



## NRDC Responses to CEC Invitation to Participate – Light Emitting Diode (LED) Lamps Category

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Submitted By:  
Noah Horowitz, Senior Scientist  
[nhorowitz@nrdc.org](mailto:nhorowitz@nrdc.org)  
Natural Resources Defense Council (NRDC)

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On behalf of the Natural Resources Defense Council (NRDC) and our more than 250,000 California members and electronic activists, we respectfully submit responses to the California Energy Commission's (CEC's) Invitation to Participate (ITP) for Light Emitting Diode (LED) lamps.

Introduction – Despite vast improvements in the quality, availability and price of CFLs, roughly 2 out of 3 household sockets still contain an inefficient light bulb. While CFLs provide dramatic energy savings, some consumers are not installing them more broadly for a wide range of potential reasons: non dimmable/poor dimming performance, slow warm up time, exaggerated concerns about the low levels of mercury contained in the bulbs, premature failure, or a perceived or real dislike of the light quality. The issues around “light quality” are complex and are not fully understood. For example some consumers may simply have picked the wrong bulb (e.g., a bulb with a high color temperature and marketed as “daylight”) and would have been completely satisfied with a warm white CFL with a correlated color temperature (CCT) of 2700K, which most closely represents the incandescent bulb they are replacing. In other cases they may not like the way things look under the light such as skin tones or items with a high level of red tones.

In order for California to comply with the 75% residential lighting energy savings goals outlined in AB1109, the Huffman Bill, consumers will need to select energy efficient light bulbs at much higher rates than they are doing today. In many cases consumers may be looking to buy a LED and we need to make sure the bulbs on the market provide a sufficiently satisfactory experience for the user to keep it installed and more importantly select energy saving LEDs for their other sockets the next time they go shopping for a bulb. If the bulbs fail very early, hum and flicker when dimmed, or give off poor light quality, many consumers may not come back for more. For this reason, we support CEC's development of a set of minimum performance requirements for LED replacement lamps.

NRDC has reviewed the submission made by the California Investor Owned Utilities (IOUs) and is in general agreement with their data and analysis. Rather than repeat much of their content, NRDC provides below supplemental answers to selected topics listed in the Commission's Invitation to Participate (ITP). The heading numbers below reflect the numbers contained in the Commission's data request.

## ALL LIGHTING CATEGORIES

1. **Category Definition and Scope** – Light bulbs<sup>1</sup> come in all shapes and flavors. Some are all in one piece and get screwed into a socket, while others are modular, such as a pin based lamp that rely on the electronics contained inside the fixture.

Relative to the common household and commercial LED lamps, most policies break the market down into general service lamps and directional lamps. The general service lamps include a wide range of bulbs, having various base types and lamp shapes. Some LED lamps look like the conventional pear shaped incandescent, or flame shaped “candelabra” lamp, while others look completely different and have new shapes. Most of these lamps are designed to be omni-directional, meaning they shine light up, down and outward.

The other major class of lamps is directional lamps which are designed to provide light in a more concentrated beam or cone of light. They are typically installed in recessed cans in the ceiling or track lights, both in residential and commercial applications.

In developing potential Title 20 requirements for LED light bulbs, we encourage the CEC to consider the following points in deciding the scope/coverage for its proposal:

- *Include both integral and modular (including Zhaga modules that get inserted into fixtures) LED lamps, regardless of the lamp shape/dimensions or base type, with the exception of tubular lamps with a length greater than X. Prior federal regulations have shown that regulations that narrowly define lamp shape or base type result in the introduction of new lamp shapes and base types as a means to escape regulation and result in lost energy and economic savings. A recent example where a new shape was invented to avoid regulation are the very popular family of BR type reflector lamps which include a slight bulge in the neck of the lamp which does not provide any additional functionality or limit the product's ability to meet the efficiency requirements.*
- *Include LED lamps within a certain range of light outputs (for example lamps between 200 and 3000 lumens).*
- *Include both omni-directional and directional LED lamps*

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<sup>1</sup> We interchange the words bulb and lamp. While the industry refers to them as lamps, the general public calls them bulbs.

- *Provide limited list of exemptions for niche/unique LED lamps.* This list may include some of the lamp types exempted in the federal lighting legislation within EISA. These might include bug lights, lamps for aquariums, etc.
- *Provide different levels/values for certain classes of products as necessary.*

**2. Standards** – There are currently no mandatory standards for LED lamps that we are aware of in the United States. There are however various efforts underway to develop comprehensive performance and efficiency specifications for LED lamps. These include EPA’s ENERGY STAR lamp specification that will soon be finalized and the lighting industry’s SSL 4 document published by NEMA. These serve as useful starting points for future consideration by the CEC. In addition, the California Lighting Technology Center and CLTC have developed a voluntary California LED Lighting Quality specification that was developed to specify what a very good LED would look like and is intended to inform California utility LED lamp rebate programs. It is essentially an ENERGY STAR “plus” specification.

