LIGHTINGEUROPE
THE VOICE OF THE LIGHTING INDUSTRY

Request to renew Exemption 1(d)

under the RoHS Directive 2011/65/EU

Mercury in single-capped (compact) fluorescent lamps for general lighting purpose ≥ 150 W

Date: January 15, 2015

Contents

1 Name and contact details

Industry Association: LightingEurope
Name: Attila Morotz
Function: Policy Director

Tel.: +32 2 706 86 07
E-Mail: attila.morotz@lightingeurope.org
Address:
Diamant Building
Boulevard Auguste Reyers 80
1030 Brussels, Belgium

2 Reason for application

LightingEurope submits this application to:	*request for extension of existing exemption* ***no. 1(d) in Annex III***
LightingEurope proposes to continue using the existing wording which is:	*Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):* *1(d) For general lighting purposes ≥ 150 W: 15 mg*
LightingEurope requests a duration of	*Maximum validity period required*

3 Summary of the exemption request

The validity period of DIRECTIVE 2011/65/EU Article 5(2) Annex III Exemption 1(d) will end automatically per 21/07/2016, unless an application for renewal has been made to the Commission in accordance with Annex V.

With reference to the above, this request concerns the extension of the current Annex III exemption: 1(d) of Directive 2011/65/EU Article 5(2) regarding mercury in single-capped (compact) fluorescent lamps for general lighting purposes ≥ 150 W.

One of the main characteristics of the lamps in this category is that they emit high lumen packages (12000 and more lumen). Most of these lamps are self-ballasted. They are used in The LED development in these high lumen packages is focussing typically on new luminaire solutions instead of retrofit lamps. As a result, not many replacement solutions for this specific category in LED are available in the market.

The LED solutions that come to the market are not always suitable as one to one replacement for CFL lamps ≥ 150 W. The following replacement issues in existing luminaires will not be solved by the LED technology on short notice: size, form factor, light distribution, light output, weight, heat management. Next to these issues lamps operated on separate ballasts can face problems with electrical compatibility, because many different types of gears (both conventional ballast and electronic control gear) are installed in the European market. Examples of these issues are reduced performance in dimmed mode and flickering. The person installing a LED based solution on ballasts originally designed for CFL is in most cases executing the rewiring and will as such be responsible to check if the new combination fulfils all requirements, including when the original lamp type is installed back again. This could mean that the CE conformity label of the complete luminaire is no longer valid.

Based on above arguments LightingEurope is of the opinion that for CFL lamp types offering the high lumen packages as discussed in this exemption not always a suitable replacement LED lamp is available. Removing these CFL lamps from the market would therefor force early new luminaire investments, which would unnecessarily and dramatically increase the waste of hazardous substances.

LightingEurope believes that above arguments justify the request for extension of the exemption for CFL lamps ≥ 150 W with a maximum validity period and no expiry date.

4 Technical description of the exemption request

4.1 Description of the lamps and their applications

4.1.1 Lamps covered by this exemption

This exemption covers Single capped (compact) fluorescent lamps ≥ 150 W: 15.0 mg.

Figure 1: Examples of fluorescent lamps: hand holding a low power lamp for reference

Compact fluorescent lamps (≥ 150 W) are mostly lamps for professional use.
They can either have the electronic control gear integrated in the product (self-ballasted CFLs or CFLi-s) or their control gear is separated from the lamp (plug-in CFLs or CFLni-s). Both types are mostly used for professional applications in offices, industry, retail and markets and street lighting. The CFL lamps in general have a colour rendering (CRI) above 80 and are available in a wide range of colour temperatures from warm white (2700K) to cool daylight (6500K). The energy efficiency and lifetime differ for lamps used in the different applications in the range of 70-80 lm/W and 10.000 – 20.000 h respectively. Typical for this category of lamps is their high lumen package starting at 12000 lumen.

4.1.2 Applications covered by this exemption

Typical applications are offices, public buildings, shops supermarkets and department stores, hotels, restaurants industry outdoors in residential areas and parks. Examples of these applications are illustrated in the pictures below.

Examples of luminaires:

[1]

Examples of an application in Retail segment:

[1] For more information, see: http://www.kbrhorse.net/streetlights/preserving_street_lights03.html

Examples of public buildings:

4.1.3 Annex I category covered by this exemption

List of relevant Annex I categories for this exemption

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☒ 5

☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11

Application in other categories, which the exemption request does not refer to: N/A

Equipment of category 8 and 9: N/A

The requested exemption will be applied in

☐ monitoring and control instruments in industry

☐ in-vitro diagnostics

☐ other medical devices or other monitoring and control instruments than those in industry

LightingEurope is of the opinion that lamps in general are category 5, because the most are used for general illumination. However, they have some of the characteristics of components (used in luminaires), consumables (finite lifetime and regularly replaced) or spare parts, lamps in luminaires have to be replaced when they cease functioning). Some manufacturers of electrical equipment in other RoHS categories may install fluorescent lamps into their equipment for general illumination purposes and so they will need to use lamps that comply with the RoHS directive, however the products that they place on the market are not category 6 but may be household appliances, medical devices or potentially in any RoHS category 1 - 11.

