-in, lighting devices used primarily in residences to provide low-level lighting at night or in dark spaces. We estimate that there are approximately 12.6 million nightlights in use in California—just over 1 per household (Porter, Moorefield et al. 2006). Nightlights are available in seemingly limitless combinations of light source technologies, control mechanisms, and designs. There are five common nightlight light technologies, including incandescent, mini-incandescent, light-emitting diode (LED), electroluminescent (EL), neon, and fluorescent. See Figure 1 below for examples of the light source technologies we encountered.

Figure 1. Nightlight Source Technologies



The on/off control technologies include a hard switch, photocell, motion detector or no switch (always "on" when plugged in). See Figure 2 for examples of control mechanisms.

Figure 2. Typical Control Mechanisms



Nightlights are often used in bedrooms, bathrooms, and hallways, and frequently associated with the needs of children (comfort) and the elderly and disabled (safety). Nightlights with high light output levels can illuminate floors, walls, and other surfaces thereby functioning as way-finding devices. Nightlights with low light output function as signal lights indicating the location of walls or room wall switches, but do not illuminate room surfaces well. Novelty nightlights integrate the light source with decorative features to produce effects such as changing colors of light, bubbling liquids, and sparkling glitter.

While a single nightlight consumes little energy over the course of a year—an average of 10 kWh—there are approximately 12.6 million nightlights currently in use in California. In total, we estimate that all the nightlights in California consume more than 64 GWh annually.

Nightlights are logical products to target for efficiency standards because there is significant variation in their energy use and energy-efficient light and control technologies are readily available today. The nightlight that we estimated to use the least energy annually used just 0.3% of the energy required by the nightlight with the highest estimated annual energy use. Additionally, most of the manufacturers we encountered already offer low-energy designs as part of their product lines.

Overview

Description of Standards Proposal	We recommend that California adopt a ≤ 3.0 kWh standard for annual energy use per nightlight, with a 0.5 W maximum limit for standby power. Nightlights that currently do not meet this standard could comply through the use of low-power light sources or by reducing the “on” time of high-power light sources with automatic control mechanisms (motion detector and/or photosensor). Nightlight manufacturers may use any combination of light source and control technologies to meet the 3.0 kWh limit.
California Stock and Sales	There are approximately 12.6 million nightlights currently in use in California - just over 1 nightlight per household. This estimate is based on a 50 household plug loads survey conducted by Ecos in 2006 (Porter, Moorefield et al. 2006). . Sales are estimated to be approximately 1.5 million per year. Nightlights are typically sold at general purpose retail outlets (e.g. Walmart), hardware stores, drug stores, and grocery stores.
Energy Savings and Demand Reduction	After the entire stock turnover, we estimate the proposed standard could save California 42 GWh per year, with a peak demand savings of approximately 4.5 MW.
Economic Analysis	Nearly 75% of the nightlights in our dataset meet the proposed standard. Although the incremental cost of incandescent nightlights increased with the addition of controls, in many cases the nightlights with efficient LED lighting technology were less expensive, resulting in no incremental cost between the average non-complaint and average compliant nightlight retail prices. The annual energy savings possible from replacing an average non-compliant nightlight (15.5 kWh/year) with a compliant nightlight (3 kWh/year) is 12.5 kWh per year, worth about $1.85 annually. With a 5-year lifetime, the present value of the lifetime energy savings per unit is approximately $9.00.
Non-Energy Benefits	In general, a market shift to LEDs has environmental benefits both upstream and downstream, particularly in terms of embedded energy and greenhouse gas reduction at the power generation source, helping California to meet its AB 32 goals (1990 levels by 2020). Efficient lighting and switch technologies save the consumer money. LED and EL nightlights have very long design lives. For the consumer, this means greatly reduced nightlight replacement costs. Photocells and motion detectors reduce the time nightlight spends in “on” mode thereby extending the lifespan of replaceable bulbs and/or nightlights, again saving the consumer money. In addition to the cost benefits, low-power light source technologies are safer. These technologies operate at cooler temperatures than incandescent bulbs do thereby decreasing the likelihood of burns or fires. Additionally, the danger to children of accessible fragile glass bulbs is eliminated.