**3. Test Procedures** – Consensus test methods have been developed for the key parameters related to LED lighting and include methods for measuring light output, power use, lumen maintenance, rapid cycle stress test, color rendering index, etc. One area that is less mature is the methodology for determining dimming performance. While there is growing consensus that dimming tests are needed and that the things to test for include dimmability down to x% of full light output, noticeable hum and flicker, and ability to restart from the dimmed position, there is still some work to be done regarding what dimmers to use during the testing and how to measure flicker. We expect many of these details to be addressed and resolved in the final version of the ENERGY STAR specification which should be finalized this summer.

**6. Relevant Performance Indicators** – A potential mandatory California LED lamp standard would not only include basic energy efficiency requirements but also key potential “disatisfiers” regarding a consumer’s experience with LED lamps.

Prevent Pre-mature Failure - Consumers are disappointed when they pay more for the long lasting, energy saving bulb and it fails within a relatively short period of time. In particular consumers are very upset when they have out of the box failures or the bulb fails within the first year or two of installation. While many LEDs on the market today are rated 25,000 hours, it’s conceivable that some new models might be designed to last around 10,000 hours (10 years at 3 hours per day) and provide additional consumer benefits, primarily lower first cost. As such CEC needs to be thoughtful in how it sets mandatory standards for lamp lifetime.

The key metrics to include in a future regulation include those shown below; the first two specifically address premature lamp failure and loss of light output:

- a) Rapid cycle stress test, where the lamp is cycled on and off. This test has proved to be an effective tool for identifying CFLs that had poor quality electronics, which were often the source of premature failure,

b) Lumen maintenance and lamp survival – test lamps to a minimum number of hours via cycling specified in test method (e.g., 3 hours on, 20 minutes off). Require all samples being tested to be operational at 3,000 hours and for lumen maintenance to be at least x% at 3000 hours and a methodology to extrapolate lumen output at rated life time.

c) Dimming – do not require all lamps to be dimmable but include specific minimum dimming performance requirements for those lamps labeled as dimmable. These would include noise and flicker requirements.

d) Color quality – include some minimum requirements that will result in a good consumer experience. This may include some minimum CRI (color rendering index) and additional requirements at specific points in the test such as R9, which represents red colors.

e) Lumen equivalency – lamp manufacturers usually compare the power use of the LED lamp to the power used by a conventional incandescent lamp. Marketing claims such as “10W = 60W” or “60W replacement” are quite common. In order to prevent manufacturers from over claiming the equivalency of their product, CEC should include guidelines on the minimum tested light outputs that are needed in order to make an equivalency claim. For example, in order to claim equivalency to a 60W lamp, lamps must deliver at least 800 lumens. ENERGY STAR includes equivalency tables for omni directional and directional lamps and these provide a reasonable starting point. While the Commission would not require equivalency claims to be made, manufacturers who choose to make a claim must comply with CEC’s requirements.

**7. Range of typical performance indicators** – The DOE Lighting Facts database provides a comprehensive database on manufacturer reported data for LED lamps. Their website <http://www.lightingfacts.com/content/products> includes a sortable database that allows the user to sort within lamp categories (e.g., omnidirectional screw based lamps) and determine how many products meet the specified parameters. Their tool for example permits one to do a sort of omnidirectional lamps that meet certain CRI levels, one of the key parameters within the California LED Lighting Quality specification. For example, while 98 omnidirectional lamps meet a minimum CRI of 80 only 2 today meet 90 CRI the level contained in the California LED Lighting Qualify specification.

Other sources of useful data include the DOE’s Caliper testing program and the ENERGY STAR list of qualified products.

**9. Product Development Trends** – The LED lamps that are entering the market provide improved omni-directionality compared to the initial products that entered the market. The LED’s themselves are becoming more efficient which translates to fewer LEDs needed to produce the same amount of light. This trend also translates to the need for smaller drivers and less metal for heat sinks to dissipate waste heat, both of which translate to lower lamp production costs.

## LED Lamp Data Requests

**3. Minimum Dimming Levels** – As stated above, we do not believe all lamps sold in California need to be dimmable. Those lamps that are not dimmable would need to be clearly marked on the front of the package and those marketed as dimmable would need to meet certain minimum requirements. Today many CFLs and some LEDs are sold as dimmable even though they barely dim even at the lowest dimming section and in addition may hum or flicker when dimmed. We recommend DOE consider establishing a minimum dimming level of 20% of a lamp's rated light output.

**5. Cost of improved color consistency and quality** – Color quality and consumer acceptance is a combination of the lamp's CCT and how objects are rendered under the light. Today, the industry uses CRI which reflects how objects are rendered against a set of color tiles which reflect a pastel like pallet and do not adequately represent reds. While there seems to be emerging consensus that products should have a minimum CRI of 80 and there should be some requirement around the red R9 coordinate, there is little to no human factors data on how important it is for consumers to have a higher CRI, or if most consumers would be able to distinguish between two similar products having CRIs of 80 and 90.

While today's market is dominated by lamps that have a CRI around 80 and very few products meet CRI of 90, new products may enter the market soon which will yield additional information on the incremental cost of high CRI products, if any, and what trade off their might be in terms of lamp efficacy (or the incremental power use for lamps that give off the same amount of light). We are hopeful that industry stakeholders will provide more information to the docket on this issue.