LightingEurope is aware of the difficulty to unambiguously classify certain lamps in the category set out by RoHS legislation. For lamp producers it is essential to have legal certainty regarding the possibility to put the products on the market irrespective of the planned application as we are not able to control the use of the lamps in products falling in other categories or out of the RoHS scope. In practice, most lamps are installed in buildings for lighting applications (category 5), but some are used in other types of equipment in all other RoHS categories. The way that lamps are used has no effect on lamp design so will not affect this exemption request.

4.2 Description of the substance

4.2.1 Substance covered by this exemption

LightingEurope is asking for exempting

☐ Pb ☐ Cd ☒ Hg ☐ Cr-VI ☐ PBB ☐ PBDE

4.2.2 Function of mercury in lamps

A small amount of mercury is intentionally dosed in all fluorescent lamps as it is essential for the low-pressure gas discharge. When electric current flows through the lamp bulb (=discharge tube), the mercury atoms inside are excited and produce UV radiation. This UV light is then converted into visible light by the fluorescent coating on the lamp bulb with a high degree of energy efficiency.

4.2.3 Location of mercury in lamps

Mercury is present in the so-called discharge tube.

The mercury is instrumental in the conversion of electrical energy into the UV radiation, which is converted subsequently by a phosphor into the emitted visible light.

4.2.4 Amount of mercury

Mercury is dosed in the discharge tube during lamp manufacturing as homogeneous material (pill, capsule or as amalgam). This technology enables dosing of the small and accurate amount of mercury that is needed, without unintended losses. The amount of mercury dosed per lamp depends on aspects like lamp power, optical performance and anticipated lamp life. This is reflected in the current individual RoHS exemptions. During lamp life, mercury is consumed inside the discharge tube itself. It is bound amongst others to the phosphor layer and the glass[2]. Once the mercury is bound to these elements, it is no longer available to emit ultraviolet light.

One of the principal design rules to create higher lumen packages in fluorescent lamps is to increase the length of the discharge. Consequently higher lamp wattage involves more glass and phosphor surface, thus more mercury consumption during lamp life and therefore a higher initial mercury dose. Coating of phosphors and glass can give a reduction of the Hg consumption, but in general it remains a function of the lamp dimensions and the lifetime. Next to this, processing has its influence, for instance because the actual dose per lamp scatters around the nominal dose, while the threshold value as set by RoHS directive sets a maximum limit.

For single capped (compact) fluorescent lamps in the scope of the Exemptions 1(d), the maximum dosed mercury is 15 mg.

The influence of mercury consumption on the required dose

The amount of mercury which is needed for the low pressure discharge itself is very low, typically below 0.1mg per lamp. But there are many processes within the burner, which make a large part of the mercury unavailable for the discharge over lifetime. This is called mercury consumption. The mercury consumption is much higher than the mercury amount needed for the discharge, viz. in the order of a milligram. This is the reason why more mercury has to be dosed to make sure the intended lifetime is not shortened due to too low available mercury. Therefore a balance has to be found between mercury needed

[2] *Reference: I. Snijkers-Hendrickx et al, Low-Mercury Containing Discharge Lamps. Sustainable and Environmental Friendly Lighting Solutions, LS 11*

over lifetime, mercury variance per dosing unit but also the measurement failure when estimating the amount of mercury in a lamp for market surveillance.

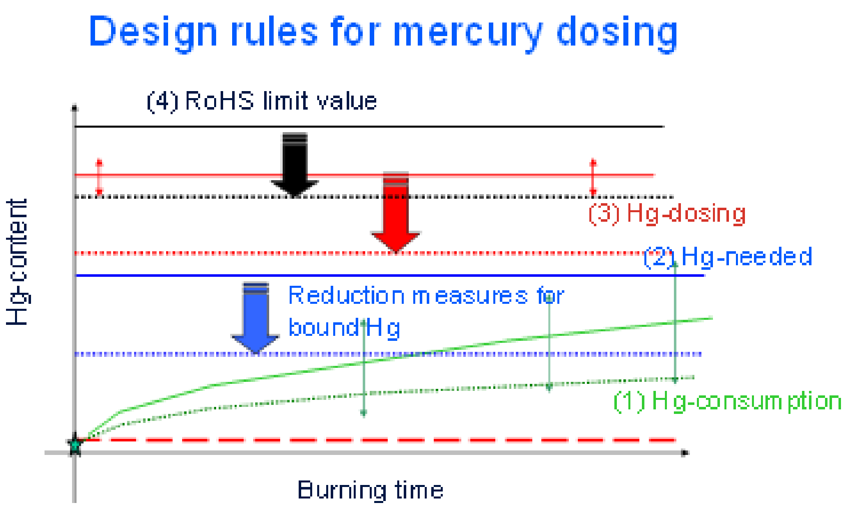

Figure 2: Design rules for mercury dosing in fluorescent lamps, schematically showing the process of setting RoHS limit values based on insights in mercury consumption and mercury dosing.

