

Environmental NGOs Response to Stakeholder consultation 2015 #2 on mercury-containing lamps – Exemption 1-4 (Review of Annex to the RoHS directive)

16 October 2015

1. Introduction

The European Environmental Bureau, the Mercury Policy Project, and the Responsible Purchasing Network¹ appreciate the opportunity to comment on proposed Exemptions 1-4 under the 2015-2 Consultation. We are very much concerned about Lighting Europe's request to renew for the maximum validity period RoHS Directive 2011/65/EU exemptions for continued use of mercury in several types of fluorescent and high-intensity lamps and with the present maximum mercury limits. As explained in detail in our comments below, equivalent products with no or less mercury are widely available. More importantly, equivalent lighting emitting diode (LED) *mercury-free* products are not only widely available but are also more energy-efficient and have a longer rated life than Compact Fluorescent Lamps (CFLs). In addition, they are rapidly becoming more cost competitive, especially when their long life and ability to cut energy, replacement, and waste disposal costs are considered.

We do not favour the length of many of the requested mercury exemptions largely on the statement that equivalent LED lamps are not a practical replacement today for every application. Instead, we are requesting definite, near-term expiry dates *in certain categories of lamps* on the basis that LEDs are environmentally preferable and practical for *most* applications. Our case is bolstered by credible sources – including the European Commission and its consultants – that are predicting the availability, performance and price of LED lamps to continue to quickly improve. In some other lamp categories, we are proposing lower mercury limits, which we

¹ NGOs include the **European Environmental Bureau, (EEB)**, www.eeb.org, is a federation of more than 140 environmental citizens' organisations based in all EU Member States and most Accession Countries, as well as in a few neighbouring countries. These organisations range from local and national, to European and international. The aim of the EEB is to protect and improve the environment of Europe and to enable the citizens of Europe to play their part in achieving that goal.

The **Mercury Policy Project (MPP)**, a project of the Tides Center, www.mercurypolicy.org, works to promote policies to eliminate mercury uses, reduce the export and trafficking of mercury, and significantly reduce mercury exposures at the local, national, and international levels. We strive to work harmoniously with other groups and individuals who have similar goals and interests.

The **Responsible Purchasing Network**, www.responsiblepurchasing.org, is a non-profit organization based in the United States that helps government agencies, institutions and businesses to specify, evaluate and purchase environmentally preferable goods and services.

believe can be achieved when the current expiry date goes into effect – or shortly thereafter (within the next 2 years) – since our research has determined that many lamps in those categories are already meeting the mercury limits that we are proposing based on more accurate dosing methods that are now being widely used.²

Due to limited resources, we are addressing some – but not all – of the proposed RoHS exemptions. Our comments and recommendations are focused on the proposed exemptions relating to the allowance of mercury in single-capped (compact) fluorescent lamps (particularly in low-wattage models of <30 watts), linear and non-linear fluorescent tubes, and mercury-containing high-intensity discharge (HID) lamps, including high-pressure sodium (HPS) and Metal Halide lamps (MH).

Although limited resources and time does not permit us to provide comments for the remaining categories, we would urge the consultant and the Commission to investigate and consider LED applications for these remaining categories, as well as the possibility to manufacture such lamps with the least amount of mercury as is necessary to ensure reliable lamp performance, and not to rely only on reactions during the consultation.

Below is an overview of our comments:

- **Section I** focuses on the **environmental and economic benefits of light-emitting diode (LED) lamps** generally. This section applies primarily to Exemption 1(a) but also has broader applicability to other exemptions since LED lamps are now considered to be a practical replacement for CFLs as well as many types of linear fluorescent and HID lamps.
- **Section II** addresses the **Requests to Renew Exemptions 1(a,b and e)**, which apply to “Mercury in single capped (compact) fluorescent lamps not exceeding (per burner)”
 - (a) *For general lighting purposes < 30 W*
 - (b) *For general lighting purposes ≥ 30 W and < 50 W*
 - (e) *For general lighting purposes with circular or square structural shape and tube diameter ≤ 17 mm*
- **Section III** addresses the **Requests to Renew Exemptions 2**, including:
 - **Exemption 2(a)(2,3 and 5)**, which apply to “Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp):
 - (2) *Tri-band phosphor with normal lifetime and a tube diameter ≥ 9 mm and ≤ 17 mm (e.g. T5)*

² Corazza, A., Boffito, C., *Mercury dosing solutions used in Fluorescent Lamps*, [Journal of Physics D Applied Physics](https://doi.org/10.1088/0022-3727/41/14/144007) (Impact Factor: 2.72). 07/2008; 41(14):144007. DOI: 10.1088/0022-3727/41/14/144007
http://www.researchgate.net/publication/230988669_Mercury_dosing_solutions_for_fluorescent_lamps

(3) Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm (e.g. T8)

(5) Tri-band phosphor with long lifetime ($\geq 25\,000$ h)

- [Exemption 2\(b\)\(3\)](#), which applies to "Mercury in other fluorescent lamps not exceeding (per lamp)
(3) Non-linear tri-band phosphor lamps with tube diameter > 15 mm (e.g. T9)"
- Section IV addresses the **Request to Renew Exemptions 4(b, c and 3)**, concerning High Pressure Sodium (Vapour) Lamps and Metal Halide Lamps
 - [Exemption 4\(b\)\(I-III\)](#) "Mercury in High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner) in lamps with improved colour rendering index $R_a > 60$:
I) $P \leq 155$ W: 30 mg per burner
II) $155\text{ W} < P \leq 405$ W: 40 mg per burner
III) $P > 405$ W: 40 mg per burner"
 - [Exemption 4\(c\)\(I-III\)](#) "Mercury in other High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner):
I) $P \leq 155$ W: 25 mg per burner
II) $155\text{ W} < P \leq 405$ W: 30 mg per burner
III) $P > 405$ W: 40 mg per burner"
 - [Metal Halide lamps \(MH\)](#)

2. Summary of recommendations

Exemption as per Directive 2011/65		Directive's [maximum value][mg] currently	Proposal EEB/RPN/M PP maximum value][mg] and other	Remarks
1. Mercury in single capped fluorescent lamps not exceeding (per burner):				
1 (a)	For general lighting purposes < 30W	2.5	0	To expire by 1 st September 2018
1 (b)	For general lighting purposes ≥ 30W and < 50W	3.5	2.5	3.5 mg limit to expire by 1 st September 2018, 2.5 mg limit to expire by 2020
Proposal for new category	For general lighting purposes ≥ 30W and < 50W, for long life (>30.000 h)		3	Consider creating this new category to cover for these exceptional lamps.
1 (d)	For general lighting purposes with circular or square structural shape and tube diameter ≤ 17 mm	7	4	4 mg to apply by after 1 st September 2018
2 (a) Mercury in double-capped linear fluorescent lamps for general purposes not exceeding:				
2 (a) (2)	Tri-band phosphor with normal lifetime > 9mm and ≤ 17 mm (e.g. T5)	3	3	Remove the words 'normal lifetime' since T5s, no matter their lifetime, meet already these limits. Also, monitor improvements in performance and life-cycle price of LED T5 tubes to consider future expiry date as practical, for some or all fluorescent T5 lamps.
2 (a) (3)	Tri-band phosphor with normal lifetime > 17 mm and ≤ 28 mm (e.g. T8)	3.5	3.5	Remove the words 'normal lifetime' since T8s no matter their lifetime meet already these limits Also, monitor improvements in performance and life-cycle price of LED T8 tubes to consider future expiry date by 2020 for some or all fluorescent T8 lamps.
2(a)(4)	<i>Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12): 5 mg</i>	3.5	3.5	Monitor improvements in performance and life-cycle price of LED tubes to consider future expiry date by 2020, for all or some T12s.
2 (a) (5)	Tri-band phosphor with long lifetime (≥ 25 000 h)	8		This exemption should be eliminated and the exemptions above for T5s and T8s should remove the reference to normal life since all models can now meet the existing mercury limits. In the case

				where long life T2 and T12 are really affected, the exemption should be rephrased accordingly to cover only those; the T5 and T8s should all meet 3 and 3.5 mg respectively no matter the lifetime.
2 (b) Mercury in other fluorescent lamps not exceeding:				
2 (b) (3)	Non-linear tri-band phosphor lamps > 17 mm (e.g. T9)	15	8	The example of T9 may not be correct. T9s are halophosphates.. Even ELC at the 2009 submission was talking about halophosphate lamps in relation to the T9s. Therefore the example there should rather be T8 and the limit should be reduced since U-shaped T8s can meet this lower limit.
4 Mercury in High Intensity Discharge lamps for general lighting purposes				
4 (b)	Mercury in High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner) in lamps with improved colour rendering index Ra > 60:			LEDs are increasingly being made to replace HPS lamps and are expected to increase for this application. We recommend the Commission to monitor improvements in the availability, performance and price of LED replacements, to consider an expiry date as practical.
4(c)	Mercury in other High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner):	I) P ≤ 155 W: 25 mg per burner	I) P ≤ 155 W: 20 mg per burner	There are HPS lamps that can meet these lower mercury limits from multiple manufacturers.
		II) 155 W < P ≤ 405 W: 30 mg per burner	II) 155 W < P ≤ 405 W: 20 mg per burner	LEDs are increasingly being made to replace HPS lamps and are expected to increase for this application. We recommend the Commission to monitor improvements in the availability, performance and price of LED replacements, to consider an expiry date as practical.
		III) P > 405 W: 40 mg per burner"	III) P > 405 W: 25 mg per burner"	
4(e)	Mercury in Metal Halide Lamps (MH)		Change to Ceramic metal halides <250 watts and all metal halide lamps over 250 watts	Allow this exemption for ceramic metal halide lamps after 1 September 2018. Ceramic metal halide lamps have less mercury and a higher efficiency and longer rated life than quartz metal halide lamps. Ceramic metal halides are widely available up to 250 watts. Monitor improved availability, performance and price of LED retrofit lamps for metal halide lamps and consider an expiry date for some types of MH lamps as they become practical.

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4. Analysis and Recommendations

4.1 Section I: The Environmental and Economic Benefits of LED Lamps Compared to CFLs.

The energy-efficiency, performance, design, and affordability of LED lamps have all dramatically and consistently improved over the past few years since the previous RoHS mercury-content limits were established and promise to keep improving in each of these areas. Today, even without further improvements, LED lamps have many advantages over CFLs:

- i. They use less energy to emit the equivalent light output;
- ii. They are more easily dimmable than CFLs, which facilitates even further energy savings;
- iii. They are considered environmentally preferable to CFLs from a life-cycle cost perspective; and
- iv. They are mercury-free.

These four points are analysed further below.

Several credible sources have found LED lighting equipment to be a practical and environmentally preferable alternative to conventional lamps and fixtures. For example, a 2014 European Commission JRC Science and Policy report³ stated the following:

In just the last few years, LED performance has accelerated quickly and a wave of new commercial, industrial and institutional LED fixtures has been introduced. LED technology is fulfilling its promise of offering the market the most efficient means of converting electrons into photons. LEDs have thus surpassed many conventional lighting technologies in terms of energy efficiency, lifetime, versatility, and colour quality, and due to their increasing cost competitiveness are beginning to successfully compete in a variety of lighting applications. Therefore, LED lighting is no longer “around the corner”; it is here and has a solid market foothold. Performance is improving and costs are coming down.

