High Quality Super-Efficient Lighting Products: the SEAD Global Efficiency Medal

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Abstract

The Global Efficiency Medal competition, a cornerstone activity of the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative, is an awards programme that encourages the production and sale of super-efficient products. SEAD is a voluntary multinational government collaboration of the Clean Energy Ministerial. This competition recognises high-quality super-efficient products, enabling early adopters to identify the most efficient products and demonstrating levels of efficiency in commercially available and emerging technologies.

The fourth Global Efficiency Medal competition recognises super-efficient lighting products in four regions around the world. This competition complements existing labelling programmes and advances comparable and transparent international test methods that support market transformation programmes. For an emerging technology like LEDs, this competition enables manufacturers to distinguish themselves and informs policymakers about what is possible for this product group.

To establish the Efficient Lighting competition, experts and policymakers in participating regions provided input on lamps and luminaires that are either popular, high-volume products in each regional market or are niches for which inefficient products are currently used. Eight categories allowed manufacturers to nominate products in a range of sizes, colour temperatures, and lumen outputs.

In addition, to ensure the nominated products were of high quality and had the potential to influence the lighting market, the competition required nominated products to meet 19 quality criteria and to be sold below a cost threshold specified by product and region. These 20 criteria are part of an ongoing conversation about what makes a quality LED product that will satisfy consumer preferences for reasonable cost and high quality. The competition's criteria were based on similar requirements developed and published by the IEA 4E Solid State Lighting Annex.

Introduction: the SEAD Global Efficiency Medal competition

The fourth Global Efficiency Medal competition of the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative recognises super-efficient lighting products in four regions around the world. The four regions were selected based on the governments participating in the SEAD Awards Working Group – Australia, Europe (based on participation from Sweden and the United Kingdom), India, and North America (with participation from Canada and the US). This competition complements existing labelling programmes and advances comparable and transparent international test methods that support market transformation programmes. For an emerging technology like light-emitting diodes

(LEDs), this competition enables manufacturers to distinguish themselves and informs policymakers about what is possible for this product group.

This SEAD Global Efficiency Medal competition encourages the production and sale of super-efficient equipment, appliances, electronics, and lighting by identifying the most efficient product in each category in four regions, as well as an overall global winner. The main objectives of the competition are to:

- Maximize energy savings;
- Increase market share of highly efficient products, moving the median of the market to efficient products while staying technology neutral;
- Spur innovation among manufacturers;
- Support test procedure harmonization activities, moving closer to being able to apply the test results of region A to region B;
- Build test lab capacity;
- Provide internationally comparable and transparent test results; and
- Complement and support S&L policies. [1]

When selecting products to be covered by the SEAD Awards, several factors are taken into account. Products should have significant energy savings potential; well-established and accepted test methods (to the extent possible); large energy saving potential between products, which enables products to be differentiated through energy efficiency; and potential to benefit the market – that is, the market for that product has high interest in an award and stakeholders are seeking to differentiate products.

The SEAD competition is a recognition award, not a financial award. SEAD builds awareness of the competition before announcing winning products, and promotes the competition and the winning products. SEAD holds regional and international ceremonies to recognize the manufacturers of winning products, releases a press announcement about the winners, works with partners to promote winning products.

SEAD Lighting Awards Rules Development

To establish the Efficient Lighting competition rules, lighting experts and policymakers in participating regions provided input on lamps and luminaires that are popular, high-volume products in each regional market. Twenty-seven stakeholders from all participating awards regions plus China and Korea provided input over the course of four ninety-minute technical consultation calls to determine the appropriate product categories, technical criteria, and testing methods that were ultimately used for the competition. The rules document also underwent review from lighting industry representatives (including manufacturers, manufacturer associations, and expert technology consultants) to ensure the competition was appropriately scoped for the market.

Lighting Awards Categories

Eight award categories allowed manufacturers to nominate products in a range of sizes, colour temperatures, and lumen outputs.