The lowest (red dashed) line in Figure 2 gives the ideal situation for a low pressure mercury discharge: there is just enough mercury for the discharge to properly function. For a compact fluorescent lamp this is typically in the order of 0.005 to 0.05 mg per lamp (in the gas-phase), depending on the lamp dimensions. However, because of the several mercury consumption mechanisms a significantly higher amount must be dosed (which will be explained below). So up to now a lamp with normal functional properties over lifetime, but dosed with only 0.005 to 0.05 mg could not be designed.

In practice, mercury from the discharge gets consumed over lamp life. The mercury gets mostly deposited and effectively bonded to the glass and the phosphor layer. This is reflected by the full green curve (1) in Figure 2, which represents more or less a square root relationship with lamp life. The longer the burning time, the higher the amount of mercury needed. The variance in this mercury consumption, as depicted by the arrows, is considerable and depends on many factors (see below for counteracting measures). To obtain the designed lamp life, the right amount of mercury has to be dosed, taking into account the consumption during lamp lifetime and the variance. The solid blue line 2 in Figure 2 represents the typical amount that is needed and the solid red line 3 is the amount that also incorporates the variance. Alternatively, this target value is called nominal or average value, and can be listed in catalogues. This average value is lower than the threshold value so the actual amount per lamp is lower than the limit set by the directive.

The solid black line 4 in Figure 2 is the line representing the RoHS limit (expressed as mg per lamp), the value of which, as explained before, has to take into account both variances of mercury consumption and of mercury dosing. On the one hand, we like to have this value as low as possible, but on the other hand, it should be safely chosen to (1) eliminate the customer risk of a non-performing product over the designed lamp life and (2) to be able to demonstrate in internal manufacturer's tests and in market surveillance tests that products comply with the RoHS Directive. This leads to a built-in safety margin on top of the target mercury dose, finally leading to RoHS content limit. The lifetime and performance of CFL lamps in Europe are regulated[3],[4].

Figure 3 shows the dosing variation relatively to the RoHS threshold value.

[3] *Commission regulation (EC) No. 244/2009, March 18, 2009*

[4] *Commission regulation (EC) No. 245/2009, March 18, 2009*

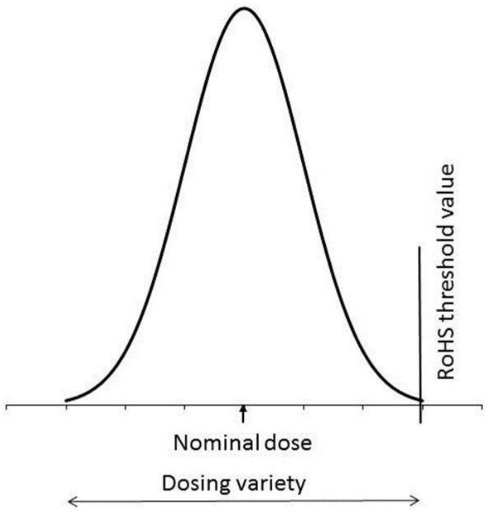

Figure 3: Dosing variety in mercury

Key to reduction of mercury is influencing the factors that determine mercury consumption. These include:

- Glass type and protective coating
- Type phosphor material
- Interaction with gasses and impurities
- Lamp processing during manufacturing
- Lamp-ballast interaction during operation

It is also important to take into account the technical capability to reduce both the absolute mercury dose to very low values, and to reduce its variance. Hence, by combining a series of interlinked and complex measures, in a consistent manner, the mercury has been reduced, based on scientific and technical progress in recent years.

4.2.5 Environmental assessments, LCAs

There are several external LCA's performed regarding lighting. There is general agreement, that the main environmental impact is created during the use phase, meaning through electricity consumption when burning the lamp.[5] This means that currently the energy efficiency of the lamp is the determining parameter. Specifically regarding mercury, the biggest amount is released to the environment by power plants

[5] *(see Enlighten report, Section 5, Ch. 3 fig. 4 & 5* p. 111-112 http://www.learning.enlighten-initiative.org/ebook/en_lighten_english_complete.pdf*)*

when generating energy (especially when fossil fuel is the primary power source).[6] Technological advancements in the lighting industry have resulted in a significant reduction in the amount of mercury used in many types of fluorescent lamps over the last two decades.[7] Manufacturers have developed technology that enables a small amount of mercury to be 'dosed' or placed inside a CFL.[8]

For the future however the manufacturing part in the LCA becomes more relevant[9], because the energy consumption by the lamp is already dramatically reduced (higher energy efficiency leads to decreased negative environmental impact).