A 2013 report by LightingEurope to the Eco-Lighting Project projected a rapid increase in utilization of LED lamps in both the residential and commercial sectors, stating:

Forecasts for LED uptake in the residential segment remain high, at almost 50 percent in 2016 and over 70 percent in 2020. Architectural lighting remains the early adopter, and its LED market share is expected to reach close to 90 percent by 2020.⁴

³European Commission Joint Research Centre, JRC Science and Policy Reports: 2014 Update on the State of LED Market, 2014,

http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/regno_jrc92971_jrc92971_online.pdf.pdf

⁴LightingEurope, Request to Renew Exemption 1(a) under the RoHS Directive 2011/65/EU: Mercury in Single-Capped (Compact) Fluorescent Lamps Below 30W, January 15, 2015.

4.1.1 Advantages of LEDs

Provided below is the substantiation of the important benefits of LEDs over mercury-containing CFLs.

i. LED light bulbs use less energy than CFLs to create the same amount of light.

According to a December 2013 report by iNSPiRe, “In 2013 CFL bulbs reach up to 66 lm/W while LED bulbs provide in maximum 80 lm/W.”⁵ The iNSPiRe report further noted: “Looking at the efficiency development of different light source in Figure 11, LEDs show the highest potential, while all other incumbent lamps’ efficiency is not expected to undergo major improvements as this technology is already mature...”⁶

Similarly, a 2012 US Department of Energy lifecycle assessment (LCA) comparing LEDs to CFLs and incandescent lamps indicated that CFLs have an average efficacy of 55 lumens/watt, while LEDs have an average efficacy of 65 lumens/watt. Moreover, it predicted that the efficacy of LED would increase to 134 lumens/watt by 2017.⁷

When LEDs are used instead of CFLs, power plant-related mercury (and other air pollutant) emissions are typically reduced because LEDs are far more energy efficient. This benefit is expected to be even greater in the future as LED energy efficiency continues to improve.

ii. LED lamps are more often compatible with dimmers than CFLs.



LightingEurope states in its request for many of its RoHS Mercury Exemptions that some LEDs are incompatible with dimmers and, therefore, cannot be used for many general-purpose lighting applications. Ironically, LEDs are *more easily dimmable* than CFLs, which makes them a more practical alternative to replace halogen lamps. A 2014 iNSPiRe report rated LEDs’ dimming control as “excellent” compared to CFLs’ dimming control, which it noted only works “with special lamps”.⁸ Some

LED light bulbs, such as Osram’s *Lightify* models, can even be dimmed remotely with “smart technology” such as Android and I-phone devices.⁹ Because they are more easily dimmable, LED lamps can achieve even higher energy efficiency and further reduce mercury emissions.

⁵ iNSPiRe, *D 4.1 Report on Artificial Lighting Solutions*, December 2013, page 6, http://www.inspirefp7.eu/wp-content/uploads/2014/05/WP4_D4-1_20140327_P11_Report_on_artificial_lighting_website_adaptation21.pdf

⁶ iNSPiRe, *D 4.1 Report on Artificial Lighting Solutions*, December 2013, page 7, http://www.inspirefp7.eu/wp-content/uploads/2014/05/WP4_D4-1_20140327_P11_Report_on_artificial_lighting_website_adaptation21.pdf

⁷ US Department of Energy, Building Technologies Office, *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products: Part 2: LED Manufacturing and Performance*, June 2012, http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_led_lca-pt2.pdf

⁸ iNSPiRe, *D 4.1 Report on Artificial Lighting Solutions*, December 2013, http://www.inspirefp7.eu/wp-content/uploads/2014/05/WP4_D4-1_20140327_P11_Report_on_artificial_lighting_website_adaptation21.pdf

⁹ Osram Lighting Company, *Data Sheet for Lightify Classic A RGBW*, Accessed online on 11 October 2015, http://www.osram.com/osram_com/products/led-technology/lightify/lightify-home/lightify-lamps/lightify-classic-a-rgbw/index.jsp

- iii. **LEDs have been determined to be environmentally preferable from a life-cycle perspective and are expected to far surpass CFLs in the near future.** A comprehensive lifecycle assessment (LCA) published by the US Department of Energy in 2012, which was cited by LightingEurope in its request to renew several RoHS exemptions for CFLs, concluded:

The LED lamp had a significantly lower environmental impact than the incandescent, and a slight edge over the CFL. The CFL was found to be slightly more harmful than today's LED lamp on all [15] impact measures except hazardous waste landfill, because of the LED lamp's large aluminum heat sink. As the efficacy of LED lamps continues to increase, aluminum heat sinks are expected to shrink in size—and recycling efforts could reduce their impact even further.

The US Department of Energy LCA further noted that:

The light source that performed the best was the LED lamp projected for 2017, whose impacts are expected to be about 50 percent lower than the 2012 LED lamp and 70 percent lower than the CFL.¹⁰

LightingEurope also focused on one aspect of LCA's energy consumption analysis in which CFLs outperformed LEDs. Then, based on this one criterion, it concluded that there is a lack of consensus about the overall benefits of LEDs compared to CFLs, stating:

Another [LCA] concludes that LED lamp product manufacturing uses approximately three times more energy than the manufacturing of a CFL with comparable light output. Thus, it needs to be acknowledged that at present no widely accepted consensus exists among experts.¹¹

We do not concur with this conclusion of LightingEurope for several reasons.

- First, many credible sources have reported that the production phase of the LED lamp represents only a small percentage of the overall energy use of the product over its life. An LCA conducted by Osram, for example, concluded that only 2% of the total energy consumed by LED-based lamps is used in their production.¹² The US DOE, which is based on a review of 10 major LCAs comparing LEDs, CFLs and incandescent lamps, concluded that the *overall* lifecycle energy consumption of LEDs and CFLs is comparable

¹⁰ US Department of Energy, Building Technologies Office, *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products*, Summary, page 3, April 2013, http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/lca_factsheet_apr2013.pdf

¹¹ US Department of Energy, Building Technologies Office, *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products: Part 2: LED Manufacturing and Performance*, June 2012, http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_led_lca-pt2.pdf

¹² "Osram Unveils Life-Cycle Assessment of LED Lamps," *LEDsMagazine*, August 2009, <http://www.ledsmagazine.com/articles/2009/08/osram-unveils-life-cycle-assessment-of-led-lamps.html>

despite the higher energy consumption associated with LEDs during production.

The key results of this analysis indicate that the average life-cycle energy consumption of LED lamps and CFLs are similar, at approximately 3,900 MJ per functional unit (20 million lumen hours)...

It was also found that the “use” phase of incandescent, compact fluorescent, and LED lamps represents the most energy intensive life-cycle phase, accounting for 90 percent of total life-cycle energy on average. This is followed by the manufacturing and transport phases, respectively with transport representing less than one percent of life-cycle energy use for all lamp types.¹³

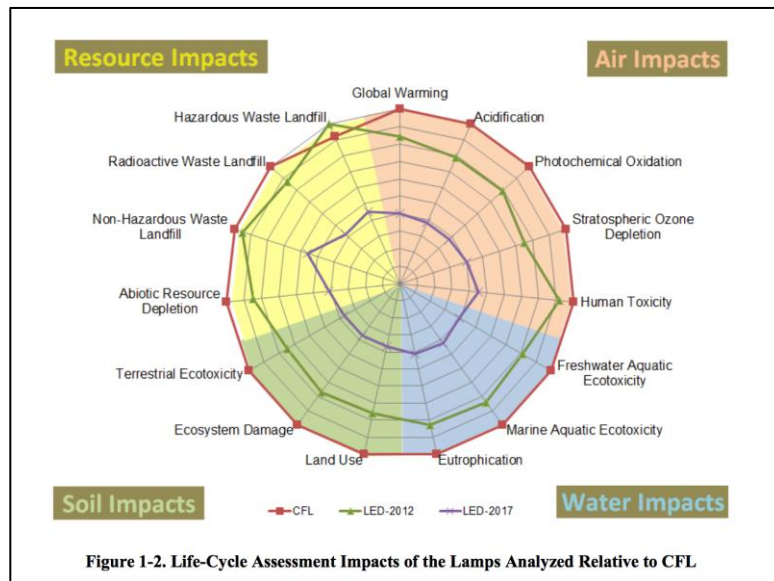
Because nearly all of the energy consumption associated with the life-cycle of a lamp occurs during the use phase, the criterion highlighted by LightingEurope contributes very little to the overall energy consumption of the LED and CFL lamps.

- The relatively high energy consumption that has been associated with manufacturing LEDs is, however, mainly due to their aluminum heat sink. As noted above, the size and resulting environmental impacts of the LED heat sink have continued to shrink over time, according to the US Department of Energy LCA. Similarly, the International Energy Agency reported in its 2014 LCA that “today there are several new LED lamp designs on the market that have greatly reduced or completely eliminated aluminium heat sinks.”¹⁴ This is reducing the energy consumption associated with the manufacture of LEDs as well as the associated amount of hazardous waste generated that is going to landfill. See comparison of an LED lamp with an aluminum heat sink (left, more common with older models) and one without (right).
- Furthermore, the US Department of Energy’s 2012 LCA projected that by 2015, LEDs will significantly surpass the CFLs in terms of overall energy efficiency. It projected, “*In addition, by 2015, if LED lamps meet their performance targets, their life-cycle energy use is expected to decrease by approximately one half.*”

¹³US Department of Energy, Building Technologies Program, *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products Part I: Review of the Life-Cycle Energy Consumption of Incandescent, Compact Fluorescent, and LED Lamps*, Updated August 2012, http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_LED_Lifecycle_Report.pdf

¹⁴International Energy Agency, *Solid State Lighting Annex: Life Cycle Assessment of Solid State Lighting: Final Report*, 17 September 2014, http://ssl.iea-4e.org/files/otherfiles/0000/0068/IEA_4E_SSL_Report_on_LCA.pdf

The US Department of Energy's LCA concluded that LEDs have a lower overall environmental impact based on multiple criteria including, but not limited to, impacts on global warming, stratospheric ozone depletion, human toxicity, freshwater and marine toxicity, land use, abiotic resource depletion, and more. The chart (right) depicts the lower environmental impacts of LEDs compared to CFLs in 14 out of 15 categories included in the US Department of Energy's LCA.



Finally, LED lamps are considered the “Best Available Technology” because they meet the European Commission’s “Indicative Benchmarks” of having no mercury AND being among the most energy efficient that were established when it developed its Energy Using Products (EUP) Regulation in 2009.¹⁵

iv. LED light bulbs are mercury-free products.

1. Waste related issues

The mercury reduction benefits of LEDs are the greatest when they are compared to CFLs that are not recycled and, therefore, end up in the regular trash, where they break and release their mercury. According to LightingEurope’s exemption request, less than half of the CFLs sold in the EU (45%) are collected and recycled.

The European Environment Agency has warned that many EU countries will fail to meet the European directive of recycling 50% of waste by 2020. The latest annual lamp recycling figures for five European countries in terms of 2013 lamp recycling in tonnes are: Germany (over 9,600); the UK (5,370); France (4,590); Spain (over 2,500); and Italy (2,380). However, Greece only recycles 18%, and Romania recycles a mere 1%. Croatia and Bulgaria recycled nothing. Some countries have even gone into reverse, with Finland's rates reducing from 34% to 33% and Norway's falling from 44% to 42%, albeit with already good figures¹⁶.