The original category proposal, shown in Figure 1, was very ambitious in terms of scope, and SEAD quickly realized that there was not enough capacity available to cover all of these categories. Therefore, in consultation with the technical committee, SEAD established subcategories to target specific, high-impact products. Selections were driven by: (1) market considerations, (2) the potential for the market to benefit from the SEAD award, and (3) the relevance of a global award for the product category (for instance, the differing regional requirements for street lighting would have made a global award difficult for the product category). Subcategories were differentiated around luminous flux, color temperature, voltage, and size.

	General Service Lamps	Directional Lamps	Planar Luminaires	Downlight Luminaires	Street Lights
Picture					
Description	Lamps that emit light in all directions ("non-directional"); e.g., A19 shape [a], mains voltage replacement lamp	Lamps that emit directional light; e.g., MR16, PAR38 shapes [b], mains voltage replacement lamp	Recessed ceiling fixtures commonly used in offices for general illumination.	Recessed directional fixtures that deliver light to a space or highlight an object or area.	Outdoor luminaires used for street / roadway lighting and area illumination

Notes:
[a] This was the category for the first round of the L-prize administered by the U.S. Department of Energy [2]
[b] This is the category for the second round of the L-prize administered by the U.S. Department of Energy

Figure 1: Originally Proposed Categories for Consideration for the SEAD Lighting Awards

SEAD Awards competitions seek to include commercially available technologies and emerging technologies that are not yet on the market. Potential emerging technologies that were discussed with the technical consultation committee included organic LEDs, vertical surface cavity emitting lasers (VSCELs), and sulfur lamp technology heated with microwaves. However, the committee indicated that those technologies have not yet been shown to exceed the efficacy of LEDs in terms of lumens/watt. Therefore, these emerging technology categories were not included.

In place of this, a "new technology" category was included for general lighting service lamps that could replace a 100W incandescent bulb. Because of the higher luminous flux, these products are more difficult to make and therefore are not at as advanced a stage as lower wattage replacement lamps.

The final categories for the SEAD Lighting Award are shown in Figure 2. The subcategory specifications – lumen output, color temperature, and size where applicable – were determined based on considerations of the most common products preferred and used in each region.

Regional Awards	GLS Lamps					Directional Lamps		Planar Luminaires	Downlight Luminaires	
	Commercially Available			New Technology		Commercially Available		Commercially Available	Commercially Available	
	≥800 lumens 2700-3000K CCT	≥800 lumens 4000-5500K CCT	≥700 lumens 5500-6500K CCT	≥1500 lumens 4000-5500K CCT	≥1300 lumens 5500-6500K CCT	Low-voltage ≥600 lumens 2700-3000K CCT	Mains-voltage ≥600 lumens 2700-3000K CCT	600mm x 600mm (2ft x 2ft); ≥2000 lumens	≤51mm (2 in) ≥700 lumens 3000K CCT	≥102mm (4 in) ≥1500 lumens 4000K CCT
AUSTRALIA	• 230V	• 230V		• 230V		• 12V	• 230V	•	•	•
EUROPE	• 230V	• 230V		• 230V		• 12V	• 230V	•	•	•
INDIA	• 230V	• 230V	• 230V	• 230V	• 230V	• 12V	• 230V	•	•	•
NORTH AMERICA	• 120V	• 120V		• 120V		• 12V	• 120V	•	•	•
GLOBAL AWARDS	• 230V	• 230V		• 230V		• 12V	• 230V	•	•	•

Figure 2: Final SEAD Lighting Awards Categories

Another possible category mentioned by the committee was industrial lighting, specifically high-bay lighting. This product category provides significant opportunity for LED developments in terms of managing heat given that these are high flux, high power fixtures. This category was not added for the

2014-2015 competition, but SEAD is considering including this category in the next round of awards, potentially to be focused on industrial and outdoor lighting.

Lighting Awards Criteria

To ensure the nominated products were of high quality and had the potential to influence the lighting market, the competition required nominated products to meet 19 quality criteria and to be sold below a cost threshold specified by product and region. These 20 criteria seek to ensure consumers selecting winning products will be satisfied thanks to the reasonable cost and high quality criteria. The competition's criteria (with the exception of the cost criteria) were developed by adapting similar requirements developed and published by the IEA 4E Solid State Lighting Annex [3]. Some criteria were deemed applicable only to particular categories because of the technology used in that category and the desired light service. The criterion for center beam luminous intensity, for example, is only relevant to directional lighting (directional lamps and downlight luminaires).