The total life cycle environmental impact of the light sources is interesting due to the importance of the lighting sector in the total energy consumption. The lighting sector is filled with different light sources of different shapes and sizes. The environmental and economic performance comparison of those various types is difficult, due to lack of established rules for the LCA of light sources. As a result, it creates distortion and makes it difficult to numerically compare the results of the LCAs.

Historically the comparison was done with respect to incandescent lamps[10], where it was concluded that the net mercury emission over life cycle is reduced when changing from incandescent to CFL lamps. More recently LCA is done in comparison with LED sources[11], however here it is even more challenging to compare these various-shaped LED light sources to conventional lamps and luminaires. LED technology provides new possibilities for manufacturers to design luminaires, lamps, components and packages

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[6] *(see Enlighten report, Section 5, Ch. 3 fig.6* p. 111-112 http://www.learning.enlighten-initiative.org/ebook/en_lighten_english_complete.pdf*)*

[7] *ENERGY STAR. (2012). Frequently Asked Questions Information on Compact Fluorescent Light Bulbs (CFLs) and Mercury. Retrieved March 29, 2012, from: http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf,*

[8] *Complete paragraph UNEP toolkit, p.106*

[9] *Life cycle assessment of light sources – Case studies and review of the analyses Leena Tähkämö, Aalto University publication series DOCTORAL DISSERTATIONS 111/2013*

[10] *Pfeifer RP.Comparison between filament lamps and compact fluorescent lamps. International Journal of Life Cycle Assessment 1996; 1: 8—16.; Parsons D. The environmental impact of compact fluorescent lamps and incandescent lamps for Australian conditions. The Environimental Engineer 2006; 7: 8—14; Gydesen A,Maimann D. Life cycle analyses of integral compact fluorescent lamps versus incandescent lamps: RightLight, Stockholm, Sweden, 1991*

[11] *Department for Environment, Food and Rural Affairs (DEFRA).Life Cycle Assessment of Ultra-Efficient Lamps.Navigant Consulting Europe Ltd. 2009.; Analysis and comparison of incandescent, compact fluorescent lamps and light emitting diode lamps in residential applications, The scientific consulting group inc. (2010) submitted to the U.S. environmental protection agency office of the science advisor; Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products, The U.S. Department of Energy (DOE) building technologies office; Life cycle assessment of light sources – Case studies and review of the analyses, Leena Tähkämö, Aalto University publication series DOCTORAL DISSERTATIONS 111/2013; Life Cycle Assessment of Ultra-Efficient Lamps SPMT08_069, Navigant Consulting Europe, Ltd. A research report completed for the Department for Environment, Food and Rural Affairs,*

containing LED chips, thus the question on which basis those should be compared remains.[12]

In some analyses the current LED alternative comes close to compact fluorescent lamps. Another however concludes that LED lamp product manufacturing uses approximately three times more energy than does the manufacturing of a CFL with comparable light output[13]. Thus it needs to be acknowledged that at present no widely accepted consensus exists among experts. However one must consider the improving LED alternative in the right perspective: according to reference[14] the LED sources are expected to have a real advantage in the total life cycle over time, at least if energy efficiency keeps improving at the same rate and expected long lifetime is proven.

5 Waste management

5.1 Waste streams

☒ Article is collected and sent without dismantling for recycling

☐ Article is collected and completely refurbished for reuse

☐ Article is collected and dismantled:

- ☐ The following parts are refurbished for use as spare parts: _____
- ☐ The following parts are subsequently recycled: _____

☐ Article cannot be recycled and is therefore:

- ☐ Sent for energy return
- ☐ Landfilled

Single capped (compact) fluorescent lamps are in the scope of EU Directives

2002/96/EC - WEEE and 2012/19/EU– WEEE Recast. Take back systems are installed in all EU Member States: end users and most commercial customers can bring back the lamps free of charge. Single capped (compact) fluorescent lamps are collected separately from general household waste and separately from other WEEE waste. Also a dedicated recycling process exists for lamps because, according to legislation, the mercury shall be

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[12] *Life cycle assessment of light sources – Case studies and review of the analyses Leena Tähkämö, Aalto University publication series DOCTORAL DISSERTATIONS 111/2013, p. 17-18*

[13] *U.S. Department of Energy. (2012). Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products. Retrieved March 10, 2012 from http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_LED_Lifecycle_Report.pdf*

[14] *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products, The U.S. Department of Energy (DOE) building technologies office*

removed from the gas discharge lamps. Mercury is recovered in specialised facilities by distillation. Figure 4 shows the various steps in the recycling process:

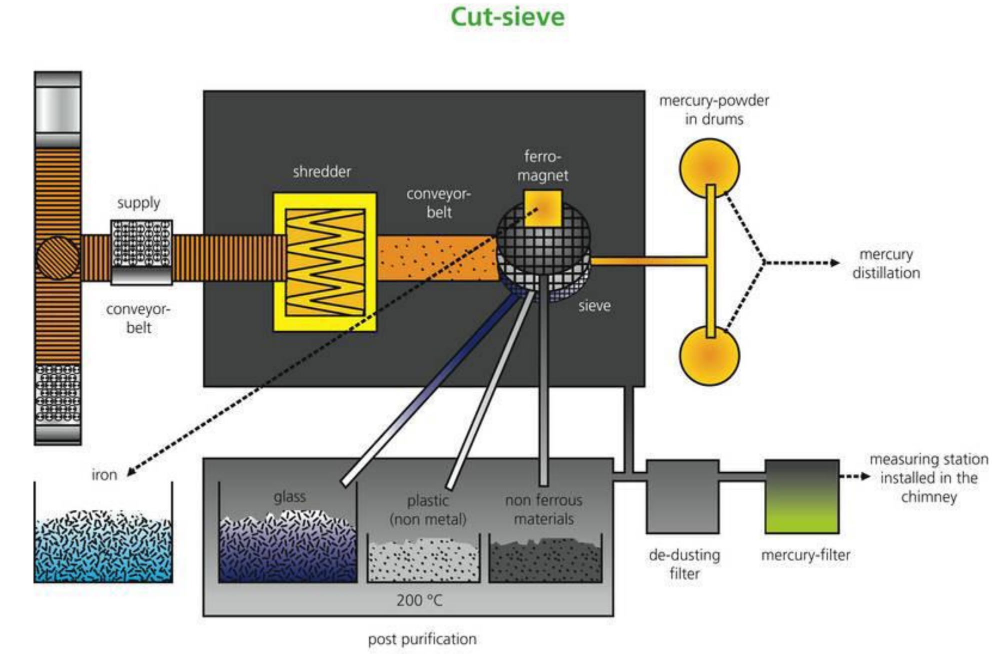

Figure 4: Recycling steps of fluorescent lamps in Indaver (Belgium). Source:www.indaver.be/waste-treatment/recycling/mercurial-waste.html

The next picture, Figure 5, illustrates the specifics of recycling the mercury:

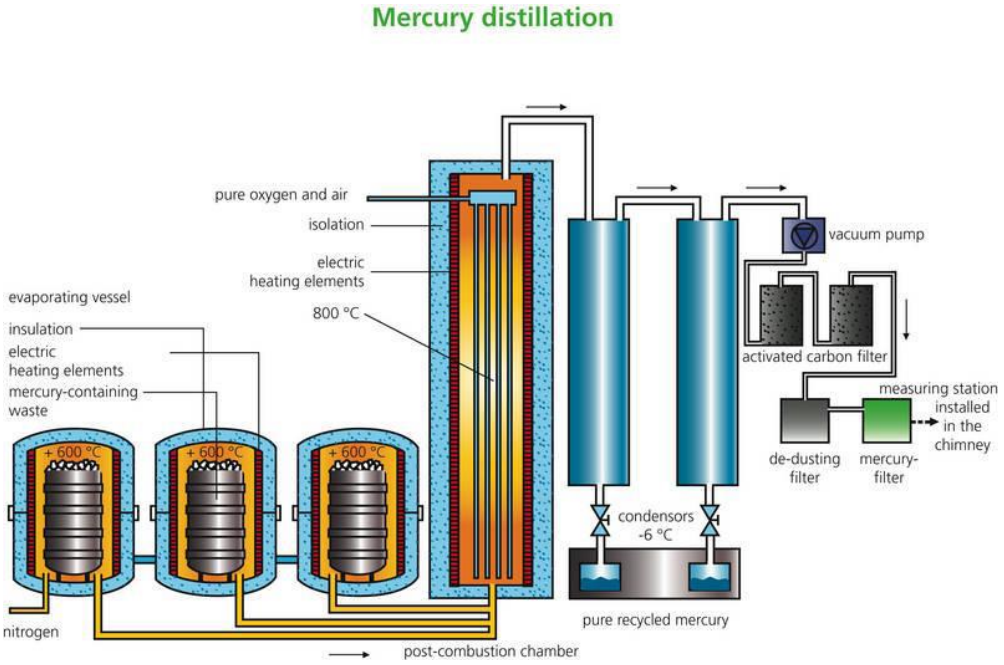

Figure 5: Specific recyclcing steps of mercury in Indaver (Belgium).

European legislation on Waste Electrical and Electronic Equipment makes producers responsible for end of life products within this category as from August 13th, 2005. Target setting as consequence of the present legislation is 45% of EEE placed in the market by 2016, rising to 65% in 2020 per year for all categories.

European Lamp Companies have founded Collection & Recycling Organizations in the EU Member-States, with the objective to organize the collection and recycling of gas discharge lamps. Goal is to comply with present and probable future EU legislation and meet or exceed national targets.

In general the following channels have been established in the respective member-states providing countrywide coverage:

- Direct collection from large end users:

  Containers have been made available, ad hoc or permanently, and will be collected upon notification by the end user that the container is full.

- Collection through distribution:

  Wholesalers and Retailers place collection means at their premises respectively in their shops. Collection is done upon notification.

