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**Comments on DOE-EPA Integration Proposal for Energy Star Requirements for Lighting Products**

## Comment on 25% Guiding Principle

The integration proposal articulates a guiding principle to be used in establishing specific technical requirements for qualifying as an Energy Star product. The articulated principle is:

> "To identify top performing products, ENERGY STAR specifications will be set to identify approximately the top 25% most efficient of models within a product class under the ENERGY STAR specification at the time that specification becomes effective, with consideration of expected improvements in product efficiency and market penetration trends of those products that will take place between establishing a specification and the specification becoming effective."

This guiding principle should be augmented by a specific requirement that stipulates that Energy Star criteria products have efficiency that is no less than a certain percentage (e.g., 25%) worse than the best commercially available product. For example if the best commercially available LED PAR 38 lamp has an efficiency of 100 lumens per watt, then (assuming the 25% limit) Energy Star qualified LED PAR 38 lamps will be permitted to have an efficacy of no less than 75 lumens per watt.

In fact I believe 25% is too lax for this requirement. It would be more appropriate to require that Energy Star products have an efficiency that is not 10% worse than the most efficient commercially available product in the relevant category. 25% is OK for percentage of models allowed to qualify for Energy Star.

The proposed lower limit relative to the top performer will spur competition for greater efficiency by providing a mechanism through which companies can eliminate their competition from a lucrative market segment (e.g., the energy efficient upmarket). Once a new best efficiency product is confirmed, notice of the intent to raise the standard should be issued to stakeholders and the Energy Star requirements should be adjusted based on the new best product not later than the end of the next quarter. Accordingly manufacturers of Energy Star Products should make contingency plans for changing packaging to remove the Energy Star logo if their product falls below the new standard.

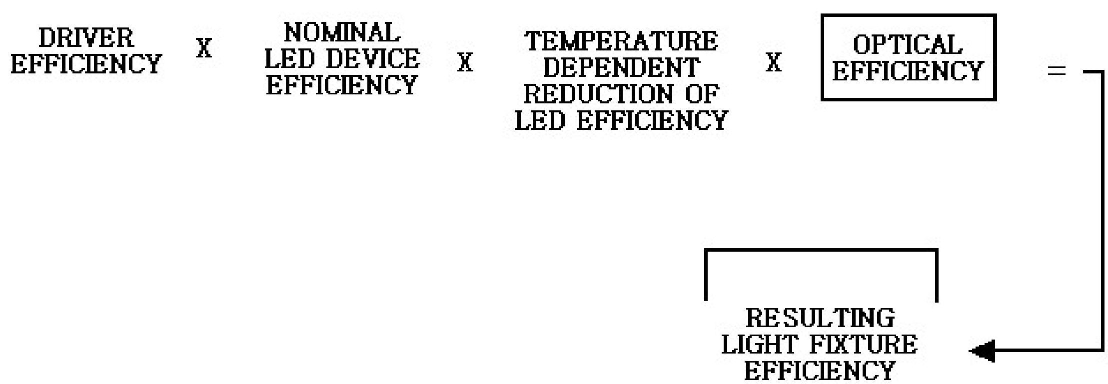
In the case of LEDs significant year-on-year improvements are forecast for the next few years, so it should be expected (by stakeholders) that the Energy Star requirements will be rapidly rising.

This proposal has similarities to the Japanese “Top Runner” program. It is not as comprehensive because it only applies to a voluntary program (Energy Star), however it is faster acting.

## Comments on RLF 4.2

The block diagram below shows that there are several efficiency factors including 1) driver efficiency, 2) nominal LED device efficiency 3) temperature dependent reduction of LED efficiency and 4) the optical efficiency that determine the Real-World overall efficiency of an LED luminaire. Allowing any factor to drop too low compromises the efficiency of the fixture. Proper engineering must be applied insure that each factor is at a sufficiently high level.

Real World Efficiency of LEDs is dependent on multiple factors




At this early stage in the introduction of LED based general illumination products, the strategies of a small number of companies are premised on the view that certain companies will mass produce “light engines” which will be sold to other companies that incorporate the “light engines” into larger luminaires. The RLF specification appears to be premised on this view as well. This business model may not ultimately be triumphant as it would require luminaire makers to be dependent on other companies for large subsystems, which contrary to the hype do not involve highly complex engineering but that would amount to a large fraction of their products. The engineering involved in designing the presently available light engines is far less complex than designing a laptop computer or a cellular telephone for example.

An alternative business model that may become predominate is that luminaire manufacturers will purchase LEDs only and design the remainder of the luminaire.

The EPA adapted the following definition of light engines:

> "LED Light Engine: A subsystem of an LED luminaire that includes one or more LED packages, or an LED array, or an LED module; an LED driver; electrical and mechanical interfaces; and an integral heat sink to provide thermal dissipation. An LED light engine may be designed to accept additional components that provide aesthetic, optical, and environmental control (other than thermal dissipation). An LED light engine is designed to connect to the branch circuit. [from IESNA RP-16-05 revision draft, March 2008]."