Although the SEAD Lighting Awards were technology neutral, the technical consultation committee assumed that solid state lighting products would be likely to win most if not all categories. For some of the desired criteria for these products, test methods have not yet caught pace with technological innovation. There is a new test method since published for solid state lighting products with the International Commission on Illumination (Commission Internationale de l'Eclairage, or CIE), CIE TC2-71, but the draft of this test method was not published in time for inclusion in the SEAD Lighting Awards official rules document (which was finalized 9 June 2014).

Cost Criteria

Cost criteria were established based on market research for the average cost of relevant products in each award region. The goal of the cost thresholds was to be low enough that a significant number of consumers would purchase award-winning lamps. If the prices were too high, then the winning products would not be able to bring about market transformation due to low consumer demand.

Prices listed are $/unit	General Lighting Service (GLS) lamp, Omnidirectional, Commercially Available^	Directional lamp, Low voltage	Directional lamp, Mains voltage	Planar luminaire	Downlight luminaire	
					700 lumens	1500 lumens
Australia	$30	$25	$35	$400	$80	$175
Europe	$22	$25	$32	$400	$75	$165
India	$20	$15	$25	$350	$100	$130
North America	$18	$20	$25	$350	$50	$110
^These price thresholds do not apply to the GLS lamp New Technology Class, which has no price threshold.						

Table 1: Maximum Allowed Retail Prices for SEAD Award Nominated Products

Efficacy and Light Output Criteria

The criteria in this category that were ultimately required in the competition – indicated in Table 2 with an "x" – were subject to verification testing by a test laboratory selected by SEAD.

Lamp/fixture luminous efficacy (lm/watt)

This criterion – lamp efficacy for the General Lighting Service (GLS) or directional lamps, or complete luminaire efficacy for the downlight or planar luminaires – is the total light output (measured in lumens) of the lamp or luminaire divided by the power consumed (measured in watts). The higher the efficacy

value, the more energy-efficient the lighting product. This criterion is of high importance for the consumer and society to save energy and money.

For fixture luminous efficacy, this is also important because if a very efficient light source is installed in an inefficient light fixture, a large part of the light will be lost inside the fixture. As a result, even with a very efficient light source, there will be no efficiency gains or energy saved.

This criterion was the main metric to determine winners for the competition.

Metric	GLS Lamps	Directional Lamps	Planar Luminaires	Downlight Luminaires
Efficacy & Light Output – Subject to verification testing				
A) Lamp/fixture luminous efficacy (lm/w)	×	×	×	×
B) Light output (lm)	×	×	×	×
C) Replacement lamp equivalent wattage claims	×	×		
D) Luminous intensity distribution	×			
E) Zonal lumen density		×	×	×
F) Center beam luminous intensity		×		×
G) Glare luminance (cd/m^2)				
H) Lag start time (ms)				

Table 2: Summary of Potential and Selected Efficacy and Light Output Criteria for the SEAD Lighting Awards

Light output (lm)

This criterion is the total light output (measured in lumens) emitted by the lamp or luminaire. This measurement is required to determine the luminous efficacy and the replacement lamp equivalent wattage claims.

Replacement lamp equivalent wattage claims

The measured level of light output will assist in evaluating manufacturer claims that a given efficient lighting product is an equivalent replacement for a typical wattage incandescent light product. The "equivalent wattage" was as compared to incumbent, traditional technologies.

The technical consultation committee determined this to be an important criterion to include. Experts cautioned, however, that equivalent wattage should not be benchmarked to incumbent technologies, since doing so can produce systems that deliver too much light and result in less energy savings.

Luminous intensity distribution

This criterion describes the measured distribution of a GLS lamp, which is important because many LED products poorly approximate the light distribution of the products they are intended to replace. This criterion ensures better equivalency with regards to meeting consumer expectations when they purchase an LED lamp. This criterion was required for GLS lamps.

Center beam luminous intensity

The technical consultation committee agreed that this criterion was important for assessing the performance of directional lamps and downlight luminaires.