Figure 6: 'Wecycle' collection container

- Collection through municipalities:

  Where infrastructure allows collection means are placed at municipality depots.

Campaigns are being executed or have been planned to re-enforce the role of the government to educate the population that gas-discharge lamps have to be disposed of in an environmentally friendly way. Examples of how take back from both consumers and professional users is organized are via dedicated containers like ‘Wecycle’ in the Netherlands (Figure 6) and ‘Recylum’ in France (Figure 7).

Figure 7: ‘Récylum’ collection container

5.2 Amount of mercury in WEEE

☐ In articles which are refurbished
☒ In articles which are recycled
☐ In articles which are sent for energy return
☐ In articles which are landfilled

Amount of substance entering the EU market annually (base year 2013) through application for which the exemption is requested:

Market information from various sources (e.g. McKinsey, IHS, China export data) indicates a total shipped volume of CFL lamps in Western Europe volumes of roughly 600 Mpcs for. This volume includes all wattages.

The collection rate of lamps in Europe compared to the average amount of lamps put on the market during 2010 – 2013 is shown in below graph (Figure 8) based on Collection & Recycling Service Organization (CRSO) data consolidated by Philips Lighting.. It also includes the targets set for 2016 and 2019. Please be aware that this graph includes all lamp types, not specifically the CFL ≥ 150 W types.

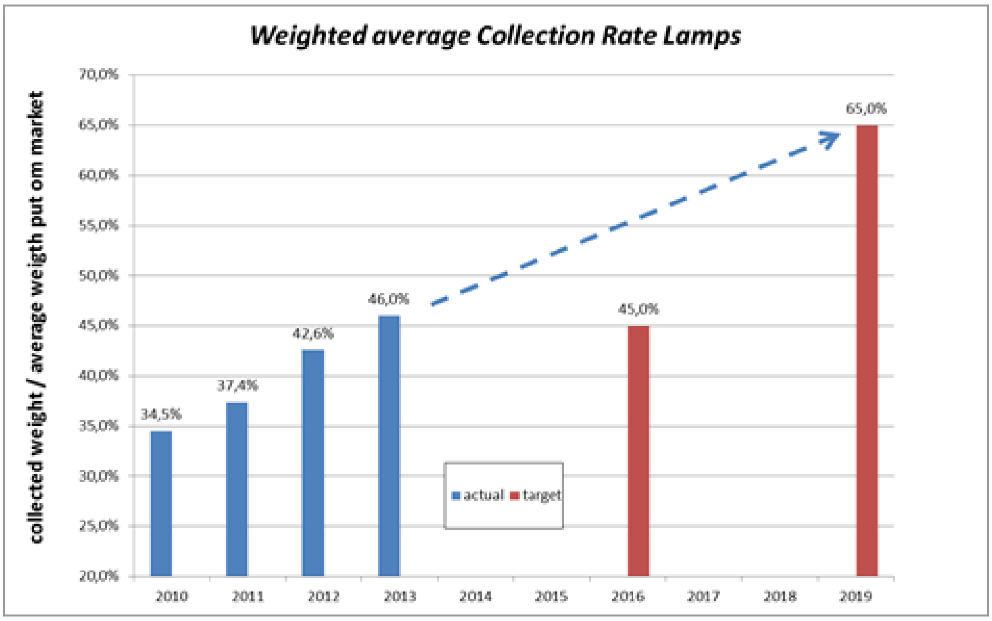

Figure 8: Collection rate of lamps

Reporting on the collection of lamps is available on 2 groups:

- CFL lamps and LED retrofit lamps
- PLL (specific CFL lamp type), Fluorescent tubes

This makes it impossible to give specific accurate figures for CFL lamps in the segment 50 to 150W as the available information covers the whole CFL family.

The majority of the wattages sold are below 30W, so are included in exemption 1a. An external report indicating the exact wattage split is not available. Based on experience of the LE members, CFL lamps ≥ 150 W count for less then 0.5% of the total CFL volumes in Europe. It is difficult to estimate because the members of LightingEurope do not produce these products but expect the customers would like to continue using them since there is no alternative as efficient.

The maximum allowed mercury content for CFL lamps ≥ 150 W is 15 mg.

Combining these numbers indicate that in 2013 (0.5% * 342Mpcs * 15 mg) a maximum of 26 kg of mercury has entered the European market (market volume in pieces taken from VHK report for EU)[15].

The McKinsey study as used in the VHK report[16] gives the following rough forecast of volumes in 2016 and 2020. Using this information source and their assumptions gives the following rough forecast for the amount of mercury entering to EU market with CFLs ≥ 150 W:

2016: (0.5% * 220Mpcs * 15 mg) = 17 kg

2020: (0.5% * 93Mpcs * 15 mg) = 7 kg

It is emphasized that this is an estimation of the upper limit based on the threshold value of the directive. In reality the amount entering the market will be lower as the average dose per lamp is most often below this threshold value (see 4.2.4).