¹⁵ Ecodesign Requirements for Directional Lamps, <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32012R1194&from=EN>

¹⁶ <http://www.mrw.co.uk/news/lamp-recycling-costs-rise-after-changes-to-weee-regulations/8685571.article>; <http://www.voltimum.co.uk/articles/study-shows-uk-be-among-top-lamp-recyclers-europe>

There are now lamp/lighting not-for-profit Collection & Recycling Service Organizations (CRSOs) in 22 EU member-states. These CRSOs have a market share of 75-95%; the other part of the market is occupied by other collective schemes which altogether result in enormous expenditures for end of life management of CFLs, compared for example with LEDs. For example, with yearly sales of over 200 million WEEE lamps in the EU, and an average collection and recycling fee of €0.14, Philips liability in Europe is an estimated € 30 million per year¹⁷.

Lamps are a commodity, and as such are very price-sensitive. The WEEE fee that consumers pay is a significant part of the lamp purchase price especially for low quality lamps with a short lifetime. On a per country basis, this fee is calculated on the basis of a net cost related to the cost of collection and recycling of the Lamp. There is no fee differentiation between different type of lamps under the scope of the directive. The longer the lifetime, the lower the impact of the WEEE fee but also the amount of waste. LEDs have the longest lifetime of all existing lighting products. Thus LEDs are the best choice with respect to the lowest waste impact regarding costs and material.

The longer CFLs are on the market, the longer they create a mercury waste problem since they will be entering the waste stream (in volume) for several years after the ban. Since the recycling rate is lower than 50% for the EU-28, this exemption creates an unnecessary and extended waste problem that could easily be shortened by assigning a near-term expiration date to the exemption, with all the related economic and environmental benefits. According to a 2008 report for the EC:

*The main benefits accruing from reduced mercury uses and releases outlined in the various policy options are related to human health impacts, environmental impacts and waste management impacts. A reduction of the input of mercury to society would result in reduced mercury exposures and reduced emissions to the environment over both the short and the long term.*¹⁸

LightingEurope's comparison to incandescent light bulbs to justify the use of mercury-containing CFLs is largely irrelevant at this point in time since most incandescent lamps are already banned throughout the EU and most halogen light bulbs will be banned due to their poor energy efficiency by September 2018. The more important comparison needs to be between CFLs and LEDs.

¹⁷ http://www.lighting.philips.com/pwc_li/main/lightcommunity/assets/sustainability/Waste-Electrical-Electronic-Equipment-WEEE.pdf

¹⁸ COWI A/S and Concorde East/West SpA European for the European Commission Directorate-General Environment. *Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society* (December 2008) Contract: ENV.G.2/ETU/2007/0021.

2. Mercury Exposure issues

The presence of mercury in CFLs (and in other fluorescent lamps) raises several risk issues. Workers may be exposed to mercury when manufacturing, transporting, installing, recycling or disposing of mercury-add lamps and consumer can be exposed when fluorescent lamps are broken, and the risk is greatest indoors where there is no ventilation to remove mercury vapors right after breakage.

The State of Maine in the United States carried out a study in which CFLs were broken under controlled conditions and air mercury levels in the room where the bulbs were broken were measured. Their results are consistent with other studies and reinforce the conclusion that a broken CFL can produce mercury vapor levels well in excess of current governmental guidelines, at least for brief periods.¹⁹

The main concern when a CFL breaks is focused on infants, small children or pregnant women inhaling mercury vapor. This is based on strong scientific evidence that the very young and the fetus are much more sensitive to the potential toxic effects of mercury. During early childhood development, the brain grows and changes rapidly. This process is vulnerable to the disruptive effects of toxic exposures. Young children, infants and fetuses have been shown to be highly susceptible to developmental effects associated with mercury in fish in their (and their mothers') diets.²⁰

There is no comparable body of epidemiological evidence on the effects of mercury vapor in the very young, but an analogous hypersensitivity of the developing brain to damage from elemental mercury has been well documented in animal studies. Mercury vapor is heavier than air, and mercury concentrations in indoor air tend to be higher near the floor. Infants and toddlers who crawl, sit, walk, play and breathe on or close to the floor are thus likely to be most heavily exposed to the mercury vapor from a broken CFL.²¹

According to the 2008 Maine study²², directly after breakage the mercury concentration in the study room air often exceeds the Maine Ambient Air Guideline (MAAG) of 300 nanograms per cubic meter (ng/m³) for some period of time, with short excursions over 25,000 ng/m³, sometimes over 50,000 ng/m³, and possibly over 100,000 ng/m³ from the breakage of a single compact fluorescent lamp. While a short period of venting can significantly reduce the mercury air concentrations after breakage, concentrations can sometimes rebound when rooms are no longer vented, particularly with certain types of lamps and during/after vacuuming. Mercury readings at the one foot height tend to be greater than at the five foot height in non-vacuumed

¹⁹ Rice, D., 2007. Health Issues Associated with Exposure to Elemental mercury from Compact Fluorescent Bulbs. Presentation at a Workshop on Clean-Up Advice for Compact Fluorescent Lamps, sponsored by the Northeast Waste Management Officials Association, held at University of Southern Maine, Portland, November 7, 2007.

²⁰ Debes, F., Budtz-Jørgensen, E., Weihe, P., White, R.F., Grandjean, P., 2006. *Impact of methylmercury exposure on neurobehavioral function at age 14 years*. *Neurotoxicology and Teratology* 28:363-375.

²¹ Groth, E. (2008) *Shedding Light on Mercury Risks from CFL Breakage*, Mercury Policy Project

²² Stahler, D., Ladner, S., Jackson, H. (2008) *Maine Compact Fluorescent Lamp Study*, Maine Department of Environmental Protection. Available at: <http://maine.gov/dep/rwm/homeowner/cflreport.htm>

situations. The Maine study also found that variability among brands/models of CFLs appears to be significant.

4.1.2 LED Lamps Are a Practical Replacement for Most CFLs

a. Many Different LED Models are Already Available

Our research has documented that LED light bulbs can easily replace halogen and compact fluorescent lamps in *most*, if not all, general lighting applications. For example, GE Lighting's September 2015 brochure on its LED replacement lamps lists more than 160 single-capped models. This includes a wide array of LED bulbs of the following shapes: A19s, A21s, globes, candles, and various types of reflectors (e.g., R20s, R30s, BR40s, MR16s, PAR16s, PAR20s, PAR30s, and PAR38s).²³



Similarly, according to Osram's website, it is "entering the new lighting season [2015/2016] with a considerably extended LED lamp portfolio - a total of around 150 different cutting-edge LED lamp types..., LED lamps by OSRAM are characterized by their enormous product range. Various types of bases and shapes of lamps - from screw and plug bases via high-voltage and low-voltage versions up to reflector lamps, and classic incandescent lamp shapes - are within our range. They are therefore ideally suited to both commercial and private use."²⁴

LightingEurope's primary arguments against LEDs serving as a practical replacement to CFLs are based on their contention that LEDs cannot *always* serve as a fully compatible replacement for CFLs needed by consumers and professional users. LightingEurope presents this as their "opinion"²⁵ and has failed to substantiate the extent of this potential problem – if any. The crux of their argument lies in their contention that "LEDs in *many* [emphasis added] cases are not suitable drop-in replacements...so the availability of suitable discharge lamps needs to be secured to prevent a forced, early refurbishment resulting in extra costs and environmental burden."²⁶ While the issues they raised were a problem in the past, these concerns have largely been overcome by improved designs.

²³GE Lighting Company, *Awaken: LED Replacement Lamps*, 4 September 2015, http://www.gelighting.com/LightingWeb/na/images/78945_GE_LED_Overview_Brochure_SS_tcm201-20394.pdf

²⁴Osram, *LED Lamps: The Big Product Offensive for More Energy Efficiency and Less Costs*, Webpage accessed on 11 October 2015, http://www.osram.com/osram_com/news-and-knowledge/led-lamps-from-osram---the-big-product-push/index.jsp

²⁵See page 6 of 35 of LightingEurope's exemption request.

²⁶LightingEurope, *Request to Renew Exemption 1(a) under the RoHS Directive 2011/65/EU: Mercury in Single-Capped (Compact) Fluorescent Lamps Below 30W*, January 15, 2015.

b. LEDs Can Replace Non-directional Lamps

LightingEurope argues that LEDs are directional and, therefore, cannot be used for many non-directional applications that have been – or are currently – met with general lighting service (GLS), halogen, and CFL lamps. This is no longer a problem. Manufacturers are designing LED light bulbs that are non-directional by pointing the individual LEDs in many directions, which distributes light evenly from the bulb. Below are several examples:

- According to GE Lighting Company, its “traditionally shaped LED bulbs are omnidirectional. That is, they are designed to emit light all around, just like a standard incandescent light bulb.”²⁷ GE boasts that its LED Start GLS lamps have *smooth light distribution* that makes it a practical substitute for the most commonly used types of general purpose lamps.²⁸ In addition, its Omni-Directional LED retrofit lamps “offer great possibility to replace incandescent, compact fluorescent or halogen lamps with a 2700K Extra Warm White LED lamp with *wide light distribution* [emphasis added] (230°, 255°) for general lighting.”²⁹
- Some of Osram’s LED lamps use LED filaments to replicate a traditional incandescent look and feel (see photo, right).



c. LEDs are not as large as they used to be

LightingEurope argues that LEDs are larger than incandescent lamps and, therefore, cannot be used for many general-purpose lighting applications. This is no longer a problem. Many manufacturers now offer LED light bulbs that have a similar size and shape as GLS (incandescent) and halogen lamps as well as CFLs. For example:



- Osram, a major manufacturer of LED lighting products in Europe, claims that its LED lamps “can be deployed in virtually any application” and are

²⁷GE Lighting Company, *CFL vs. Halogen vs. LED*, <http://pressroom.gelighting.com/facts/cfl-vs-halogen-vs-led-232394>

²⁸GE Lighting Company (Europe), *Data Sheet for LED Start GLS Lamps*, January 2015, http://www.gelighting.com/LightingWeb/emea/images/LED_Start_GLS_Data_Sheet_EN_tcm181-83867.pdf

²⁹GE Lighting Company (Europe), *Data Sheet for Omni-Directional GLS LED Lamps*, January, 2014, http://www.gelighting.com/LightingWeb/emea/images/LED-Omni-Directional-GLS-8W-12W-14W-Lamps-Data-sheet-EN_tcm181-66546.pdf

“available in many different typical shapes and with conventional lamp bases for easy replacement.” Its website states:

*Thanks to the broad range of OSRAM products, LED lamps are the ideal solution in many different areas – for new installations or **as a replacement for classic incandescent lamps, compact fluorescent lamps or halogen lamps, and for T8 fluorescent lamps**. Whether for private or commercial use, for example in restaurants and hotels: LED lamps by OSRAM are the perfect alternative for general lighting as well as ambient lighting.*³⁰

Osram’s line of Superstar Classic A LED light bulbs “can be easily fitted instead of ordinary light bulbs” and used for general illumination, including, fixtures with dimmers.³¹

- Philips offers a wide array of LED lamps that are designed to fit into standard fixtures that previously accommodated incandescent, halogen or compact fluorescent lamps.