Glare luminance (cd/m^2)

This criterion defines total luminance levels where the visual contrast between task and light source are so high that the task cannot be distinguished – the amount of light makes it physically painful or difficult

to work. This criterion was considered potentially important for street lighting, as glare is unsafe for drivers and can increase light pollution. There is also some indication that products with strong glare impede work efficiency in offices.

To test for glare luminance, the Design Lights Consortium has a method that the IEA-4E SSL Annex has been using for glare measurements. However, it is not widely accepted. Although this criterion was thought to be important, in the absence of available quantifiable test methods it was excluded from this competition.

Lag start time (ms)

This item measures the amount of time for a lighting product to begin emitting light after power is turned on. It is important that the starting time of a lighting product is very short, both for emergency situations and for consumer acceptance.

This criterion was eliminated from this competition because it was not believed to be an issue for LED lighting (which it was assumed would be the technology behind winning products), and because although there is a test method for compact fluorescent lamps (CFLs), there is no existing test method for LEDs.

Color and Light Quality Criteria

The criteria in this category that were ultimately required in the competition – indicated in Table 3 with an "x" – were subject to verification testing by a test laboratory selected by SEAD.

Metric	GLS Lamps	Directional Lamps	Planar Luminaires	Downlight Luminaires
Color & Light Quality – Subject to verification testing				
A) Color rendering (CRI and R9)	×	×	×	×
B) Correlated color temperature (CCT)	×	×	×	×
C) Chromaticity tolerance (Duv)	×	×	×	×
D) Minimum power factor	×	×	×	×
E) Flicker (flicker index)	×	×	×	×

Table 3: Summary of Potential and Selected Color and Light Quality Criteria for the SEAD Lighting Awards

Color rendering index (CRI and R9)

Color rendering is a measure of how similar object colors appear under one light source as compared to the object colors under a reference light source (usually an incandescent light or daylight). Color rendering is very important for consumer satisfaction with a lighting product. R9 determines the accurate rendering of the color red, which is not used in the calculation of the CRI.

This criterion was required for all nominated products.

Correlated color temperature (CCT)

This criterion was a requirement for all nominated products. The CCT metric helps consumers (1) select the appropriate product depending on their light color temperature preference, and (2) match light color temperature across different manufacturers' lighting products. This way, when different manufacturers' light products are used in the same space, there is not an unintended mix of cool-white lighting with warm-white lighting.

Because most lamps are currently based on blue LED pumping of phosphor – a technique that results in cooler color temperatures – there is less efficacy at warmer color temperatures. Therefore, the competition created separate subcategories of CCT ranges for cool white and warm white lamps. CCT

was determined to be a necessary defining factor in the development of subcategories, focusing on the most popular CCT in the market and requiring lamps to fall within a certain defined range.

Luminaires are generally designed around a specific CCT, for example, 3000K, 4000K, or 5000K. Luminaires would exhibit different efficacies based on the different light engines, so the subcategory was defined at the most popular color temperature with a tolerance around that CCT. For these luminaires, it would not be fair to compare them with each other if they had different CCTs.

All CCTs had an allowed tolerance, such that any lamp or luminaire claiming to have a certain CCT would not deviate from that requirement by more than the IEC standard allows.

Chromaticity tolerance (Duv)

This criterion is critical in commercial or professional settings and also important for household applications. For professional products, this measurement makes sure that products are in line with any color temperature or light quality claims, resulting in consistent color between fixtures that illuminate a hotel lobby or office space. This criterion also has considerable cost and complexity to test.

Minimum power factor

Power factor is the ratio of the real power flowing to the load over the apparent power of the circuit. For electrical power suppliers, this can be of very high importance depending on the power network. However, for residential customers there has not been established any significant relation between the power factor of small electronic loads like efficient lighting and the grid power factor.

This criterion was a must have. Although products tend to have sufficient power factors, a minimum requirement would prevent power factors falling to unacceptable levels.