Environmental Impacts	No negative environmental impacts are anticipated.
Acceptance Issues	We anticipate that protecting consumer safety will be a strong concern with a nightlight standard. Because nightlights are often used to aid in the navigation of dark spaces, limiting the availability of the higher power, higher light output nightlights could be seen as jeopardizing safety, especially of the elderly and disabled. Preliminary measurements of light output on selected nightlights indicate that lower power light sources did not provide the same level of light as the high power light sources. The technology that consistently provided the most illumination of room surfaces (floors, walls, stairs, etc.) was the replaceable incandescent bulb. The proposed standard considers safety concerns by allowing the higher power light sources to remain in the market if automatic control mechanisms such as photosensor and motion detectors are employed to reduce their annual energy usage.
Federal Preemption or other Regulatory or Legislative Considerations	UL and the Canadian Standards Association (CSA) share a common safety standard for nightlights. We did not locate any performance standards for nightlights. With the technological advances and growing interest in LEDs, several entities are developing standards pertaining to the performance and safety of LEDs, including the Department of Energy (DOE), ANSI, IESNA and UL.

Methodology and Modeling used in the Development of the proposal

In lighting applications, efficiency is typically described as efficacy, that is, the service provided—light output measured in lumens—divided by energy input measured in watts. However unlike general purpose lighting, nightlights have a variety of built-in control mechanisms that affect the amount of time the nightlight is “on’, and associated energy use. Therefore, instead of light output, we chose to evaluate nightlights by annual energy consumption.

To determine baseline energy use, we measured the power demand in watts of 65 nightlights. Power was measured in “on” mode and in “standby” mode, if applicable. We then used the duty cycle assumptions (see Table 2, Appendix A) to estimate annual energy use per nightlight. Duty cycle assumptions were derived from experience and observation, but not measured directly.

In order to determine the distribution of light source technologies in California, and associated savings opportunity, Energy Solutions conducted in-store surveys of three nightlight retailers in California. Surveyors counted all nightlights displayed in each store, and recorded the features of each nightlight counted. In order to make our tested dataset match the distribution of light source and control technologies found in the California retailers as closely as possible, we normalized our dataset first by light source, then by control technology.

Our sample set of 65 nightlights contained 14 different configurations of light source technologies and control mechanisms. To simplify our analysis, we categorized nightlights by their annual energy usage rather than their physical characteristics. By doing so, we created two categories of nightlights that cover all nightlight configurations: 1) those that use ≤ 3.0 kWh per year and 2) those that use >3.0 kWh per year.

Data, Analysis, and Results

The average annual energy use of a nightlight is approximately 11 kWh per year. In our sample set, the estimated annual energy use ranged from 0.12 kWh (EL, no switch) to 48.7 kWh (incandescent, hard on/off switch). These same nightlights also represented the extremes in power demand in “on” mode. The EL nightlight used 0.01 W in “on” mode while the incandescent drew 6.4 W in “on” mode. In addition to light source, the various control mechanisms have a significant impact on annual energy use. For example, incandescent nightlights with motion detectors use far less energy than those with hard switches. The nightlights with photosensors and motion detectors have some power draw in “standby” mode, however, it is typically very low (<0.01 W).

In our dataset, 75% of nightlights passed the 3 kWh proposed standard, with some combination of efficient light source and/or control technology. We observed many novelty and signal nightlights that met their purposes using small amounts of energy overall. This was achieved primarily through the use of light source technologies with very low power demand (i.e., EL, LED, and neon). Way-finding nightlights, however, need to provide more light to fulfill their service of illuminating dark spaces for safety. A higher power demand in “on” mode may be used in order for the nightlight to fulfill its purpose. Under the proposed standard, nightlights can achieve energy reductions through two measures: 1) using a low-power light source (e.g. LED, EL, or neon), and/or 2) using automated controls to turn the nightlight off when it is not needed (e.g. motion detector combined with photosensor).

Proposed Standards and Recommendations

Based on our analysis, we recommend that California adopt a 3.0 kWh standard for annual energy use per nightlight. In addition, we recommend a power limit for “standby” mode of 0.5 W. While many nightlight manufacturers are already offering compliant designs, a standard would accelerate the transition to energy-saving technologies. Nightlight manufacturers may use any combination of light source and control technologies to meet the 3.0 kWh limit.

