

# High quality super-efficient lighting products: the SEAD Global Efficiency Medal

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## Abstract

The Global Efficiency Medal (GEM) competition, a cornerstone activity of the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative, is an awards programme that encourages the development, production and sale of super-efficient products. SEAD is a voluntary multinational government collaboration of the Clean Energy Ministerial. This winner-takes-all competition recognises energy-efficient products, guides purchasers towards energy-efficient product choices, and demonstrates the levels of energy efficiency achievable by commercially available and emerging technologies. This competition is designed to complement existing national and regional appliance and product labelling programmes, and to advance comparable and transparent international test methods that support minimum energy performance standards.

This paper summarises the findings from the fourth Global Efficiency Medal competition, which focused on super-efficient lighting products in four regions around the world. For an emerging technology like light emitting diodes (LEDs), the competition provides an opportunity for manufacturers to distinguish themselves in the market and it informs policymakers who are considering policies to promote high quality, energy-efficient LED products. This competition attracted more than 19 product applications in Australia, Europe, India, and North America. Global Efficiency Medals will be issued in June 2015, covering replacement lamps and luminaires in each of these regions. Building on these positive outcomes, SEAD is consid-

ering another lighting competition in the near future focusing on other common luminaires.

## Introduction

The SEAD Initiative launched its fourth Global Efficiency Medal (GEM) competition on 12 May 2014<sup>1</sup>. As the only global mark of energy efficiency, SEAD's Global Efficiency Medal helps identify the world's most efficient products, with the fourth competition focusing on lighting products. It allows consumers and businesses that care about energy-efficiency to easily identify the super-efficient products on the market. The Medal also spurs competition and innovation among manufacturers, encouraging them to bring more efficient products to market. And by using one set of internationally accepted measurement criteria to evaluate product nominations, the competition also promotes more transparent and harmonised product testing around the world.

In the months preceding the competition's launch, the SEAD Awards Working Group (WG) worked closely with international lighting experts, supporting policymakers, lighting industry representatives, and the IEA 4E Solid State Lighting (SSL) Annex<sup>2</sup> to develop the rules governing the competition. The final competition scope included products from four different lighting categories: (1) general lighting service replacement lamps, (2) directional replacement lamps, (3) planar luminaires, and (4) downlight luminaires. The Working Group identified 20 key competition criteria, discussed below, spanning a range

1. See <http://superefficient.org/> and links therein.

2. <http://ssl.iea-4e.org/>

of energy-efficiency, light quality and product performance aspects, which were used to select the winning products.

In the months following the competition's launch, interested manufacturers nominated the lighting products from their product lines that they considered the most energy-efficient. This competition attracted more than 19 product applications in Australia, Europe, India, and North America. Presumptive winners were selected based on manufacturer claims for product energy efficiency performance that met all the supporting product quality criteria requirements and samples were selected at random to test and verify these claims. Verification testing was completed at a single test laboratory that had taken part in the International Energy Agency's Energy Efficient End-use Equipment implementing agreement (IEA 4E) Solid State Lighting (SSL) Annex's 2013 Interlaboratory Comparison.<sup>3</sup> The global winners will be honoured at a ceremony in June, 2015.

This paper focuses on the design and implementation of the SEAD Global Efficiency Medal competition for lighting products. It provides an overview of the awards programme design and goals, an examination of the way the rule-making process was utilised to achieve those goals, and a description of the product scope and competition criteria.

## Background

The SEAD Initiative of the Clean Energy Ministerial is a voluntary international government collaboration that seeks to engage governments and the private sector to advance global market transformation for energy efficient equipment and appliances. To this end, SEAD is engaged in the following five activities: (1) awards (SEAD Global Efficiency Medal competition), (2) procurement, (3) incentives, (4) standards and labelling, and (5) technical analysis. The first three activities focus on mechanisms to increase demand for energy efficient products, the fourth facilitates exchange of technical information, and the last creates a strong analytical foundation for SEAD activities. Each activity is managed by a working group comprised of government representatives from participating countries. SEAD also pursues opportunities to connect the different activities – for instance, integrating award-winning products into procurement or incentive programs.