The specifications sheet for the standard-shaped LED lamp offered by Philips Lighting states: “Familiar shapes are a perfect fit for your fixtures: we have retained the shapes and appearance of the classic light bulb” and “designed for retrofit replacement of incandescent bulbs.” Its website also states, “Shaped in a familiar way, this LED bulb offers all of the most recent innovations while maintaining the look and feel of a traditional bulb.”³²



In its 2013 report to the Eco-Lighting Project, LightingEurope pointed to market analyses projecting that the strong demand for LEDs will cause manufacturers to redesign their LED retrofit products to fit into fixtures that were originally designed for incandescent and

³⁰ Osram, *LED Lamps: The Big Product Offensive for More Energy Efficiency and Less Costs*, Webpage accessed on 11 October 2015, http://www.osram.com/osram_com/news-and-knowledge/led-lamps-from-osram---the-big-product-push/index.jsp

³¹ Osram, *LED Lamps: The Big Product Offensive for More Energy Efficiency and Less Costs*, Webpage accessed on 11 October 2015, http://www.osram.com/osram_com/news-and-knowledge/led-lamps-from-osram---the-big-product-push/index.jsp

³² Philips UK, *LED Bulb*, <http://www.philips.co.uk/c-p/8718291193029/led-bulb>

halogen lamps, which are in the process of being phased out of the market. It stated that, “the shift towards LED will affect the entire lighting market, forcing the participants to redesign their products as well as supply and distribution strategies. LED is seen as the long-term future for many applications. The improvement in technology will help to increase the potential of LED lighting in general illumination, resulting in a continuous movement from restricted applications in architectural lighting to functional lighting indoors and outdoors.”³³

d. The cost of LEDs has Decreased Considerably and is Becoming Similar to CFLs

The final argument made by LightingEurope in favour of their Exemption request is that LEDs would cost consumers too much to purchase as replacements for Class C halogen lamps. This argument is only true when the initial cost of LEDs is considered. When energy costs and replacement costs are factored in, LED lamps have been found to be less expensive than halogens.

The European Commission reported in April 2015 that “Switching from an average halogen lamp to an energy efficient LED will already save approximately **115 Euros over the LED's lifetime of up to 20 years**, and pay-back its cost within a year. This savings will increase further by 2018 with lower LED prices and a better LED performance.”³⁴

A report authored by LightingEurope for the Eco-Lighting Project, which was created to guide the development of an EU ecolabel for lamps projected that by 2015 LED retrofit bulbs would start becoming the most cost-effective technology. It stated:

*Another vital metric has altered. LED prices have eroded more aggressively, pulling forward the payback time of LED lighting. The inflection point for LED retrofit bulbs in the residential segment, for example, is now likely to be around 2015.*³⁵

IKEA, a one of the world’s largest retailers of light bulbs, explained that its decision to stop offering CFLs (as well as halogen lamps) in all of its stores worldwide as of 2015, was based in part on its determination that it is less expensive for them to manufacture LED light bulbs than CFLs. In an email to the European Environmental Bureau, IKEA’s Sustainability Leader for Lighting explained:

³³ LightingEurope Report for the Eco-Lighting Project, *Revision of European Ecolabel and Green Public Procurement Criteria for Lamps: Preliminary Background Report*, February 2013, http://www.eco-lighting-project.eu/uploads/docs/docs1_Eco_lighting_Draft_Background_Preliminary_Report.pdf

³⁴ European Commission, Energy, *Phase Out of Inefficient Lamps Postponed to 1 September 2018*, <http://ec.europa.eu/energy/en/news/phase-out-inefficient-lamps-postponed-1-september-2018>

³⁵ LightingEurope Report for the Eco-Lighting Project, *Revision of European Ecolabel and Green Public Procurement Criteria for Lamps: Preliminary Background Report*, February 2013, http://www.eco-lighting-project.eu/uploads/docs/docs1_Eco_lighting_Draft_Background_Preliminary_Report.pdf

*CFL-i formerly from our range: needed 7 W to power, gave 315 lumen light output, had a colour rendering index of 80% and a life time of 10 000 hours. The corresponding LED light source to this one, in our range needs 6,3 W, gives 400 lumen light output, has a colour rendering index of 80% and a life time of 15 000 hours. Both bulbs had a light colour of 2700 Kelvin. These bulbs are directly comparable but as you can see the LED outperforms the CFL-i and **the CFL-i bulb costs 55% more to produce than the LED bulb.** [emphasis added].*

*In the near future we plan on offering LED light sources to our customers at even lower prices than today, with at least maintained quality and performance, making them even more superior the CFLi than today. In terms of technical specification, efficiency, efficacy, light quality and dimmability, LED bulbs are equal or surpassing CFLis so there is no reason to keep the mercury containing light sources from these aspects either.*³⁶



The economic benefits to consumers of LED lamps are enhanced by the fact that they have a rated life that is approximately three times longer than the rated life of CFLs. According to the iNSPiRe report, the average lifetime of LED retrofit light bulbs is approximately 25,000 hours, while the average

lifetime of CFLs is only 8000 hours.³⁷ Their relatively long life yields environmental benefits as well as long-term cost savings since they need to be purchased fewer times.

LEDs are not only expected to be a cost-effective replacement for the non-directional Class C halogen lamps that will be phased out of the marketplace by September 2018, they also can cost-effectively replace directional halogen lamps, which likewise have a low energy-efficiency rating and a relatively short rated life compared to LEDs. Consequently, CFLs will not be needed to replace these directional halogen lamps.

A market assessment of directional LED lamps (such as spot lights and flood lamps) that was conducted for the European Commission and published in September 2015, concluded “Using life-cycle costs and payback times as a criterion, LED lamps are more affordable than Halogen lamps.”³⁸ It noted that the payback time for LEDs is approximately one year, which seems

³⁶ Sofia Gape, Sustainability Leader, Lighting, IKEA of Sweden, Email to European Environmental Bureau, 14 October 2015.

³⁷ iNSPiRe, *D 4.1 Report on Artificial Lighting Solutions*, December 2013, page 16, http://www.inspirefp7.eu/wp-content/uploads/2014/05/WP4_D4-1_20140327_P11_Report_on_artificial_lighting_website_adaptation21.pdf

³⁸ European Commission, *Market Overview on Directional Mains-Voltage Lamps Related to Stage 3 of Commission Regulation EU No. 1194/2012*, September 2015, page 68, <https://ec.europa.eu/energy/sites/ener/files/documents/Draft%20Final%20Market%20Assessment%20data.pdf>

reasonable for consumers. It further noted that the downward price spiral for these products will make them even more affordable in the near future:

A survey of prices of directional LED lamps on on-line sales' sites reveals that LED prices are quickly coming down and that the gap between prices for halogen lamps and comparable LED lamps is narrowing. For some LED lamps, the study team even noticed price reductions of more than 25% between January 2015 (start of work on the database) and April 2015 (final version of database).

This downward price trend is expected to continue, further improving the situation up to September 2016.³⁹

4.1.3 Conclusion

While LightingEurope seems content to allow LED growth to run a natural course – without policy intervention – we urge the European Commission to facilitate a more rapid transition to LEDs by “going all-in” with this technology, and especially for low-wattage CFLs (<30 watts), which dominate the CFL market .

Already other entities in the European Union are taking this committed approach as a way to speed up the utilization of LED lighting technology, which they consider ready for prime time. As mentioned earlier, as of September 1, 2015, IKEA began selling *only* LED lighting products in its stores worldwide. By doing so, IKEA made good on its 2012 promise to eliminate CFLs as well as halogen lamps from its shelves. According to IKEA:

LED is a light source which uses 85 percent less energy than incandescent bulbs and can last up to 20 years. LED offers high quality light and solutions for different lighting between warm and cool light...IKEA LED bulbs are mostly all dimmable [and come] in all shapes and sizes...⁴⁰

In 2012, Steve Howard, IKEA Chief Sustainability Officer, explained why this giant retailer decided to pick a winner among the lighting technologies available to replace incandescent light bulbs, which are being phased out throughout the European Union and elsewhere around the world, stating:

The reason why we're going 100 percent behind LEDs is because we can see the technology is already there. It's not just about energy-efficiency; it's the whole functionality from color temperature through to strength and durability....LEDs are more

³⁹ European Commission, *Market Overview on Directional Mains-Voltage Lamps Related to Stage 3 of Commission Regulation EU No. 1194/2012*, September 2015, page 67, <https://ec.europa.eu/energy/sites/ener/files/documents/Draft%20Final%20Market%20Assessment%20data.pdf>

⁴⁰ IKEA, “IKEA first major U.S. retailer to only sell LED bulbs and lighting, August 10, 2015, http://www.ikea.com/us/en/about_ikea/newsitem/081015_IKEA_100_percent_LED

*efficient and longer-lasting than compact-fluorescent and halogen bulbs, and are the “next best thing” to natural light.*⁴¹

When IKEA made its announcement, World Wildlife Fund also expressed its support for moving to LEDs:

*“In order to move away from our dependency on fossil fuels, we need to take advantage of all opportunities. Almost 20% of global electricity consumption comes from lighting, so shifting lighting to LED technology is a cost-effective way to get change at scale. IKEA converting its lighting range to LED will have a real impact in reducing energy use in many households.”*⁴²

By phasing out CFLs at the same time that it is restricting Class C lamps (which will include most non-directional halogen lamps) from the European marketplace, which is scheduled to take place by 1 September, 2018⁴³, the European Commission can further hasten the EU’s transition to LEDs, which will yield both environmental and economic benefits to European consumers. This will increase utilization of the most energy-efficient lighting technology on the market, prevent an increase in mercury-containing lighting products (and waste) as halogen lamps are being phased out, and yield another important benefit – creating more jobs in the European Union.

CFLs do not offer the same economic development opportunities as LEDs because the bulk of the CFLs that are sold on the European market are manufactured outside of the European Union – with most being imported from China.⁴⁴ In April 2015, the EC announced that it was postponing its phase out of halogens in order to give manufacturers the time to create replacement jobs by supporting innovative companies in the EU that are increasingly providing novel lighting solutions based on LEDs. According to the EC:

*Everyone agrees that a maximum of around 6,800 job losses in halogen lamp production are inevitable and will happen irrespective of any policy intervention due to the arrival of LEDs. The phase-out of halogen lamps and faster market uptake of LEDs can help overcome some of these negative impacts by focusing on high value creation and employment opportunities in the EU.*⁴⁵

Eliminating the RoHS exemptions for CFLs will send a clear and consistent signal to lamp manufacturers that the EU is doing all that it can to support the development of LED production facilities in Europe.

⁴¹Bloomberg News, “IKEA Plans to Sell Only LED Lights Worldwide to Cut Emissions,” October 1, 2012, <http://www.bloomberg.com/news/articles/2012-10-01/ikea-plans-to-sell-only-led-lights-worldwide-to-cut-emissions>

⁴² Statement by Samantha Smith, leader of the WWF (World Wildlife Fund) Global Climate and Energy Initiative. http://www.csrwire.com/press_releases/34685-IKEA-To-Sell-Only-LED-Lighting-By-2016

⁴³ European Commission, Press Release: Frequently asked Questions about the Regulation on Ecodesign Requirements for Non-directional Household Lamps, 18 March 2009, http://europa.eu/rapid/press-release_MEMO-09-113_en.htm

⁴⁵ European Commission, News Release: Phase Out of Inefficient Lamps Postponed to 1 September 2018, 17 April 2015, <http://ec.europa.eu/energy/en/news/phase-out-inefficient-lamps-postponed-1-september-2018>

In some cases, where the availability of LED replacement lamps is more limited – such as for retrofit lamps that would replace high-wattage CFLs (≥ 30 watts), linear and non-linear fluorescent tubes, and some high-intensity discharge (HID) lamps, we are recommending lower mercury limits at this time, when there is evidence that products can meet a lower limit.

Below are our recommendations on specific exemptions that have been proposed:

4.2. Section II Requests to Renew Exemptions 1(a, b and e), which apply to “Mercury in single capped (compact) fluorescent lamps not exceeding (per burner)”

4.2.1 Exemption 1(a): Mercury in single-capped (compact) fluorescent lamps not exceeding 30W per burner (current limit is 2,5 mg).

We urge the European Commission to reject any RoHS extension of the current mercury limit of 2,5 mg for this lamp category beyond 1 September 2018 in order to facilitate a rapid and smooth transition away from halogen lamps and CFLs to LEDs.