To the Title 20 Code language, we recommend the following addition: <u>The annual energy use of nightlights sold in California on or after XX date shall not be more than the value shown in Table 1:</u>

Table 1. Proposed California Nightlight Standard

Proposed CA Standard	Active Power Draw (W)	Standby Power Draw (W)	Percent of Units Operating During Peak Period	Annual Operating Hours Active	Annual Operating Hours Standby	Unit Electricity Consumption (kWh/yr)
≤ 3.0 kWh per year and ≤ 0.5 W “standby” power draw	< 10 W [a]	≤ 0.5 W	67% [b]	TBD based on “on” mode power[a]	Dependent on control mechanism	≤ 3.0 kWh

a Annual operating hours defined in Table 1
b Manufacturers may use any combination of light source and power control technology to meet annual kWh limit. Limit less than 10 W is specified for “active” (“on”) mode because that is the maximum limit for UL certification as a nightlight.

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The following source was used for the electricity pricing methodology for this report:

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References and Appendices

Appendix A – Proposed Test Procedure for Standard

TABLE 2. NIGHTLIGHT ANNUAL OPERATION IN HOURS

Nightlight Control Mechanism	"On" Mode (hours/year)	"Standby" Mode (hours/year)
No switch[a]	8760	NA
Hard on/off switch[b]	7592	NA
Photosensor[c]	3650	5110
Hard on/off switch & photosensor[d]	4161	4599
Motion detector[e]	365	8395
Photosensor & motion detector[f]	183	8577

Assumptions:

a. No switch : 100% are "on" 24 hours/day
b. Hard on/off switch: 80% are "on" 24 hours/day, 20% are "on" 8 hours/day
c. Photosensor: 100% are "on" for 10 hours/day and in "standby" for 14 hours/day
d. Hard on/off switch and photosensor: 10% are "on" for 24 hours/day, 90% are "on" for 10 hours/day and in "standby" for 14 hours/day
e. Motion detector: 100% are "on" for 1 hour/day and in "standby" for 23 hours/day
f. Motion detector and photosensor: 100% are "on" for 0.5 hour/day and in "standby" for 23.5 hours/day

<u>Proposed California Nightlight Test Procedure</u>

1. Power measurements shall be made with a suitably calibrated voltmeter and ammeter or power analyzer as specified under IEC 62301. Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2%. Measurements of power of less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W. The power measurement instrument shall have a resolution of:
   a. 0.01 W or better for power measurements of 10 W or less
   b. 0.1 W or better for power measurements of greater than 10 W up to 100 W
   c. 1 W or better for power measurements of greater than 100 W
2. Use high quality power meter capable of accurate readings down to 0.001 W
3. Nightlight to be plugged into vertically-oriented meter outlet in darkened room.
4. Voltage should be 120 V ac +/- 1 V.
5. To determine power (W) in "on" mode: The room illumination level should be 0 +/- 1 lux (0 +/- 0.1 footcandle) on the same vertical plane as the meter outlet, and within a 12" diameter of the outlet.
   a. The illumination reading should be taken in the same vertical plane as the meter outlet.
   b. If a nightlight has a hard switch, regardless if that switch is coupled with other control mechanisms such as photosensors, the nightlight should be turned "on" and allowed to warm up for 15 minutes.
   c. If the nightlight has a dimmer setting, the switch should be adjusted for the greatest light output.
   d. Record power in watts. If the power demand of the nightlight varies by more than 0.01 W, the power value should be derived from the average value recorded over 5 minutes.

6. To determine power (W) in "standby" mode (if applicable):
    a. The room should be illuminated so that the lux/footcandle reading on the same plane as the outlet and within a 12" diameter of the outlet is 30 +/- 1 lux (3 +/- 0.1 footcandles).
    b. The nightlight should be allowed to warm up for 15 minutes at this light level.
    c. If it is possible to orient the photosensor in different directions, then the photosensor should be oriented towards the room light source
    d. Record power in watts. If the power demand of the nightlight varies by more than 0.01 W, the power value should be derived from the average value recorded over 5 minutes.
7. Annual energy use to be calculated using the following formula:

$$W_{on} * t_{on} + W_{st} * t_{st} = E_{total}$$

where W_{on} is power in watts in "on" mode, t_{on} is time in hours spent in "on" mode per year, W_{st} is power in watts in "standby" mode, t_{st} is time in hours spent in "standby" mode per year, and E_{total} is total annual energy consumption per nightlight in watt-hours (Whrs).