One commercially available "light engine" consists of LEDs mounted on circuit board possibly with some optics[1]. Another also includes a housing[2] and yet another is also furnished with an associated driver[3] in a separate housing. At least one thermal dissipation system is separately available from a different manufacture[4] for the latter light engine. Another light engine appears to meet the above stated definition but is not intended for use in residential fixtures[5]. At present there may not actually be any LED Light Engines suitable for use in residential light fixtures that meet the RLF 4.2 definition.

[1] See http://products.lsgc.com/product/titanturbotm/
[2] See http://www.xicato.com/technology.php

[3] See http://www.lighting.philips.com/us_en/applicationsolutions/led/modules/fortimo.php?main=us_en&parent=0&id=us_en_application_solutions&lang=en
[4] See http://www.nuventix.com/news/Nuventix-Launches-More-Compact-SynJet-Cooler-for-Philips-Fortimo-LED-Downlight-Module
[5] http://www.enfis.com/files/Quattro-Mini%20Air%20Cooled%20Light%20Engine%20General.pdf

The EPA caused a controversy (or tempest in a teapot) when it proposed to qualify residential light fixtures under the Energy Star program based on the efficiency of the light source (e.g., light engine) alone. Doing so ignores the final factor "optical efficiency" indicated in the block diagram above. Notwithstanding high efficiency in the "light engine" (as defined above) poor "optical efficiency" would undermine the real-world efficiency of the luminaire. The question may be posed as to whether including requirements on the optical efficiency is too onerous a requirement. The answer is decidedly not. The issue of optical luminaire efficiency has been known and addressed for at least 79 years. So at present it is not too onerous to expect that engineers charged with designing an Energy Star product properly address the issue of optical efficiency. The following quote from the top of page 285 of "*The Theory and Design of Illuminating Engineering Equipment*" published in 1931 is illustrative[6].

*"The ratio of luminous output to input must be high for a glass enclosing unit… The point to remember is, however, that the best diffusers can also be the best from the point of view of efficiency, and there is no excuse for a glass which only possesses one property.* "

Requiring overall efficiency does not preclude the "light engine" business model it simply means that manufactures that use 3rd party "light engines" must do a good job of providing good optical efficiency and not compromise the thermal performance of the "light engine", e.g., by restricting air flow.

'Decorative' vs 'Both'

[6] The ratio of luminous output to input must be high for a glass enclosing unit…The point to remember is, however, that the best diffusers can also be the best from the point of view of efficiency, and there is no excuse for a glass which only possesses one property.

The *ENERGY STAR Qualified Lighting An Integration Proposal* document states that the RLF4.2 will only be applied to decorative light fixtures as defined by ALA and NEMA in the document LSD 51-2009. The distinction between the ‘Decorative’ vs. ‘Both’ category is subjective and thus should not form a part of the Energy Star standard. Even if it were not subjective it does not properly enter into the Energy Star calculus. By way of analogy, should a car that is well styled be exempt from fuel efficiency standards ? Any company aspiring to make an Energy Star fixture must concern itself with the complete system energy efficiency as well as addressing the aesthetics of the light fixture-the two are not mutually exclusive and one is not a substitute for the other. Per the ALA/NEMA document two categories of light fixtures fall under the ‘Decorative’ category and therefore would fall under RLF4.2. The two categories are wall sconces and accent lights.

Regarding accent lighting this may be an attractive niche market for LEDs. A single 1 watt LED may provide sufficient light for this application. On the other hand the energy usage for this application is not significant and it may be impossible to achieve high optical efficiency. Another issue is that the implementations would generally be very cheap and poorly designed with poor thermal management resulting high rates of premature failures and consumer disappointment. Does the Energy Star program really want to put the credibility of the Energy Star *imprimatur* at risk by allowing the Energy Star logo to go on cheap novelties ? The ALA/NEMA document shows paper lanterns as one of the two examples of an accent light. Is the Energy Star program contemplating having the energy star logo on paper lanterns ?

An expensive LED lit art glass sculpture might also come under the accent light category, but may well constrain the thermal management solution. Does a $1000 art glass lamp need to have the Energy Star logo ?

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Manufactures of accents lights, whether they be $5 paper lanterns or $1000 glass sculptures can take it upon themselves to promote the fact that they use “LED Lights”. They don’t need the Energy Star logo. However if they qualify under an overall efficiency standard they would be equally entitled.

Regarding wall sconces, the ALA/NEMA document itself states that in commercial settings sconces are ‘Both’. A review of online light fixture catalogues reveals that sconces are generally designed to accept incandescent lamps with a total power of at least 60 watts. This is no less than other residential fixtures, so there is no rational (tied to energy usage) for exempting wall sconces from overall energy efficiency requirements including optical efficiency. Therefore RLF 4.2 should not be used for wall sconces. Overall efficiency requirements should be established for wall sconces.

The separate “light engine” based standard should be abandoned. It does not insure real-world energy efficiency and is based on speculation as to how the LED lighting business will evolve. The DOE, in its technical role supporting Energy Star, should commence a program of benchmarking the efficiency of residential light fixtures in the ‘Both’ category of the ALA/NEMA document so as to be in a better position to establish future efficiency standards. The benchmarking should include determining of optical efficiency (aka Light Output Ratio).

Cordially,

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