

# **Ecos<sup>1</sup> Response to Comments Regarding the eceee Report “Evaluating the potential of halogen technologies”**

**Note:** The original report commissioned by eceee is available at [http://www.eceee.org/Eco\\_design/products/](http://www.eceee.org/Eco_design/products/)

**May 10, 2011**

We would like to thank the European Lamp Companies Federation (ELC) and others for providing feedback on the recently published eceee report “Evaluating the Potential of Halogen Technologies.” Some of the comments noted typographical, formatting, or units problems, or furnished new data which helped to improve the clarity of our findings. We are grateful for the additional information and it is reflected in our revised draft. Other comments either call for additional research beyond the scope, budget and timeframe of our original work, or reflect differences of technical opinion regarding the potential for incandescent lamp technologies to deliver additional energy savings cost effectively. We provide additional detail about each of these issues below:

## **Scope of tested lamps & methodology:**

Many of the comments from the ELC and other stakeholders raised concerns about the limited number and types of lamps tested to obtain (230V and 12V) performance data from currently available lamps in the EU. While it is true that our testing focused on a subset of lamps that will be covered under the scope of the regulations, we intentionally selected lamp types and models likely to represent the largest sales volumes and most popular applications. Likewise, technical constraints regarding the capabilities of our laboratory grade integrating sphere prevented us from testing large luminaires, for example, even though they are within the scope of the EU’s proposed regulations.

Many of the comments centered on the limitations of using an integrating sphere for measuring the light output of directional sources. While it is true that goniophotometers yield a more complete sense of these products’ performance, and how their light output is distributed spatially, such equipment is costly and beyond the physical capabilities of our laboratory space as well as the budget and timeframe of our research. Those manufacturers and research laboratories with access to goniophotometers could do much to inform this debate by placing their measured data in the public domain for consideration by all parties to the EU policy decision. The EU’s own consultants were even more constrained in their ability to conduct product

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<sup>1</sup> Not to be confused with the European NGO Ecos.

testing, so relied on public domain data in formulating their initial proposals. Our attempt in conducting additional measurements was to supplement their findings with a more detailed look at the most energy efficient incandescent technologies available in the global marketplace.

Other researchers in Australia have considered the question of how to correlate total light output of directional sources to the fraction of light output occurring within a particular solid angle. This research was conducted prior to ours, yielded reasonable approximations and correlations for key directional lamp types, and was cited in our report. We also measured reflector losses in a small number of sample products in our lab to further refine our methods for converting total lumens into “functional lumens” within a particular solid angle. The reason why we chose to include VITO-reported data in the report was to demonstrate that although simplified, our normalization method resulted in lamp performance assumptions that closely match data which has been previously reported. The continuity of our results to the data previously reported indicates that we were successful in this regard. Ultimately, our approach was to publish our raw data and the correction factors employed to make it as transparent as possible for readers to understand what was measured, what was estimated, and the limits associated with converting one to the other. We are willing to revise our data and associated MEPS recommendations if goniophotometric data provided by others can improve the precision and usefulness of our results.

We recognize that the reflector loss factor that we employed (16% light loss) was based on a relatively small data set of lamps previously tested in our lab, and that an average value from a variety of lamp shapes may not have been reasonable. However, testing and determining the light loss due to a reflector body for all directional lamp types bound to be covered by these regulations was beyond the scope of our research project. We would welcome reflector loss data from the ELC for all applicable lamp types that will be covered in the regulation, which we could then use to further refine the presented data and subsequent recommendations. However, we predict that updated reflector loss values would only change our assumptions to a small extent.

The European Commission and other governments have considered many different performance metrics for reflector lamps: beam angle, center beam candlepower, total lumens, functional lumens, light output within a 90 degree cone, spill factor, etc. The choices made in that regard are arguably far less important than the choice of which plateau of incandescent technology the final MEPS should require. *We believe that the technology behind infrared-reflective halogen lighting is sufficiently mature, well-understood, broadly commercialized, and cost effective to form the basis for mandatory efficiency requirements, regardless of what fraction of that light output is ultimately compared amongst different reflector lamps.* Similarly, the opportunities to make further improvements in the reflectivity of reflectors and the preferential

emission of visible light from filaments are compelling enough to be encouraged through government policy.