The SEAD Global Efficiency Medal competition was developed by the SEAD Awards Working Group, which is comprised of government representatives from Australia, Canada, India, Japan, Sweden, the United Kingdom and the United States, and is administered by CLASP<sup>4</sup>. The country membership of the Awards Working Group is important to note since these countries determine the regions that participate in the competitions. The lighting competition, like the three competitions that preceded it, has covered four regions: Australia, Europe, India, and North America.

The SEAD Global Efficiency Medal competition is a global and regional awards programme that encourages the development, production and sale of super-efficient products. Specifically, this competition aims to accelerate efficiency gains in existing technologies and to promote the introduction of

new technologies into the market by recognising both commercially available and new technologies in different award categories. The SEAD Global Efficiency Medals complement existing national and regional efficiency labelling programmes and the competition process actively engages the manufacturing industry in the design of the award categories and rules. The competition fosters international collaboration amongst government agencies responsible for promoting and regulating product energy efficiency by encouraging the development of transparent international test methods. As SEAD's most publicly visible activity, the awards programme is a cornerstone of SEAD's market transformation strategy.

The first three SEAD Global Efficiency Medal competitions successfully identified the world's most energy efficient flat-panel televisions, computer monitors, and electric motors; recognising super-efficient products in the residential, commercial, and industrial markets. In this fourth competition, the lighting product categories cover both residential and commercial lighting applications.

However impressive the energy performance of the winning products, equally remarkable was the depth and breadth of international cooperation required to meet the practical challenges of running an international market transformation initiative like this competition, outlined in more detail below.

## Competition Objectives

The SEAD Initiative chose to develop a recognition programme for energy efficient products, as awards are an easily understood market transformation mechanism available to energy efficiency policymakers. To guide the design of the competitions, the SEAD Awards Working Group identified and prioritised the following objectives in order to achieve the market transformation goals of SEAD:

1. *Maximise energy savings:* A primary objective of SEAD is to maximise energy savings by increasing the energy efficiency of products in the market. Thus, products with the highest energy savings, efficiency improvement and efficiency promotion potential are selected for the SEAD Global Efficiency Medal competitions. According to the United Nations Environment Programme, grid-based lighting accounts for about 15 % of world electricity consumption and 5 % of worldwide greenhouse gas (GHG) emissions. A switch to efficient on-grid lighting globally would save 1,044 Terawatt-hours per year, equivalent to the annual electrical consumption of India and the United Kingdom. This would save consumers more than US\$120 billion and reduce CO<sub>2</sub> emissions by more than 530 million tons every year.<sup>5</sup>
2. *Increase market share of highly efficient products:* For many products, there is a broad range of efficiencies in the market. The SEAD awards programme aims to move the median of this distribution towards more efficient products already available in the market, and seeks to engage with procurement and incentive programs to increase the purchase of these super-efficient products.