The total amount of mercury entering to the EU market in compact fluorescent lamps covered by this exemption will decrease in the coming years.

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[15] *Preparatory Study on Light Sources for Ecodesign and/or Energy Labelling Requirements ('Lot 8/9/19'). Draft Interim Report, Task 2 by Prepared by VHK, in cooperation with VITO and JeffCott Associates Date: 19 November 2014, Table 1.*
16 Preparatory Study on Light Sources for Ecodesign and/or Energy Labelling Requirements ('Lot 8/9/19'). Draft Interim Report, Task 2 by Prepared by VHK, in cooperation with VITO and JeffCott Associates Date: 19 November 2014, Table 29.

It is also important to note that almost every country within EU has a collection and recycling service organisation (Figure 10, status per 2009). The collection and recycling rate of CFL lamps is continuously increasing, contributing to the overall mercury reduction program.

Figure 9: Map of ELC Collection and Recycling Service Organisations (CRSOs). Source: Environmental aspects of lamps[17]

[17] ELC: Environmental aspects of lamps, second edition, APRIL 2009
http://www.elcfed.org/documents/090811_elc_brochure_environmental_aspects_lamps_updated_final.pdf

6 Substitution

Can the substance of this exemption be substituted?

☐ Yes, by
- ☐ Design changes:
- ☐ Other materials:
- ☐ Other substance:

☒ No
Justification: see in below chapters

6.1 Substituting mercury in the fluorescent technology

Fluorescent lighting technology.

Fluorescent lamps need a certain amount of mercury since it is consumed over life. Technology has evolved over the last decade. And the average amount of mercury within fluorescent technology per lamp is considerably reduced (Figure 11.)[18]

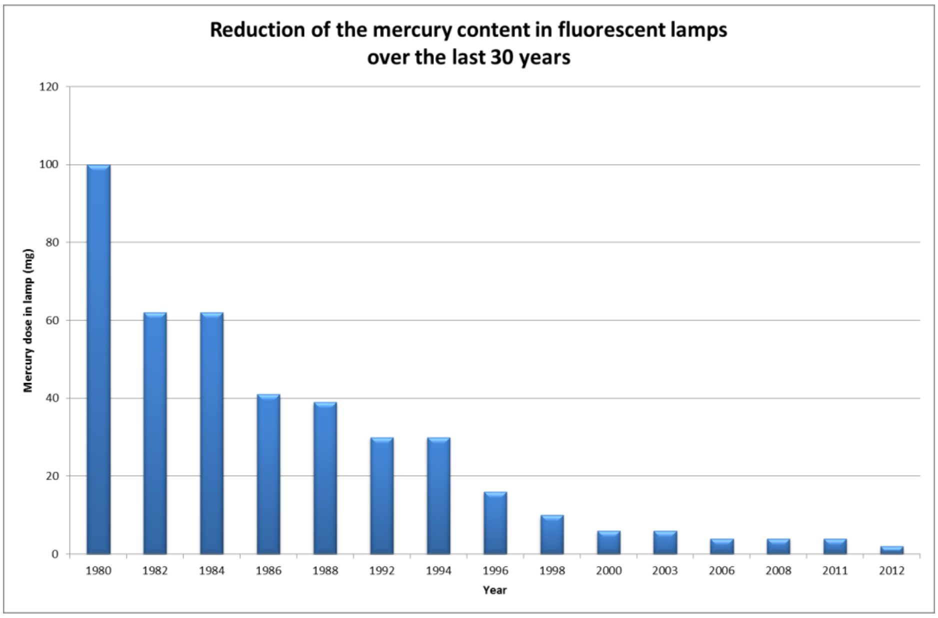

Figure 10: Mercury content of fluorescent lamps

[18] http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_VI/Request_7/Request_No7_1st_Clarification_Questions_20120622_final.pdf

But low pressure fluorescent lamps without mercury are not possible despite of all the research that has been done on this subject:

The mercury discharge is highly efficient in transforming electrical energy into light. The technology has only two drawbacks: first the generated UV radiation needs to be transformed into visible light, a process for which large losses occur: this is due to the Stokes shift (an energetic UV photon generates a visible photon which has a much lower energy) and secondly the discharge inherently contains mercury as the source to create the UV photons[19].

Attempts to generate UV with noble gases succeeded partially[20]. However the plasma radiates in the deep UV. At such wavelengths, the Stokes shift is even larger causing lower energy efficiency. The lack of suitable phosphors[21] prohibited progress in this direction. Other alternatives investigated are low pressure metal halides (for example InI, InBr, GaI3)[22]. Such plasma's generate the visible light directly without the Stokes shift of the phosphor[23]. There are alternatives from research but the energy efficiency in prototypes lamps is significantly reduced to approx. 40lm/W level or below. Mass production is not (yet) feasible. More over these are thus far only found feasible for very high light fluxes.