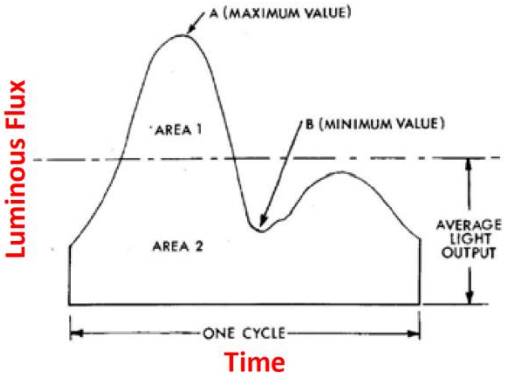
Flicker (flicker index)

This criterion was considered to be important to include, but it currently is not used in any regulatory processes. This is a notable topic in government R&D programs, such as the US DOE CALiPER (Commercially Available LED Product Evaluation and Reporting) and GATEWAY programs. [4]

For the emerging market of LEDs that work on alternating current, the chip goes on and off as the current goes up and down, which sometimes can create a visible flicker. LEDs operating on AC have an advantage in that there are no overhead losses associated with the drivers, so they have greater potential for efficacy and high efficiency performance. In that case, flicker reduction would be a must have for this program, because it would reflect poorly on the SEAD awards to award a product that is the most efficient in the market but had noticeable flicker.

After extensive discussion and follow-up correspondence, it seems that there is no established test method for flicker. Policymakers, technical experts, and industry alike noted that this is a critical issue without an established test method. The International Energy Agency (IEA) Implementing Agreement for a Co-operative Programme on Energy Efficient End-Use Equipment (4E) SSL Annex defines flicker measurement as follows:

> “This criterion measures the perceived photometric “flicker” of a light source. Flicker index defined by (Area 1 / (Area 1+Area2)); replaced by new metric under development by IEEE PAR1789 which accounts for frequency, when available.



This is an important item for both consumer satisfaction and consumer acceptance of SSL products. Some consumers may have severe health reactions to flickering light sources of certain frequencies ranging from low-grade headaches to extreme seizures. Flicker can also make rapidly moving objects seem like they are standing still, or leave after images of bright points in the visual field. The requirements minimize these stroboscopic effects."

Lifetime Criteria

For the criteria in this category that were ultimately required in the competition – indicated in Table 4 with an "x" – manufacturers were required to submit supporting documentation verifying their claims.

Metric	GLS Lamps	Directional Lamps	Planar Luminaires	Downlight Luminaires
Lifetime – Supporting documentation required				
A) Minimum rated lamp lifetime (B_{50})				
B) Minimum lumen maintenance (time to L_{70})	×	×	×	×
C) Color maintenance (Δ u'v' at 6,000h)	×	×	×	×
D) Endurance test	×	×	×	×
E) Warranty duration	×	×	×	×

Table 4: Summary of Potential and Selected Lifetime Criteria for the SEAD Lighting Awards

Minimum rated lamp lifetime (B_{50})

Lifetime is typically defined as the amount of time that it takes for 50% of a statistically significant sample to fail (also known as B_{50}). It is unrealistic to measure very long lifetimes for lighting products, but having a credible B_{50} estimation is very important as lighting products with longer lifetimes must justify their higher initial cost. If efficient lighting products are able to meet their lifetime claims, they can cut long-term energy consumption and save the consumer money over the life of the product even if the up-front cost is higher.

While the technical consultation committee would have like to include this criterion, SEAD did not have enough time or resources for testing. The competition elected instead to use lumen maintenance as a surrogate for lifetime.

Another proposed approach was to look instead at early failures from electronics. A criterion was proposed that would require less than 5% failures (or some figure) for a test of 1000 or 2000 hours. This would still present a potential challenge with the number of products needed to test, but this would test for early product failure which is a big issue from the perspective of purchasers. Due to limited time and resources, SEAD did not elect to go forward with this proposed variation.

Minimum lumen maintenance (time to L_{70})

Lumen maintenance is the percentage of a lighting product's measured light output after a period of time compared to that light product's initial total light output. This criterion helps the consumer determine how long it will take a lighting product to degrade to the point that it is no longer useable. High lumen maintenance over time helps to justify the higher initial cost of efficient lighting products.

This criterion was determined to be a requirement, with the suggestion again that the competition refer to test reports from independent test laboratories rather than test for this criterion given time and resource constraints. Participants also noted that this approach had the added value of preventing SEAD from taking too long to evaluate products, leading to awarding products that would no longer be on the market.