Elimination of the exemption is justified by 1 September 2018 – at the latest, when the European Commission is proposing to eliminate from the market many inefficient lamps (including most general purpose halogen lamps).⁴⁶ This will give manufacturers time to create a sufficient supply of affordable LED lamps that can replace mercury-containing CFLs and inefficient halogen lamps. As noted above, LEDs are a practical replacement that are more energy-efficient, more easily dimmable, and more cost-effective on a lifecycle basis (with a short payback of one year or less for most models).

LEDs Are a Practical Replacement for CFLs <30 Watts

Most CFLs <30 watts are designed to replace incandescent light bulbs, which have already been banned in the European Union due to their low efficiency, and halogen lamps, which are in the process of being banned by the European Commission for the same reason. Many CFLs on the market are non-directional, which means that light is emitted from the lamp in multiple directions. Non-directional CFLs include A19 and A21 bulbs that are shaped like a traditional incandescent light bulb as well as bulbs of other shapes such as candles and globes that are mainly used for decorative lighting applications.

As noted above, many LED lamps are designed to replace non-directional incandescent and halogen lamps. They include LEDs that have a shape and size that is similar to standard light bulbs as well as those with globe and candle shapes, which are often used for decorative applications such as vanities and ceiling lamps. Consequently, there are a large number of non-directional LEDs available that can replace non-directional halogen light bulbs as well as CFLs.

⁴⁶ European Commission, “Phase Out of Inefficient Lamps Postponed to 1 September 2018,” News Release, 17 April 2015, <http://ec.europa.eu/energy/en/news/phase-out-inefficient-lamps-postponed-1-september-2018>

According to our market research, most LED lamps are low-wattage models and could replace CFLs <30 watts.

LED light bulbs are also widely available in shapes and sizes that can replace common directional lamps such as floodlights. A report developed for the European Commission that was published in September 2015 concluded that there is a sufficient supply of direct, drop-in LED replacements for nearly all types of directional halogen lamps – including those with a screw base (also called a cap) as well as those with a pin base. This comprehensive market assessment, which was conducted for the European Commission Directorate-General for Energy, reported that “there are Stage 3 compliant [highly energy-efficient] LED alternatives which are ‘broadly equivalent’ to all directional [Mains-Voltage] MV filament [i.e., incandescent and halogen] lamps.”⁴⁷ It further noted that:

- The total number of MV directional lamp models identified in the study is 625, of which 131 are reference filament lamps (GLS or halogen lamps) and 494 LED lamps. This means that more than three times as many LED directional lamp models are available in the European marketplace as halogen and incandescent models of directional lamps they would need to replace.
- The variety of these LED lamps is larger than the variety for the less-efficient halogen and incandescent filament lamps, in particular for lamps with GU10 cap.
- 70% of the LED lamps already meet the European Commission’s stringent new Stage 3 energy- efficiency criterion.
- The LED directional lamps represent a wide variety of lumen levels, beam angles, and colour temperatures.
- In general, based on lamp characteristics declared by manufacturers, the LED directional lamps available in the European marketplace meet the functionality requirements of EU regulation 1194/2012 with respect to lamp survival, lumen maintenance, switching withstand, starting- and warm up-time, premature failure rate, colour rendering, colour consistency, and power factor. For example, more than 99% of the LED lamps emit a high quality of light based on a declared Colour Rendering Index (CRI) of ≥ 80 , including several models with CRI >90 .⁴⁸



⁴⁷ European Commission, *Market Overview on Directional Mains-Voltage Lamps Related to Stage 3 of Commission Regulation EU No. 1194/2012*, September 2015, page 62, <https://ec.europa.eu/energy/sites/ener/files/documents/Draft%20Final%20Market%20Assessment%20data.pdf>

⁴⁸ European Commission, *Market Overview on Directional Mains-Voltage Lamps Related to Stage 3 of Commission Regulation EU No. 1194/2012*, September 2015, page 62, <https://ec.europa.eu/energy/sites/ener/files/documents/Draft%20Final%20Market%20Assessment%20data.pdf>

Because a wide array of non-directional and directional LED lamps are available as practical and cost-effective replacements to CFLs <30 watts, we urge the EC to issue an expiry date on this exemption that is consistent with the phase out of inefficient halogen lamps: 1 September 2018.

Recommendation for Exemption 1(a):

CFLs for general purposes <30W, 2.5mg ... should expire by 1 September 2018

4.2.2. Exemption 1(b): Mercury in single-capped (compact) fluorescent lamps ≥ 30 W to <50W per burner.

Like low-wattage CFLs listed above, high-wattage CFLs (30 watts up to 50 watts) can be replaced by LED lamps. For example: GE offers LED 4-Pin Plug In Lamps that claim “energy savings up to 60% versus CFL 4-pin plug-in lamps; a rated life of 50,000 hours, which is 2.5 times longer than a typical equivalent plug-in CFL; high quality light (CRI >80) and compatibility with main electronic ballast types.”⁴⁹ As it also seems there are far fewer CFLs in this category, we were able to identify far fewer LED lamps that appear to be direct replacements for CFLs in this category – although there are far fewer CFLs needing replacement as well since most CFLs use <30 watts. The important point to note is that LEDs are technically capable of generating a sufficient amount of light to replace CFLs in this category. Therefore, while we are not proposing an expiry date for exemption at this time, we urge the European Commission to determine whether there are sufficient replacement lamps available to establish an expiry date prior to the maximum validation date of this Exemption.



In the meantime, according to our market research, we have determined that CFLs ≥ 30 watts and <50 watts can meet a lower mercury limit than 3,5 mg, which is currently in the RoHS Directive and proposed under the requested limit. Consequently, we urge the European Commission to lower the mercury limit for this category Exemption 1(b) from 3,5 mg to 2,5 mg.

Examples of lower-mercury CFLs in this category include:

- GE's 32-watt Spiral T4 High Power Factor CFLs with an integrated ballast (CFL-I) contain 1,8-2,0mg of mercury, which is far below the 3,5 mg RoHS limit for this product category.⁵⁰



⁴⁹ GE Lighting Company, *Data Sheet for LED 4 Pin Plug-in Lamps*, September 2015, http://www.gelighting.com/LightingWeb/emea/images/LED-Plug-In-DataSheet_EN.pdf

⁵⁰ GE Lighting Europe, *Data Sheet for 32W Spiral T4 High Power Factor 10.000 hours EU Compact Fluorescent Lamps Integrated*, http://www.gelighting.com/LightingWeb/emea/images/CFL_Integrated_Spiral_T4_HPF_Lamps_Data_sheet_EN_tcm181-12649.pdf



- GE's 32W and 42W Non-Integrated LongLast Biax T and T/E CFLs contain 1,3 mg of mercury (which is the same amount as in the low-wattage (<30W) models in this line).⁵¹
- Osram's 30-watt Superstar Stick bare integrated CFL contains 1,3 mg of mercury.⁵²
- Philips MASTER PL-T TOP 4-Pin CFLs, which include 32W, 42W and 57W models, have a mercury content of 1,4 mg.⁵³

Recommendation for Exemption 1(b):

Lower mercury limit from 3,5 mg to 2,5 mg, by 1 September 2018. The 2.5 mg mercury limit should expire by 2020.

We do know that Philips has a line of high wattage Extra Long Life CFLs, with a rated life of 33.000 hours, and a mercury content of 3,0 mg⁵⁴. Therefore in addition to the recommendation above we urge the Commission to consider creating a new category of exemptions, $\geq 30\text{ W}$ to $<50\text{ W}$, for long life (>30.000 hours) CFLs with maximum limit of 3mg of mercury, to cover for this lamp and others which would meet similar criteria.

Recommendation for new Exemption:

Consider creating a new category of exemptions, $\geq 30\text{ W}$ to $<50\text{ W}$, for long life (>30.000 hours) CFLs with maximum limit of 3 mg of mercury, to cover for this lamp and others which would meet similar criteria.

⁵¹ GE Lighting Europe, *Data Sheet for Non-Integrated Biax T and T/E Compact Fluorescent Lamps*, October 2013, http://www.gelighting.com/LightingWeb/emea/images/CFL_Nonintegrated_Longlast_Biax_T_and%20TE_Lamps_Data_sheet_EN_tcm181-12570.pdf

⁵² Osram, *Dulux Superstar Stick, Technical Data Sheet*, Accessed October 6, 2015, http://www.osram.com/osram_com/products/lamps/compact-fluorescent-lamps-with-integrated-control-gear/osram-dulux-superstar/osram-dulux-superstar-stick/index.jsp

⁵³ Philips Lighting Company UK, *Leaflet for Master PL-T TOP 4-Pin CFLs*, 8 May 2015, <http://www.lighting.philips.co.uk/prof/lamps/compact-fluorescent-non-integrated/pl-t/master-pl-t-top-4-pin>

⁵⁴ Philips MASTER PL-T Xtra 4 Pin CFL: http://download.p4c.philips.com/l4bt/3/322844/master_pl-t_xtra_4_pin_322844_ffs_eng.pdf

4.2.3 Exemption 1(e): Mercury in single-capped (compact) fluorescent lamps for general lighting purposes with circular or square structural shape and tube diameter <17mm.

According to our market research, products in this category can meet a much lower mercury limit than 7 mg, which is currently in the RoHS Directive and proposed under the requested limit. Consequently, we urge the European Commission to lower the mercury limit for this category Exemption 1(b) from 7 mg to 4 mg.

Below are examples of products in this category with a far lower mercury content.

- The Osram-brand Dulux Superstar Circolux single-capped circular CFLs contain only 2,5 mg.⁵⁵
- Osram-brand Lumilux T5 FC circular fluorescent lamps have a mercury content of 3,8 mg.⁵⁶
- Philips-brand quadrant-shaped (square) pin-based CFLs (PL-Q) contain 4 mg.⁵⁷
- Philips-brand circular T5s have a mercury content of 2,5 mg.⁵⁸
- GE-brand Circline circular T5 fluorescent lamps have a mercury content of 3,5 mg.⁵⁹



Order code	Full product name	Energy Efficiency Label (EEL)	Mercury Content (mg)	Energy consumption (W/1000h)
177025 25	PL-Q BRANDEP 152	A	4 mg	42 W/1000h
177026 25	PL-Q BRANDEP 152	A	4 mg	42 W/1000h
177027 25	PL-Q BRANDEP 152	A	4 mg	42 W/1000h



Recommendation for Exemption 1(e):

Lower the mercury content from 7mg to 4mg, after 1st September 2018.

⁵⁵Osram, *Data Sheet for Osram Dulux Superstar Circolux Circular CFL*, http://www.osram.com/osram_com/products/lamps/compact-fluorescent-lamps-with-integrated-control-gear/osram-dulux-superstar/osram-dulux-superstar-circolux/index.jsp

⁵⁶Osram, *Data Sheet for Lumilux T5 FC lamps*, 2 October 2015, http://www.osram.com/osram_com/products/lamps/fluorescent-lamps/fluorescent-lamps-t5/lumilux-t5-fc/index.jsp

⁵⁷Philips Lighting Company, *PL-Q 4-Pin Quadrant Compact Fluorescent Lamps Technical Data Sheet*, May 8, 2015, http://download.p4c.philips.com/l4bt/3/323156/pl-q_4_pin_323156_ffs_eng.pdf

⁵⁸Philips Lighting Company, *Technical Data Sheet for Master TL5 Circular*, 18 June 2015, http://download.p4c.philips.com/l4bt/3/323064/master_tl5_circular_323064_ffs_eng.pdf

⁵⁹GE Lighting Company, *Data Sheet for Circline Circular T5 Fluorescent Lamps*, May 2014, http://www.gelighting.com/LightingWeb/emea/images/Linear_Fluorescent_T5_Circline_Lamps_Data_sheet_EN_tcm181-12829.pdf

4.3 . Section III Requests to Renew Exemptions 2 (a) (2,3,5) and 2(b)(3) "Mercury in double-capped linear fluorescent lamps for general lighting purposes".