### **Incremental Cost of IRC:**

The ELC states that the incremental cost of IRC products would cause halogen products to be priced so high as to become “niche” segments of the market. Furthermore, ELC states that “the retail price will increase at least 3X compared to standard non-IRC products” and “Halogen technologies based on IRC and integrated transformers will lead to serious increase in retail price (at least 3X more expensive)”. Based on our analysis of halogen and IRC products currently available in the United States, conventional halogen lamps are currently being sold at \$2.50 (USD) per lamp compared to \$0.25 (USD) for a traditional incandescent, which represents a 10X incremental cost; however, when comparing halogen to IRC halogen products that are currently available in the US, IRC is only twice the price of halogen at this point, and expected to drop further as mandatory federal standards come into effect over the course of the next few years. Given the absolute dominance of inexpensive conventional incandescents in the marketplace in the past, sales volumes of IRC halogen have always been modest. When sales volumes increase significantly and high speed production lines for lamp coating are incorporated into them, it is evident that incremental costs will be significantly lower still. Ecos found in its previous research for eceee an incremental cost of €0.20 per lamp for IRC coating in large production volumes.<sup>2</sup> Past pricing for low quantities is a poor predictor of future pricing for large quantities.

It is equally challenging to forecast the future incremental cost of lamps with integral ac-dc power supplies based on the incremental cost seen to date for very small numbers of these products sold into niche applications. As Ecos demonstrated in its previous report for eceee, the bill of materials cost for such power supplies was about €0.69 per lamp. If anything, the last two decades of refinement in CFL size, technology, and price indicate what is possible with regard to the miniaturization and improvement in lighting power conversion technology over time.

### **Tier 2 MEPS for Mains Voltage too stringent:**

The ELC presented evidence that our proposed MEPS T2 specification for mains voltage lamps is set too far above the current performance of these lamp types and beyond what is currently technologically possible. We did make note in the report that these efficacy levels are beyond the reach of current commercially available incandescent products. However, we also presented incandescent design strategies (like a power

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<sup>2</sup> See Ecos Consulting, “B Class Halogens and Beyond: Design Approaches to Complying with Proposed EU Eco-Design Domestic Lighting Requirements: A Technological and Economic Analysis,” prepared for eceee, December 12, 2008, pp. 18-20.

supply combined with an IRC capsule) that could meet our proposed efficacy levels. For many larger diameter lamp types such as PAR and BR, there is sufficient room in the lamp body for incorporation of an integral power supply, which would allow the use of a much more efficient IRC halogen capsule. Manufacturers have been able to produce CFL variants of the lamp types (even small diameter GU10 lamps) that will be covered under this regulation, which all require the use of internal power conversion circuitry (in the form of an electronic ballast). The point of dividing the MEPS into phases or tiers is to move in the near term toward better conventional technology, and in the longer term toward much better technology, whether that be a step-down transformer + IRC, or ESL, or CMH, or CFL, or LED. The lighting industry has never had more technological options for providing directional light in an energy efficient manner, yet its members seem to have internalized a diminished sense of what they can achieve if the government forecloses more conventional, less efficient options.

#### **Patent Review:**

The ELC has requested that an un-biased patent review on the topic be performed by an independent IP law firm, which we would fully welcome. We attempted to be as transparent as possible in indicating that we had major assistance from ADLT/Auer in this regard, and that other parties may be aware of or able to locate additional patents that we have not yet found. We have not characterized the patents listed as the only relevant ones for this discussion, but rather the list of patents we have been able to locate. Furthermore, the section of this report contains a very explicit disclaimer that our patent review results were preliminary and that a full investigation from an independent IP would be required to fully address the issue. We would encourage the ELC (or any other EU entity) to provide additional patent information or fund additional research in this regard to make sure all the relevant intellectual property information is available for consideration. A number of pending patents to which we did not have previous access have already been brought to our attention by ELC, and we have added them to our patents discussion.