3. <http://ssl.iea-4e.org/task-2-ssl-testing/2013-ic-final-report>

4. <http://www.clasponline.org/en/OurPrograms/CurrentPrograms/SEAD.aspx>

5. See <http://www.enlighten-initiative.org/ResourcesTools/CountryLightingAssessments/Energysavingbenefits.aspx>.

3. *Spur innovation among manufacturers:* The market for efficient products is continuously improving in response to increased consumer awareness and consequent demand. For certain products, manufacturers make running improvements on a product line even as the products are being shipped out. SEAD works to accelerate the manufacturer's innovation cycle to drive more rapid market transformation. This objective will be more effectively achieved when the SEAD Global Efficiency Medal competition is well established and can elevate the recognition for the manufacturers that participate in the competition.
4. *Support test procedure harmonisation activities:* As markets become more global, greater test procedure harmonisation will make it possible for manufacturers to test a product in one region and sell in another region, thus fostering competition and reducing compliance costs for manufacturers.
5. *Build capacity of test laboratories:* Robust laboratory testing ensures that product energy efficiency claims are credible and that there is a level playing field against which manufacturers may test their products. Improving global test laboratory capabilities is aligned with the mission of SEAD, and inter-laboratory comparison testing can be used to bolster test laboratory capacity in the participating award regions. Improved test laboratory capabilities can also support the minimum energy performance standards (MEPS) and labelling efforts in the four target regions.
6. *Provide internationally comparable and transparent test results:* Internationally comparable and transparent test results are critical to support the efforts of global test procedure harmonisation and creating global markets. These results may be provided by the testing conducted in the four regions that are part of this awards competition.
7. *Complement Standards and Labelling policies:* Governments invest in multiple efforts to promote energy efficiency. MEPS set the minimum level of product performance in a given market. Labelling programmes, such as the EU Energy Label and U.S. ENERGY STAR label, enable consumers to differentiate between products according to their energy performance. The SEAD Global Efficiency Medal competition complements both standards and labelling efforts by recognising the most efficient products in these markets, enabling consumers to easily identify the best performing products at the time of purchase.

It is worth noting that the way in which objectives were prioritised played a significant role in determining the design of the competition. As we discovered during the design of this lighting competition, there are other requirements such as product quality and market homogenisation that can add new dimensions to a global energy efficiency competition.

### Competition Design, Requirements, and Regional Considerations

During the design phase of the SEAD Global Efficiency Medal competition for lighting products, priority requirements emerged that guided the scope and design of the rules document. In an effort to accurately reflect the markets in the four

participating regions, the SEAD Awards Working Group invited lighting experts and policymakers from each region as well as from the IEA 4E SSL Annex to provide input toward the competition design. This input was obtained through four 90 minute teleconferences and several months of follow-up emails and technical reviews. Twenty-six experts participated in the competition design phase teleconferences, with representatives from Australia, China, India, Republic of Korea, Sweden, the United Kingdom, and the United States. The priority topic areas that this international group of experts discussed covered the following six critical areas:

1. *Product categories:* Lighting products have a wide range of sizes, shapes, and applications, and thus are difficult to capture in a single competition. The first discussions focused on defining the scope of the competition by identifying the common high-volume products in each of the four regions that would be eligible for the competition. Several residential and commercial lighting products were discussed, with a decision ultimately being taken to include both replacement lamps and dedicated luminaires to have good coverage across these sectors. The experts also discussed industrial and outdoor lighting products (including street lighting), but it was decided that these products would not be included at this time, but may be considered for a future competition.

With input from all of the experts, four product categories (and 10 total product subcategories as shown in Table 1) were identified that represent relatively large market shares of the residential and commercial sector lighting applications in all four regions. For each category, required targets are indicated for lumen output and correlated colour temperature (CCT). This was done to maintain a level playing field, as it is technologically easier to increase efficiency in products with a lower lumen output and a higher CCT. In addition, the voltage at which a product is used can also affect its efficiency. Since three of the four regions use 230 V products, the International Awards are given at that voltage, which automatically eliminates 120 V products from winning an International Award. The four product categories identified were:

- a. *General Lighting Service Lamps* – Omnidirectional, traditional light bulbs used mostly in residential applications but also in commercial applications.
- b. *Directional Lamps* – Reflector lamps emitting light that can be directed in specific areas. These had been traditionally associated with commercial installations but have recently become more popular in residential applications.
- c. *Planar Luminaires* – Recessed, flat-panel ceiling fixtures commonly used in offices for general illumination. Note that this category only includes the entire fixture and did not extend to replacement linear LED tube lamps or retrofit kits.
- d. *Down Light Luminaires* – Recessed directional fixtures that deliver light to a space or highlight a specific object or area. These are primarily found in residential applications but are also used in commercial applications.