4.3.1 Exemption 2(a)(2) Tri-band phosphor with normal lifetime and a tube diameter ≥ 9 mm and ≤ 17 mm (e.g. T5) (currently at 3mg)

One area where there has been tremendous innovation over the past several years is in the development of LED tube lamps. According to a 2014 report by the International Energy Agency (IEA), LED tube lamps now have equivalent performance to even the most energy-efficient fluorescent tubes: T5s.

In the domain of professional lighting, the T5 linear fluorescent lamp luminaire was the best rated product in 2009. In studies published in 2013, the T5 lamp remains the product with the lowest environmental impacts, but thanks to the advances of LED technology, LED tubes are nearly at the same level of performance.⁶⁰

Recommendation for Exemption 2(a (2):

Remove the words ‘normal lifetime’ since T5s no matter their lifetime meet already these limits.

Also, monitor improvements in performance and life-cycle price of LED T5 tubes to consider future expiry date as practical for some or all fluorescent T5 lamps.

For lifetime related justifications, please see further below.

4.3.2 Exemption 2(a)(3) Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm (e.g. T8) (currently at 3,5mg)

For lifetime related justifications, please see further below.

Many European lamp manufacturers are now offering LED linear T8 lamps that are drop-in replacements for linear fluorescent T12 and T8 lamps, claiming that they are more energy efficient. Some of these products include an internal driver so that no additional wiring is required. Other products are compatible with either electronic or magnetic ballasts, or both. Below are some examples of available LED T8 lamp products available from major EU manufacturers:

- Philips Lighting Company UK, claims that its



⁶⁰International Energy Agency, *Solid State Lighting Annex: Life Cycle Assessment of Solid State Lighting: Final Report*, 17 September 2014, http://ssl.iea-4e.org/files/otherfiles/0000/0068/IEA_4E_SSL_Report_on_LCA.pdf

MASTER LED tube T8 lamps, which come in dozens of lengths, wattages and colour temperatures, offer the following benefits:

- Reduced operational cost thanks to lower energy consumption (only 50% energy consumption compared to fluorescent tubes); and
 - Lower maintenance costs thanks to 2-3 times longer lifetime than normal fluorescent tubes (extra long life of 40,000 hours).⁶¹
- Philips InstantFit LED T8 lamps claim to be an easy drop-in replacement for linear fluorescent lamps that “integrates an LED light source into a traditional tube form that’s quick, easy and safe to install. No wires to replace, no hassle changing drivers; InstantFit is a plug and play solution that works with High Frequency electronic ballast and slots into existing fittings.” The data sheet for this line of lamps further states, “With a wide range of tubes, you can now promise customers long lasting energy savings of up to 50% – in an instant.”⁶²
-
- GE Lighting Company, offers several lines of LED T8 Lamps, including its LED T8 Universal Tubular Lamps, which it claims have a high efficiency level (up to 120 lumens/watt), can save more than 60% on energy costs compared to T8 fluorescent lamps on electro-magnetic ballasts, and have a long lifetime (40,000 hours).⁶³
-
- Osram has several lines of LED T8 lamps that can be used on electronic or magnetic ballasts, or both. Its high-performance SubstiTUBE Advanced HF T8 tubes have a rated lamp efficiency of up to 126 lumens/watt and a rated life of 50,000 hours.⁶⁴ Its economic SubstiTUBE Value LED T8 lamps claim energy savings of 65% compared to T8 fluorescent lamps and a lifetime of 30,000 hours.⁶⁵
-

Because LED tube lights are expected to continue to improve over the next several years, we urge the European Commission to continue to monitor their advancements for performance and lifecycle costs and consider them for phase-out in the next review.

⁶¹ Philips Lighting Company, *Data Sheet for MASTER LEDtube Em/Mains*, 24 September 2015, http://download.p4c.philips.com/l4bt/3/334467/master_ledtube_334467_ffs_eng.pdf

⁶² Philips, *Professional LED Lamps Catalogue*, February 2014, http://images.philips.com/is/content/PhilipsConsumer/PDFDownloads/United%20Kingdom/ODLI20150427_001-UPD-en_GB-Professional-LEDlamps-catalogue.pdf

⁶³ GE Lighting Company, *Data Sheet for LED T8 Universal Tubular Lamps*, October 2015, <http://www.gelighting.com/LightingWeb/emea/images/LED-T8-Universal-Tubular-Lamps-DataSheet-EN.pdf>

⁶⁴ Osram, *Data Sheet for SubstiTUBE Advanced HF*, 13 October 2015,

http://www.osram.com/osram_com/products/lamps/led-lamps/led-tubes/substitube-hf/substitube-advanced-hf/index.jsp

⁶⁵ Osram, *Data Sheet for SubstiTUBE Value*, 13 October 2015, http://www.osram.com/osram_com/products/lamps/led-lamps/led-tubes/substitube-em/substitube-value/index.jsp

In the meantime, we are proposing lower mercury limits for certain T5 and T8 fluorescent lamps as detailed below.

Recommendation for Exemption 2(a)(3):

Remove the words ‘normal lifetime’ since T8s no matter their lifetime meet already these limits.

Also, monitor improvements in performance and life-cycle price of LED T8 tubes to consider future expiry date by 2020 for some or all fluorescent T8 lamps.

4.3.3 Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12): 5 mg

LED T8 tubes can also replace T12 fluorescent lamps⁶⁶. T12s are less efficient than T8s, therefore we expect LEDs to be a practical replacement for these in the near future.

Recommendation for Exemption 2(a)(4):

Monitor improvements in performance and life-cycle price of LED tubes to consider future expiry date by 2020, for all or some T12 fluorescent lamps.

4.3.4 Exemption 2(a)(5) Tri-band phosphor with long lifetime ($\geq 25\,000\text{ h}$)

We recommend that this exemption be eliminated and that all T5 linear fluorescent lamps be included under Exemption 2(a)(2), which currently has a mercury limit of 3 mg, and that all T8 lamps be included under Exemption 2(a)(3), which currently has a mercury limit of 3,5 mg. From our research we could not find long-life T2 and T12s, e.g. in the GE and OSRAM catalogues. In the case where such types of lamps exist, the exemption should be rephrased accordingly to cover only those; the T5 and T8s should all meet 3 mg and 3,5 mg respectively no matter the lifetime.

Rationale: Many “longlife” linear fluorescent T5s can meet the RoHS mercury limit of 3,0 mg that is contained in Exemption 2(a)(2).

⁶⁶ https://www.earthled.com/products/thinklux-led-fluorescent-replacement-tube-light-4-foot-18-watt-ballast-bypass-dlc-qualified?utm_medium=cpc&utm_source=googlepla&qclid=CLbZpd2ux8gCFYlsfgodZMgNGw&variant=4099400900

Below are examples of T5s with a rated life >25.000 hours that can meet the 3,0 mg mercury limit and therefore exemption 2(a)(2):

- **GE Longlast High-Efficiency T5 Fluorescent Lamps**, which have a rated life of **30.000 hours** and a mercury content of **2,5 mg**, are available in both standard wattages (14W, 21W, 28W, and 35W) and high-output wattages (24W, 39W, 49W, 54W and 80W).⁶⁷
- **Osram Lumilux XT Long-Lasting T5 Fluorescent Lamps** (including high-output models), which have a rated life of 45.000 hours and a mercury content of **2,6 mg**, are available in 35W models.⁶⁸
- **Philips Lighting Company, MASTER TL5 Xtra T5 Fluorescent Lamps**, which have a rated life of **45.000 hours** and a mercury content of **3,0 mg**, are available in 13W, 25W and 32W standard output models as well as 49W and 80W high-output models.⁶⁹
- **Philips Lighting Company, MASTER TL5 High-Output EcoPlus T5 Fluorescent Lamps**, which have a rated life of **30.000 hours** and a mercury content of **1,4 mg**, are available in 41W, 44W, and 55W high-output models.⁷⁰

Below are examples of T8s with a rated life >25.000 hours that can meet the 3,5 mg mercury limit in exemption 2(a)(3):

- **Osram Lumilux XXT Extra Long-Life T8 Fluorescent Lamps**, which have a rated life of **90.000 hours** and a mercury content of **3,3 mg**, are available in 18W, 36W and 58W models.⁷¹
- **Osram Lumilux XT Long-Life T8 Fluorescent Lamps**, which have a rated life of **50.000 hours**, have a mercury content of **3,3 mg**, are available in 18W, 36W, 58W models.⁷²
- **Philips MASTER TL-D Xtra Long-Life T8 Fluorescent Lamps**, which have a rated life of **46.500 hours** and a mercury content of **3,0 mg**, are available in 18W, 36W, 58W and 70W models.⁷³

⁶⁷GE Lighting Company, *Data Sheet for T5 LongLast Liner Fluorescent High-Efficiency T5 Lamps*, August 2013, http://www.gelighting.com/LightingWeb/emea/images/Linear_Fluorescent_T5_LongLast_Lamps_Data_sheet_EN_tcm181-12831.pdf

⁶⁸Osram, *Data Sheet for Lumilux XT Long-Lasting T5 Fluorescent Lamps*, 30 September 2015, http://www.osram.com/osram_com/products/lamps/fluorescent-lamps/fluorescent-lamps-t5/lumilux-t5-he-xt/index.jsp

⁶⁹Philips Lighting Company, *Technical Data Sheet for MASTER TL5 T5 Fluorescent Lamps*, 8 May 2015, http://download.p4c.philips.com/l4bt/3/383496/master_tl5_high_efficiency_xtra_383496_ffs_eng.pdf

⁷⁰Philips Lighting Company, *Technical Data Sheet for MASTER TL5 High-Output EcoPlus T5 Fluorescent Lamps*, 13 March 2014, http://download.p4c.philips.com/l4bt/3/383497/master_tl5_high_output_ecoplus_383497_ffs_eng.pdf

⁷¹Osram, *Data Sheet for Lumilux XXT T8 Extra-Long-Life Fluorescent Lamps*, 2 October 2015, http://www.osram.com/osram_com/products/lamps/fluorescent-lamps/fluorescent-lamps-t8/lumilux-xxt-t8/index.jsp

⁷²Osram, *Data Sheet for Lumilux XT T8 Long-Life Fluorescent Lamps*, 7 October 2015, http://www.osram.com/osram_com/products/lamps/fluorescent-lamps/fluorescent-lamps-t8/lumilux-xt-t8/index.jsp

⁷³Philips Lighting Company, *Technical Data Sheet for MASTER TL-D Xtra T8 Fluorescent Lamps*, 25 May 2015, http://download.p4c.philips.com/l4bt/3/323206/master_tl-d_xtra_323206_ffs_eng.pdf

- **GE Lighting LongLast T8 Fluorescent Lamps**, which have a rated life of 29.000 hours and a mercury content of **2.9 mg**, are available in 18W, 36W and 58W models.⁷⁴

Recommendation for Exemption 2(a)(5):

This exemption should be eliminated and the exemptions above for T5s and T8s should remove the reference to normal life since all models can now meet the existing mercury limits. In the case where long life T2 and T12 are really affected, the exemption should be rephrased accordingly to cover only those; the T5 and T8s should all meet 3 and 3.5 mg respectively no matter the lifetime.