#### **IRC Lamp Life:**

A few of the comments received mention that we did not adequately highlight the “paradox” between IRC lamp efficacy and lamp lifetime. It is true that incandescent lamp manufacturers routinely make design decisions that optimize for one of those factors or the other, or that achieve an acceptable mix of both. We note that some of the most advanced halogen reflector lamps sold in the United States achieve lifetimes 60 to 100% longer than typical halogens while also significantly improving efficiencies. See, for example, GE’s HIR Plus PAR38 halogen reflector and Philips’ Energy Advantage IR MR-16s, both of which offer lifetimes in excess of 4,000 hours.

Indeed, incandescent lamps optimized for extremely long lifetimes typically exhibit higher total cost of ownership than more efficient incandescents with somewhat shorter lifetimes, because energy costs represent a bigger share of the total cost of ownership than lamp purchase costs. At the other extreme, or course, it is possible to achieve very high efficiencies in incandescents that last for only a few hundred hours, because their filaments run at hotter temperatures, evaporating tungsten rapidly and then failing prematurely.

To avoid such data skewing our results, we have only reported achievable efficacy values in lamps capable of lifetimes of at least 1,000 hours. This distinction was already noted in the report and has now been further clarified. When the most efficient incandescent sources tested in our laboratory have achieved greater than 45 lumens per watt, that leaves considerable room for improving halogen lamp efficacy to meet our proposed MEPs levels of 15-25 lm/W without unduly sacrificing lamp lifetimes.

#### **Ecos Reliance on Input from ADLT/DSI/Auer:**

Most full-line incandescent lighting manufacturers have opposed mandatory requirements for incandescent lamp efficiency, or sought to weaken their efficacy requirements, or delay their effectiveness dates, or narrow the scope of covered products. Such standards, though they create market opportunities with new product lines, foreclose the opportunity to continue selling very low cost products made on assembly lines that are already fully amortized. As a result, our inquiries to those manufacturers about the technical and economic potential for further improvements in incandescent lamp technology have historically yielded a litany of reasons why governments should not push further with the stringency or scope of proposed efficiency requirements.

By contrast, representatives of ADLT, DSI and Auer have been far more forthcoming in response to our research requests regarding the technical potential to improve incandescent lamps, because such standards represent no downside risk to their current lighting business. Those companies have conducted much of the path-breaking research that has brought IRC halogen lamps to the marketplace, and they continue to pioneer new coating and sputtering techniques, high speed manufacturing technologies, and partnerships with other vendors to bring innovative technologies to market.

General Electric conducted and published extensive technical research on incandescent efficiency technologies between the 1960s and early 1990s,<sup>3</sup> and made claims as recently as 2007 that their newly patented selective emitter filament technology could

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<sup>3</sup> See, for example, Dr. Milan R. Vukceвич, *The Science of Incandescence*, General Electric Lighting NELA Press, 1992.

achieve 30 lumens per watt in commercial products by 2010.<sup>4</sup> By 2008, General Electric backtracked from that claim, stating:

GE Consumers & Industrial and GE Global Research have suspended the development of the high-efficiency incandescent lamp (HEI) to place greater focus and investment on what we believe will be the ultimate in energy efficient lighting — light-emitting diodes (LEDs) and organic light-emitting diodes (OLEDs). Research and development of these technologies is moving at an impressive pace and will be ready for general lighting in the near future. LEDs and OLEDs used in general lighting are now poised to surpass the projected efficiency levels of HEI, along with other energy-efficient technologies like fluorescent, and have the additional benefits of long life and durability.<sup>5</sup>

More recently, GE and the other full line manufacturers have largely shifted the focus of their research and development efforts toward solid state lighting sources instead. Their publications and advocacy efforts now largely focus on what incandescent technology is *not* capable of achieving. Given those divergent developments, it should not be surprising that ADLT, DSI, and Auer sources provided much of the industry input to our research on the potential for more efficient incandescent technologies – they are the acknowledged industry experts with regard to this topic.

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<sup>4</sup> See

[http://www.businesswire.com/portal/site/ge/?ndmViewId=news\\_view&newsId=20070223005120&newsLang=en](http://www.businesswire.com/portal/site/ge/?ndmViewId=news_view&newsId=20070223005120&newsLang=en)

<sup>5</sup> See quotation from GE spokesman David Schuellerman at <http://www.cleanbreak.ca/2008/11/26/ge-suspends-development-of-high-efficiency-incandescent/>.