Color maintenance (Δ u',v' at 6,000h)

This criterion measures the consistency of color over time as a lighting product ages. It was determined to be a must have, but again it was deemed impractical for SEAD to perform the required 6,000 hours of testing. As with minimum lumen maintenance, for this criterion the competition relied on test reports from independent test laboratories, provided by manufacturers, to mitigate time and resource constraints.

Endurance test

This criterion requires that a lighting product is rapidly switched on and off to simulate how a product will be used over its lifetime. It requires that a test is carried out to stress a lighting product over a short period of time to determine the failure rates of a product. A stress test like this one can help verify that a lighting product will not fail when installed and used in a consumer application. This criterion was required via manufacturer submission of independent test results.

Warranty duration

It is very important that consumers have a guarantee that SSL products will perform as claimed. Therefore this criterion was determined to be critical, and was included as a minimum warranty requirement of three years. This was coupled with a requirement that products have rated lifetimes of at least 15,000 hours. However, that rated lifetime was not confirmed through verification testing.

Health and Environment Criteria

For the criteria in this category that were ultimately required in the competition – indicated in Table 5 with an "x" – manufacturers were required to submit supporting documentation verifying their claims.

Metric	GLS Lamps	Directional Lamps	Planar Luminaires	Downlight Luminaires
Health & Environment – Supporting documentation required				
A) Safety requirements	×	×	×	×
B) Hazardous substances	×	×	×	×
C) Blue Light Photo-biological hazard class	×	×	×	×
D) Compatibility with controls			×	×
E) Recyclability (%)				
F) Harmonic distortion				

Table 5: Summary of Potential and Selected Health and Environment Criteria for the SEAD Lighting Awards

Safety requirements

This criterion, which specifies that a product meets electrical safety requirements and marking requirements, was very important to many participants in order to protect the program against awarding an unsellable product. However, safety markings vary by national markets, making it complicated to specify this criterion internationally. Ultimately, a consensus formed around requiring products to meet safety requirements in the country where it is entered (and therefore sold).

The competition would not have to test for safety, but manufacturers should show that they have achieved the appropriate safety standards as minimal criteria for application. In any region without a safety mark, manufacturers would be required to submit evidence that the product meets safety requirements in the market.

Hazardous substances

This criterion is about regulating hazardous substances, focusing on materials that go into making the product. It was included as a requirement. In Europe, for example, this criterion would indicate that products must be RoHS compliant.

Blue Light Photo-biological hazard class

This criterion is very important for consumer safety, as high frequency blue light can cause irreparable damage to eyesight. It was determined to be essential for domestic applications (residential and commercial). It was also noted that stakeholders in some communities expressed concerns regarding ultraviolet (UV) and blue light in lighting products because of adverse health effects on lupus sufferers.

Compatibility with controls

This criterion looks at whether a product is compatible with dimmers, which normally expect a resistive load in the socket, and controls. Dimmer compatibility is of high importance for the consumer as new lighting products often are not completely compatible with commonly available dimmers thus making it difficult for consumers to use these efficient products in existing lighting systems. As manufacturers are still trying to define and adopt a new dimming standard, the dimmer compatibility of new lighting products is likely to continue to be a problem.

This criterion could also be complicated to measure and verify due to the limitations of standards. Ultimately the committee determined this was relevant only for certain product categories.

Recyclability (%)

While this criterion would have been nice to have, no clear method exists on how to quantify recyclability. Some methods proposed included determining the per cent of components that could be recycled, or giving some bonus credit to products that were designed so that they could be disassembled and then more easily recycled. Ultimately this criterion was not included in the competition.

Harmonic distortion

Harmonic distortion measures how the lighting product will affect the quality of the electrical utility's grid. This criterion would be a must have for street lighting products, but is not essential for residential and commercial lighting.

Additional Potential Criteria

Lumen maintenance of integrated lamp/luminaire

This criterion is similar to the lumen maintenance criterion, but would test the integrated product rather than the LEDs on their own. However, this would have required the availability of new test method documents that were under development from the Illuminating Engineering Society at the time the rules were finalized: IES-LM-84 and IES-TM-28.