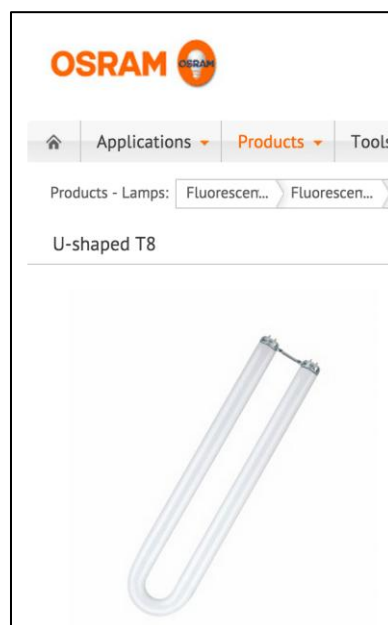
4.3.5 Exemption 2(b)(3) "Mercury in other fluorescent lamps not exceeding (per lamp): (3) Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9) " 15 mg may be used per lamp after 31 December 2011

Modern U-bent T8s, which are common fluorescent lamp types fall under this exemption for non-linear tri-band phosphor lamps with tube diameter >17 mm (e.g., T9) although they are not specifically called out in the title of this exemption. Because they have a lower mercury content than circular T9 lamps, they should have a lower mercury limit of **8 mg** rather than the current mercury limit of 15 mg. Below is information documenting that these types of energy-efficient fluorescent lamps can meet a lower mercury limit.

- Philips USA's U-bent T8 fluorescent lamps have 3 mg, according to the Philips mercury calculator.⁷⁵
- Sylvania's U-bent T8 fluorescent lamps have a mercury content ranging from 3.75 mg to 6 mg. (These are similar products to the European-made Osram products, but are made in the USA. It shows that equivalent products can be made with this lower mercury content.)
- Osram-brand U-bent T8 fluorescent lamps have a mercury content of 8 mg.⁷⁶

There has little pressure on Osram to lower the mercury content of these lamps in Europe due to the high RoHS mercury limit of 15 mg that is currently in place.

We could not find circular T9s in the catalogues and, therefore, it seems that these lamps are not affected.



⁷⁴ GE Lighting Company, *Data Sheet for LongLast T8 Fluorescent Lamps*, February 2013, http://www.gelighting.com/LightingWeb/emea/images/Linear_Fluorescent_T8_LongLast_Lamps_Data_sheet_EN_tcm181-12834.pdf

⁷⁵ Philips USA, *Mercury Calculator*, http://applications.nam.lighting.philips.com/us/sustainability_calculator/sustain_calc.php

⁷⁶ Osram, *Data Sheet for U-Shaped T8s*, 21 August 2105, http://www.osram.com/osram_com/products/lamps/fluorescent-lamps/fluorescent-lamps-t8/u-shaped-t8/index.jsp

Recommendation for Exemption 2(b)(3):

The mercury limit for non-linear tri-band phosphor lamps with tube diameter > 17 mm, including the U-bent T8s, should be lowered to 8 mg from the current limit of 15 mg.

4.4 . Section IV addresses the Renew Exemptions concerning High Pressure Sodium (vapour) lamps (4)(b and c) and Metal Halides (4e)

4.4.1. There are LED and low-mercury replacement lamps for high-mercury High-Pressure Sodium (HPS) HID lamps (4b and 4c).

High-pressure sodium lamps (HPS) are primarily used for street lighting and other exterior lighting applications, although they are rapidly becoming replaced by other technologies because:

- of their poor color quality – they appear yellow because their CRI is typically in the 20s;
- they cycle on and off, which causes maintenance problems; and
- because of their relatively short life.

Some HPS lamps have already been phased out from the market due to energy efficiency under the ErP Directive⁷⁷. For those that remain, HPS lamps with a lower mercury content and more-efficient ceramic metal halide lamps, which also have a lower mercury content than equivalent HPS lamps, are widely available as practical drop-in replacements.

There have been innovations in HPS lamps –including the use of amalgam mercury-dosing technology – that results in a lower mercury content and no trade-off on rated life or efficiency. For example:

- GE Lighting has a line of low-CRI (<25) Lucalux Standard High Pressure Sodium Lamps (in both tubular and elliptical shapes) in a wide array of common wattages including 70W, 100W, 150W, 250W, 400W and 1000W that can meet the following lower mercury levels through the use of amalgam technology.
 - $P \leq 155 \text{ W} = 20 \text{ mg}$ per burner
 - $>155 \text{ W} < P \leq 405 \text{ W} = 20 \text{ mg}$ per burner
 - $P > 405 \text{ W} = 25 \text{ mg}$ per burner

The Data Sheet for these products explains how the use of amalgam is resulting in HPS with high efficiency and a longer rated life than standard HPS lamps. Our review of the Data Sheet also shows that these products have a lower mercury content (see tables below).

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From GE's invention of HPS lighting in 1965 to today's advanced sources, GE Lucalox™ High Pressure Sodium lamps have led the way in quality and innovation. GE's exclusive amalgam reservoir design works to increase life expectancy and improve lumen maintenance. With efficiencies approaching 137 lumens per watt, GE Lucalox™ Standard lamps are the most efficient light source available with acceptable colour rendering. High efficiency results in lower operating costs and thus a lower electricity bill. Most Lucalox™ lamps have an average rated life of up to 28,500 hours. Long life means lower replacement and maintenance costs.⁷⁸

Lucalox™ Standard – Tubular Clear										
Product Code	46221	93767	44244*	97241	22453*	93010296	11678*	97240	45751	85886
Product Description	LU 70/90/ MO/T/E27 1/25	LU100/100/ MO/T/40	LU150/100/ 100/40	LU150/100/ HO/T/E40	LU250T/40	LU250/HO/T/ E40	LU400/T/40	LU400/HO/ T/40	LU1000/110/ T/40 4pk	LU1000/40
Nominal Wattage [W]	70	100	150	150	250	250	400	400	1,000	1,000
Rated Wattage [W]	71	99	149	157	252	258	393	404	970	1,000
Weighted Energy Consumption [kWh/1000 hrs]	77.98	107.57	163.71	172.70	276.78	283.42	431.83	444.40	1067.10	1100
Volts [V]	90	100	100	100	100	100	100	100	110	250
Cap	E27	E40	E40	E40	E40	E40	E40	E40	E40	E40
Nominal Lumen [lm]	6,000	9,600	15,300	17,500	28,500	32,500	48,000	56,200	13,000	130,000
Rated Lumen [lm]	6,420	9,880	15,490	17,600	28,750	33,270	48,300	56,200	133,340	127,590
Rated Lamp Efficacy [lm/W]	91	100	104	110	114	129	123	135	137	128
Energy Efficiency Class [EEC]	A+	A+	A+	A+	A+	A+	A+	A++	A++	A+
Mercury Content [mg]	10	13.3	16.4	12	16.4	20.0	15.8	20	21.1	24.8
Rated Average Life [h]	28,500	28,500	28,500	24,000	28,500	24,000	28,500	24,000	24,000	24,000
CCT [Ra]	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Ambient Temperature [°C]	25	25	25	25	25	25	25	25	25	25
Bulb	Soft	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Mass Weight [g]	65	155	155	140	155	165	200	177	445	368
Operating Position	Universal	Universal	Universal	Universal	Universal	Universal	Universal	Universal	Universal	Universal
Minimum Starting Temperature [°C]	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40

Lucalox™ Standard – Elliptical Diffuse					
Product Code	46217	93766*	44245*	44052*	44057*
Product Description	LU 70/90/MO /D/E27 1/12	LU100/100/MO /D/40	LU150/100 /D/40	LU250/ D/40	LU400/ D/40
Nominal Wattage [W]	70	100	150	250	400
Rated Wattage [W]	71	104	149	251	404
Weighted Energy Consumption [kWh/1000 hrs]	77.79	114.72	163.68	276.44	444.01
Volts [V]	90	100	100	100	100
Cap	E27	E40	E40	E40	E40
Nominal Lumen [lm]	5,800	9,200	14,500	26,000	48,000
Rated Lumen [lm]	6,180	9,230	14,620	26,690	48,090
Rated Lamp Efficacy [lm/W]	87	89	98	106	119
Energy Efficiency Class [EEC]	A	A+	A+	A+	A+
Mercury Content [mg]	10.0	13.3	16.4	16.4	15.8
Rated Average Life [h]	28,500	28,500	28,500	28,500	28,500
CCT [Ra]	2,000	2,000	2,000	2,000	2,000
Ambient Temperature [°C]	25	25	25	25	25
Bulb	Soft	Hard	Hard	Hard	Hard
Mass Weight [g]	65	130	175	195	250
Operating Position	Universal	Universal	Universal	Universal	Universal
Minimum Starting Temp. [°C]	-40	-40	-40	-40	-40

- **GE's Lucalox XO Superlife HPS Lamps** can meet our proposed lower mercury limit since the mercury content per burner is within these limits. (Note: each of these long-life lamps has two burners.) For example, the 100W and 150W models contain 26,6 mg of

⁷⁸GE Lighting (Europe), *Data Sheet for Lucalox Standard High Pressure Sodium Lamps, Tubular Clear & Elliptical Diffuse, 70W, 100W, 150W, 250W, 400W and 1000W*, October 2014, http://www.gelighting.com/LightingWeb/emea/images/HPS_Lucalox_Lamps_Data_sheet_EN.pdf

mercury; therefore, each burner has only 13,3 mg. The 400W model contains 38,3 mg; therefore, each burner contains <20 mg. The Data Sheet for this product, which uses ceramic technology, explains that these products are easy drop-in replacements for standard HPS lamps. It states:

*Lucalox™ XO Superlife lamps comprise a sodium discharge system operating at a high pressure within a ceramic arc tube which is mounted in an outer glass bulb. These lamps offer outstanding luminous efficacy, lumen maintenance thus reducing energy and maintenance costs....**Easy replacement of standard HPS lamps, fits standard HPS sockets – no new wiring, ballast or fixture are required.***⁷⁹

- Philips MASTER SON-T APIA Plus Xtra High Pressure Sodium Lamps, which contain a ceramic discharge tube, are this manufacturer's most energy-efficient and long-lasting HPS lamps (with rated lifetimes that range from 38.000 to 45.000 hours). It is promoted as "the longest life, most reliable" and "most cost-effective solution in road lighting. All of the HPS lamps in this family of products, which include common HPS wattages of 50W, 70W, 100W, 150W, 250W and 400W) can meet our proposed limits.⁸⁰



- Philips has a similar line of **MASTER SON-T Mercury-Free HPS Lamps** that are A+ rated for energy efficiency and have a similarly long rated life of 38.000 hours.⁸¹

In the long term, LEDs are increasingly being made to replace HPS lamps and are expected to increase for this application. A study cited by the International Energy Agency found [LED and induction lamp] impacts were about 30% lower in global warming potential, respiratory effects and ecotoxicity compared to high pressure sodium and metal halide luminaires [for street lighting and other outdoor lighting applications].⁸²

Many companies offer a variety of drop-in LED replacement lamp for HPS lamps. The benefits of LEDs over HPS lamps are many:

- LED lamps are much more energy efficient than HPS lamps.
- LEDs also have a longer rated life, which reduces their replacement and installation costs as well as their lifecycle environmental impacts.