2. *New Technology Category*: The question of a new technology category was also discussed by the Experts. In the previous competitions, an “emerging” technology category was always separate from the commercially available product categories. Instead of choosing a technology-focused emerging category, the group decided to create a higher output flux general service lamp category to act as the new technology category. The new technology category did not require a cost ceiling. This is an acknowledgement of the fact that there are not many products in the market today with high flux, but as LED efficacy improves, investment in new designs and LED technology will accelerate the commercial availability of these lamps.
3. *Product assessment criteria*: The longest and most detailed discussions on the expert teleconference calls focused on the competition criteria to select the winners. The SEAD Global Efficiency Medal competitions are first and foremost energy efficiency competitions, so the most important factor had to be luminous efficacy<sup>6</sup>, measured in lm/W. Efficacy was the principal criterion that ultimately decided the winning products in each region and category. However, the group decided that there also had to be a number of other minimum quality criteria to ensure consumer satisfaction.

LEDs are the most efficient lighting products in the market and they were expected to be the primary technology winning Global Efficiency Medals. LED technology is still relatively new and does not yet have an established market like compact fluorescent lighting (CFL) or incandescent technologies; therefore, the experts wanted to ensure that the winning products met a number of key quality and performance criteria. These criteria were noted as being particularly important as some experts highlighted problems when poor quality CFLs were marketed in the early days of CFL technology adoption. The 19 technical criteria were divided into four areas:

- a. *Efficacy and Light Output.*
- b. *Colour and Light Quality.*
- c. *Lifetime.*
- d. *Health and Environment.*

Due to time limitations for lifetime testing, SEAD did not perform lifetime measurements on the winning products but required documentation to be provided from an accredited third-party test facility showing the criteria had been met. In addition to lifetime measurements, applicants were also required to submit health and environmental compliance documentation.

4. *Test procedure and comparison testing*: The ability to differentiate between the energy efficiency of the products was important for a clear outcome of the competition so a well-established and globally accepted test method was critical for the credibility of the competition and to encourage strong participation. For lighting products, the IES test method LM-79-08 is internationally accepted and used

among all of the major testing labs. This test method was used to determine the luminous efficacy in addition to a majority of the other quality criteria. Lifetime measurements according to the IES LM-80-08 test method and TM-21-11 extrapolation method were completed by the nominating manufacturer and documentation was required to be submitted during the nomination process showing the lifetime criteria were met. It should be noted that LM-80 and TM-21 only test the lifetime of the LED light source. The committee considered using the test methods LM-84 and TM-28, which test the lifetime of the whole lighting product (including the engine), but these were not released in time for the competition.

5. *Regional product considerations*: With such a diverse set of countries and global regions involved in the competition design process, many regional differences in lighting markets were found. For example, correlated colour temperature (CCT) preferences can vary from region to region. In North America and Europe, consumers tend to prefer a warm-white light around 2800 K, whereas in warmer Asian countries like India, consumers prefer cooler white light, with a CCT greater than 4000 K. To account for these different colour temperature preferences, sub-categories had to be created within the general service lamp category to prevent comparisons across CCT which may not be a fair comparison due to efficiency advantages at higher CCTs. This regional issue resulted in the establishment of two global general service lighting awards – one for warm-white light and one for cool-white light. Due to the international nature of this competition, it was desirable to keep as many regions as possible in every category, and allow the market to dictate when a subdivision of categories is necessary.

The experts also discussed extensively the issue of product performance in tropical environments, such as India and Australia. The discussion centred on the application of the *lites.asia*<sup>7</sup> criteria for LED lamps, which were developed for the tropical operating environment. These difficult operating conditions may be applicable in certain regional markets participating in the competition, but not all (e.g., not Europe). Thus, if these criteria were required for all regions, consumers in Europe would be purchasing more expensive and potentially bulkier and less efficient lamps, simply because these tropical criteria were applied across the whole programme.