Standby

The technical consultation committee recommended consideration of a criterion for maximum standby and wireless power for the general service category, or for a separate category for controllable domestic lighting. With LED lighting that is capable of being controlled remotely, there is a real possibility that every light bulb in a future home could experience standby losses. In order for LED products to be perceived as more valuable, features like remote control and smart-phone application control are being incorporated into many lamps. These features mean that when the lights are turned "off," they will actually be in standby mode all the time waiting for instruction.

Including this criterion would ensure that nominated LED products had taken standby losses into consideration.

SEAD chose to leave out this criterion, as it is not yet included in national policies, but to request this data from manufacturers for nominated products and to include tests for standby power usage for tested lighting products.

Work is underway to further investigate how best to include this criterion in policies for lighting products, for instance in the IEA 4E SSL Annex [5], the IEA 4E Electronic Devices and Networks Annex (EDNA) [6], and the G20 Energy Efficiency Action Plan [7].

Tropical Criteria

The technical consultation committee also considered including criteria for performance in tropical environments, such as those developed by lites.asia [8]. These additional rigorous requirements were put in place because products were not surviving in tropical markets due to these difficult operating conditions. These tests subject lamps to:

- An over voltage test, where the rated voltage is exceeded by 10% and the lamp must be able to deliver the rated lumen output during 15 minutes of operation;
- An under voltage test, where the rated voltages is dropped by 30% and the lamp must be able to operate;
- A high temperature and humidity test, where the lamp is exposed to 85°C and 85% humidity for 500 hours and then has to have not less than 10% lumen depreciation relative to the original test; and
- Ingress protection and heat sink maintenance tests.

These difficult operating conditions may be applicable in certain climates and markets, but not all (e.g., not in the EU). Thus applying these criteria to all products in the SEAD Awards would lead to winning products in the EU that were more expensive, bulkier, and maybe less efficient in order to meet locally unnecessary tropical test conditions. However, the inclusion of regional requirements would also prevent those categories from having a comparable international winner.

Ultimately, SEAD chose not to include the tropical criteria in this competition.

Winning Products

Regional and global winners have been determined for the GLS categories. The global winning product in the commercially available, 60W replacement category (>800lm) with 2700-3000K CCT had an efficiency of 121 lm/W. Replacing inefficient general service lamps with the SEAD Global Efficiency Medal Award winner would reduce electricity consumption in this end-use application by 82%. This would provide annual savings of approximately 850 TWh (terawatt hours) of electricity, or approximately 426 million tonnes of CO_2.

At the time of publication the other award category winners were still being determined.

Conclusions

A team of 27 lighting experts and government representatives from 8 countries were able to identify 20 common efficiency, quality, and cost criteria across 8 residential and commercial lighting product categories. These 8 lighting product categories covered the largest global market applications. The 20 common criteria were used to ensure *high-quality and market ready* efficient lighting products were eligible to win the competition.

References

[1] Ravi et al 2013. *Policy into practice: the SEAD global efficiency medal*. eceee summer study proceedings. Available for download at: http://proceedings.eceee.org/visabstrakt.php?event=3&doc=6-180-13

[2] The L-Prize is a technology competition sponsored by the US government, designed to spur lighting manufacturers to develop high-quality, high-efficiency SSL products that set leading-edge performance benchmarks for industry. More information is available at: http://www.lightingprize.org/

[3] IEA 4E SSL Annex, 2012. Available for download at: http://ssl.iea-4e.org/task-1-quality-assurance/performance-tiers

[4] The US DOE launched the CALiPER program in 2006 to address a need for unbiased, trusted product performance information in the early years of SSL. DOE GATEWAY demonstrations enable detailed LED product evaluation and hands-on experience that cannot be replicated in a lab. More information on CALiPER is available at: http://energy.gov/eere/ssl/caliper-testing and on GATEWAY at: http://energy.gov/eere/ssl/gateway-demonstrations

[5] More information on the IEA 4E SSL Annex is available at: http://ssl.iea-4e.org/

[6] More information on the IEA 4E EDNA is available at: http://edna.iea-4e.org/

[7] More information is available online at: http://www.g20australia.org/sites/default/files/g20_resources/library/g20_energy_efficiency_action_plan.pdf

[8] http://www.lites.asia/downloads/tropical-performance-criteria