⁷⁹ GE Lighting Company (Europe), *Data Sheet for Lucalox OX Superlife High Pressure Sodium Lamps, Tubular Clear 70W, 100W, 150W, 250W, and 400W; Elliptical Diffuse 50W, 70W and 100W*, May 2014, http://www.gelighting.com/LightingWeb/emea/images/HPS_Lucalox_XO_Superlife_Lamps_Data_sheet_EN_tcm181-12784.pdf

⁸⁰ Philips Company, *Data Sheet for MASTER SON-T APIA Plus Xtra High Pressure Sodium Lamps*, 3 July 2015, http://download.p4c.philips.com/l4bt/3/344247/master_son-t_apia_plus_xtra_344247_ffs_eng.pdf

⁸¹ Philips Company, *Data Sheet for MASTER SON-T APIA Mercury-Free HPS Lamps*, 28 August 2013, http://download.p4c.philips.com/l4bt/3/342556/master_son-t_apia_plus_hg_free_342556_ffs_eng.pdf

⁸² International Energy Agency, *Solid State Lighting Annex: Life Cycle Assessment of Solid State Lighting: Final Report*, 17 September 2014, http://ssl.iea-4e.org/files/otherfiles/0000/0068/IEA_4E_SSL_Report_on_LCA.pdf

- LEDs emit a higher quality of light, which is white rather than the yellow light that is emitted from HPS lamps.
- LED lamps do not cycle on and off.
- LEDs are mercury-free unlike HPS lamps.

Below are examples of LED lamps that can serve as a drop-in replacement for HPS and other HID lamps.

- **GE's LED Replacement for a 400-Watt HID lamp** uses 50% less energy for a similar light output (approximately 200 watts for the LED), it lasts at least twice as long as an equivalent HID lamp (50.000 hours for the LED versus 24.000 for the HID lamp), and improved light quality (its Colour Rendering Index is 73, compared to 22 for a typical HPS HID lamp).⁸³



- **Venture Lighting's Line of Retrofit LEDs**, which come in a variety of wattages that can replace a wide variety of HID lamps and high-wattage CFLs in indoor and outdoor applications. Its 20-watt to 150-watt LEDs can replace 70-watt to 400-watt HIDs including high-pressure sodium and metal halide lamps. With an A+ energy rating, these LED retrofit lamps can reduce energy consumption by 60% and have a rated life that is twice as long as standard HPS lamps. (See table listing LED wattages.)⁸⁴

The perfect LED replacement solutions for your lighting.

All VLED retrofit lamps offer:

- integrated high power drivers so no control gear is needed
- active cooling to maximise LED efficiency and lamp life
- high colour rendering index for quality output
- installation in indoor and weatherproof fittings
- -40°C to 45°C ambient temperature range
- CE, RoHS, ECA and IP20 conformity

The table below shows how VLED energy saving retrofit solutions can be used as possible alternatives.

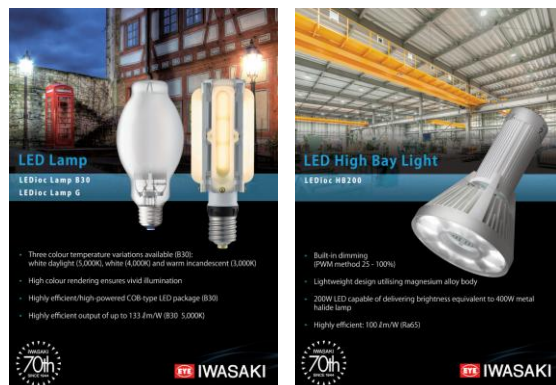
LUMENS	LED RETROFIT LAMP	NH/ HPS/ MH/ U	STANDARD GLS (E27)	COMPACT FLUORESCENT (E24)
2,000	20W	Replaces up to 70W	150W	25W
4,000	30W	Replaces up to 100W	250W	40W
8,000	40W	Replaces up to 150W	300W	50W
12,000	60W	Replaces up to 200W	400W	70W
16,000	80W	Replaces up to 250W	500W	90W
20,000	100W	Replaces up to 300W	600W	110W
24,000	120W	Replaces up to 350W	700W	130W
28,000	140W	Replaces up to 400W	800W	150W

 An advertisement for Venture Lighting's LED retrofit lamps. It features a red and orange geometric background. At the bottom, three different sizes of the LED retrofit lamps are shown. The lamps have a cylindrical shape with a wider base and a narrower top section.

⁸³ GE Lighting Company, *LED Replacement Lamp for 400 Watt HID*, GE webpage accessed 06 October 2015, <http://www.gelighting.com/LightingWeb/na/solutions/led-lamps-and-modules/led-replacement-for-hid/>

⁸⁴ Venture Lighting Europe, *A New Venture in Retrofit LED*, Accessed online on 06 October 2015, <http://www.venturelightingeurope.com/media/assets/downloads/vled-retrofit-brochure.pdf>

- Other EU-based lighting equipment distributors sell LED drop-in retrofit products that can directly replace HID lamps. One example is Eye Lighting Company, which offers a variety of exterior and high-bay/interior LED lamps that can replace high-pressure sodium and metal halide HID lamps, which are often used to light gymnasiums, streets, pedestrian walkways, stadiums, and more.⁸⁵



Since high-efficiency, long-lasting HPS lamps are available today and LEDs are expected to replace HIDs in the future, we are proposing lower mercury limits for this category and urge the European Commission to consider these findings and work to develop an expiry date for this category of mercury-containing lamps.

Recommendation:

For categories 4 b and c we recommend the Commission to monitor improvements in the availability, performance and price of LED replacements, to consider an expiry date as practical.

Exemption 4(c)(I-III) "Mercury in other High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner):

- I) $P \leq 155\text{ W}$: 20 mg per burner***
- II) $155\text{ W} < P \leq 405\text{ W}$: 20 mg per burner***
- III) $P > 405\text{ W}$: 25 mg per burner"***

To be met after 1 September 2018 at the latest

4.4.2 Metal Halides

Due to resource constraints, we were unable to undertake a comprehensive analysis for Metal Halides, however we consider these comments/examples below sufficient for our recommendation.

Quartz metal halide lamps – particularly low-wattage models – can be readily replaced with more energy-efficient ceramic metal halide (CMH) lamps, which have less mercury and longer rated

⁸⁵ Eye Lighting Company, *Iwasaki LED Lighting Brochures*, 2014, <http://www.eyelighting.co.uk/public/images/pdf/brochures/LEDleaflets2014.pdf>

life. Below are several examples:

- Osram's **100-watt Powerstar HQI quartz metal halide lamp** has a mercury content of 11,2 mg, while its **100-watt Powerball HCl ceramic metal halide lamp** has a mercury content of only 8,5 mg and has a longer rated life of 12,000 hours. In addition, the quartz MH lamp is less energy-efficient (Class A)⁸⁶ than the ceramic MH (Class A+).⁸⁷



- According to GE Lighting there are many benefits to ceramic MH lamps over quartz MH lamps, including their high efficiency and long life:

From bright light and excellent colour rendering to high reliability, a long life and a choice of lamps to suit all kinds of different applications – indoors and outdoors – there are dozens of reasons to choose GE's Ceramic Metal Halide (CMH) lamps. Applications range from accent and spot lighting to flood and area lighting, and they provide an extremely effective replacement for High Pressure Sodium (HPS) and Quartz Metal Halide Lamps.

More reasons to choose GE's CHM solutions:

- Widest range of wattages from 20W to 400W
- Highly controllable point source of light
- Wide range of formats for designers flexibility
- GU6.5, G8.5, G12, E27/E40 and Rx7s
- MR16 and PAR reflectors
- Tubular and elliptical versions
- High efficacy – up to 111 lm/W⁸⁸
- Long life – up to 24,000 hours
- Consistent colour over life
- Colour temperatures: 3000K & 4200K
- UV control
- Selection of approved ballasts

Another benefit of GE's ceramic MH lamps is that they often have a lower mercury content when compared to its equivalent quartz MH lamp. For example:



⁸⁶Osram, *Data Sheet for Powerstar HGI Quartz Metal Halide Lamps*, 30 September 2015, http://www.osram.com/osram_com/products/lamps/high-intensity-discharge-lamps/metal-halide-lamps-with-quartz-technology/powerstar-hqi-e-coated/index.jsp

⁸⁷Osram, *Data Sheet for Powerball HCl Ceramic Metal Halide Lamps*, 30 September 2015, http://www.osram.com/osram_com/products/lamps/high-intensity-discharge-lamps/metal-halide-lamps-with-ceramic-technology/powerball-hci-ep/index.jsp

⁸⁸GE Lighting Company (Europe), *Ceramic Metal Halide Lamps*, Accessed 15 October 2015, <http://www.gelighting.com/LightingWeb/emea/products/technologies/hid/cmh.jsp>

- GE manufactures both quartz and ceramic double-ended MH lamps in equivalent wattages. Its **150-watt Arcstream Double-Ended Quartz MH Lamp**⁸⁹ has a mercury content of 14,5 mg, while its **150-watt ConstantColor Ceramic MH Lamp**⁹⁰ has a mercury content of only 10 mg. Moreover, while the quartz MH lamp has a Class A rating and a rated life of 12.000 hours, the equivalent ceramic MH lamp has a Class rating of A+ and a rated life of 15.000 hours.
- Philips offers a wide array of ceramic MH lamps that are environmentally preferable replacements for quartz MH (and sometimes also HPS) lamps. For example:
 - Its **250-watt MASTER Plus CityWhite Tubular Ceramic Metal Halide** lamp contains only 25,3 mg of mercury and has a Class A+ rating and a rated life of 27.000 hours.⁹¹ In contrast, its equivalent 250-watt quartz MH lamp (MASTER HPI-T Plus Quartz Metal Halide Lamp contains 36 mg of mercury and has a Class A+ rating, also, but a shorter rated life of 20.000 hours.⁹²



Since quartz and ceramic MH lamps are very often available in the same shape and type of lamps and bases, they are almost always interchangeable. Therefore, offering the RoHS Exemption on the ceramic models only would result in use of these easy, drop-in replacements with multiple environmental benefits, including significant mercury reduction as well as energy savings.

Recommendation for Exemption 4(e): “Mercury in metal halide lamps”

Only allow an Exemption for Ceramic Metal Halide Lamps (not for Quartz Metal Halide Lamps) up to and including 250 Watts by 1 September 2018 as well as all metal halides over 250 watts.

Also, monitor improved availability, performance and price of LED retrofit lamps for metal halide lamps and consider an expiry date for some types of MH lamps as they become practical.

⁸⁹ GE Lighting Company (Europe), *Arcstream Double Ended Quartz Metal Halide Lamps with UV Control*, November 2013,

http://www.gelighting.com/LightingWeb/emea/images/Metal_Halide_Arcstream_Double_Ended_Lamps_Data_sheet_EN_tcm181-12560.pdf

⁹⁰ GE Lighting Company (Europe), *ConstantColor CMH TD Double Ended Ceramic Metal Halide Lamps: 35W, 70W and 150W*, August 2013,

http://www.gelighting.com/LightingWeb/emea/images/ConstantColor_CMH_TD_Double_Ended_Lamps_Data_sheet_EN_tcm181-12599.pdf

⁹¹ Philips Company (UK), *MASTER CityWhite Ceramic Metal Halide Lamps*, 28 August 2013,

http://download.p4c.philips.com/l4bt/3/322972/master_citywhite_cdo-et_322972_ffs_eng.pdf

⁹² Philips Company (UK), *MASTER HPI-T Plus Quartz Metal Halide Lamps*, 29 August 2015,

http://download.p4c.philips.com/l4b/9/928481300098_eu/928481300098_eu_pss_enggb.pdf

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