The question was therefore asked whether it would be possible to have regional criteria – and if so, how would the programme determine global competition winners if certain regions were held to a higher quality specification? Prior to the lighting competition, the SEAD Awards had covered products (i.e., televisions, computer monitors, electric motors) that are fairly homogenous across the global market, making it relatively easy to have interregional comparisons and issue a global award. The SEAD Awards Working Group was open to considering regionally specific criteria, because the principle of the competition is to highlight the most efficient products available in specific markets – indeed, this

6. Efficacy (of a light source) – The quotient of the total luminous flux emitted by the total lamp power input. It is expressed in lumens per watt (lm/W).

7. <http://www.lites.asia/>

Table 1. Forty-two Global Efficiency Medals offered across the regions and globally to manufacturers.

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	•	•	•

is the main reason why the competition has regional awards. However, the SEAD Awards Working Group ultimately decided to forego the tropical specifications to help simplify the global comparison and testing protocol.

6. *Shipment/cost thresholds and sampling:* In previous competitions, a minimum shipment threshold was necessary for all the products in commercially available categories. This minimum shipment threshold was the planned annual shipping figures for the product that was nominated in a particular category and region. For this lighting competition, shipment thresholds were determined to be potentially limiting since there are many start-up lighting companies that could have a difficult time shipping large quantities of product to the four regions. Unlike the television market where the top five television manufacturers control more than 60 % of the global market, the SSL industry is still relatively young, so there exists an opportunity for a small company with a highly efficient product to have a large impact.

Therefore, the SEAD Awards Working Group decided to use a maximum price threshold instead of a shipment threshold to make sure the winning products are cost-effective and could make an impact in the market. The price thresholds were determined by evaluating manufacturer's suggested retail prices (MSRPs) of representative products for each category in each region.

Sample size for verification testing of the lighting products was another interesting topic that involved detailed discussions with the Experts and SEAD Awards Working Group. The typical sample size for compliance testing of a lamp in regulatory programmes is 20 units, but testing that many lamps for the number of categories and regions involved in the SEAD competition would be too expensive and time consuming. In the end, a compromise was reached that would limit verification testing costs while still ensuring the integrity of the competition. The Experts and SEAD Awards Working Group agreed on a sample size of three units for the lamps categories and two units for the luminaires categories for each applicant.

7. The discussion of how to procure test samples was also very important, to protect against the problem of a golden sample being provided by the nominating manufacturers. In past competitions, manufacturers were required to pro-

vide a number of retail locations or warehouse stock from which SEAD could procure random samples. Most often, applicants provided serial numbers from multiple batches in warehouse stock, and SEAD randomly selected several of these for testing. The SEAD governments from the different regions would cover the laboratory testing costs, which was contracted in advance. The applicants would be required to pay for the shipping costs associated with the products selected for testing. This method was not feasible for the lighting competition because lighting products are not marked with serial numbers, and since the lighting product samples were much cheaper than products from the previous competitions, it was agreed that CLASP as the SEAD Awards administrator would purchase samples directly from randomly selected retailers.

## Conclusions

The SEAD Global Efficiency Medal for lighting products depended on a remarkable depth and breadth of international cooperation to meet the practical challenges of running this international market transformation initiative. Keeping in mind the SEAD Awards Working Group objectives for the competition, twenty-six technical experts from seven countries spent six hours discussing how to make this competition most successful and technically sound.

The technical consultation committee provided input regarding a number of technical and programmatic details. They discussed the competition categories that would include high-volume products with market impact, and new technology categories that would consider newer, cutting-edge technologies. They reviewed many potential product assessment criteria, with SEAD ultimately narrowing the list to 19 critical technical criteria in four areas: efficacy and light output; colour and light quality; lifetime; and health and environment. Experts discussed existing and developing test procedures to use for comparison testing, as well as regional product considerations such as CCT preferences and tropical criteria. Insight was provided for sampling techniques for lighting products, and how to approach a shipment or cost threshold.

The results of the competition will be announced in June 2015 and will be listed online at: <http://superefficient.org/lightingawards>.