With the arrival of the first energy efficient LED white light sources and the perspective of further improvements, research to alternative gas discharges has stopped at most companies and universities.

Using noble gases instead of mercury leads to a dramatic energy efficiency drop, well below 40 lm/W. Upgrading to similar performance would imply unjustifiable efforts with unknown chance of success (limit of the technology reached) and possibly resulting in a larger negative environmental impact due to higher energy consumption.

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[19] *M Haverlag, Mercury-free discharges for lighting, J. Phys. D: Appl. Phys. 40 (2007)*

[20] *R Bussiahn, S Gorchakov, H Lange, D Loffhagen and D Uhrlandt, Ac operation of low-pressure He–Xe lamp discharges, J. Phys. D: Appl. Phys. 40, 3882 (2007)*

[21] *J. Dexpert-Ghysa, Re-processing CRT phosphors for mercury-free applications, J. of Luminescence, 129, 1968, (2009)*

[22] *D.Smith, J. Michael, V. Midha, G. Cotzas and T. Sommerer D. Smith et al Efficient radiation production in a weakly ionized, low-pressure, nonequilibrium gallium-iodide positive column discharge plasma J. Phys. D: Appl. Phys. 40 3842 (2007). More references can be found in the series: International Symposium on the science and technology of Lighting LS1-14.*

[23] *An example if a UV photon of 256 nm from mercury is transformed in a visible photon of 555nm (maximum eye sensitivity) 56% of the energy is lost to heat. In xenon the UV photon is formed around 185 nm this loses 67% of the energy when transformed into the same visible photon.*

6.2 Substituting fluorescent technology by mercury free technology

Currently, the lighting market is rapidly changing base from discharge lamp technology to LED technology. The development of LEDs with higher lumen packages (above 4000 lumen) is focussing on new luminaire solutions instead of retrofit CFL substitution. However, for the current installed base of luminaires and lighting systems employing discharge lamps, replacement light sources based on discharge lamp technology will be needed for a long time. A typical refurbishment cycle in shops and offices is on average 7 to 12 years respectively and for street lighting it is even up to 30 years. Retrofit LEDs for these high lumen packages are still rare on the market and if they are offered, they are not suitable drop-in replacements, as will be explained in 6.2.1, so availability of proper discharge lamps needs to be secured to prevent a forced, early refurbishment resulting in extra costs and environmental burden.

Towards the development of possible retrofit alternatives, the LED technology developments are on limited scale addressing one-on-one replacements of high lumen CFL lamps, but this will not result in a situation which would allow for full replacement of the current discharge lamps portfolio within the timeframe of the exemption.

Towards discharge lamp technology, no major development efforts have been taking place anymore because innovation efforts in the industry are fully focussing now on LED technology.

6.2.1 Feasibility of the alternatives

Alternative lighting technologies (LED's)

In case of CFL(self-ballasted) lamps in high wattages (>150 W) no retrofit LED replacements are available on the market reaching the same lumen output.

Also for professional applications the prices for LED-based alternatives of CFL lamps (especially for increased wattages) are still significantly higher while the system energy efficiency and lifetime in principle are comparable[24] . Since the price of the LED lamp

[24] To prevent infringement of the competition law, specific price levels are not given in this document. Prices per country and brand are differing. More information on current price levels can be gathered through the internet.

increased with the number of LED's the LED replacements will be expensive ad will have difficulty removing the excess heat (and therefore not available yet)

6.2.2 Availability of substitutes

The focus of LED development in the higher lumen packages which are covered by this exemption has been on new luminaire solutions (see examples below). This focus is not expected to change in the future due to the fundamental difference in power density and accompanying heat management of LED technology in the higher lumen packages.


For the installed park of CFL luminaires in the various applications and with the variety of lamp types suitable LED replacements are very rare on the market.

6.2.3 Impacts of substitution

As indicated in 6.2.1 LightingEurope is of the opinion that no fully compatible substitutions in LED technology are available for the big variety of CFL lamp types in all types of applications.

6.2.3.1 Environmental impact of substitutes

Not Applicable

6.2.3.2 Health and safety impact of substitutes

Not Applicable

6.2.3.3 Socio-economic impact of substitution

Economic effects related to substitution:

- ☐ Increase in direct production costs
- ☒ Increase in fixed costs
- ☐ Increase in overhead
- ☒ Possible social impacts within the EU
- ☒ Possible social impacts external to the EU
- ☒ Other:

Not Applicable

6.2.3.4 Impact of substitution on innovation

Focus of the current lighting industry is already on the further development of LED technology (paragraph 6.1). An extension of the exemption will have a positive effect on the efforts to further innovate in LED, as CFL is the benchmark to be outperformed by LED.

6.2.4 Future trends of substitution

LED technology performance is developing, however the balance between cost price, lifetime and energy efficiency and the speed in which it will take place is not yet clear and at least needs time. The high lumen application is very specific and looking at the focus on new luminaire developments in LED it is questionable if the retrofit LED solutions will be fully available on the market.

6.3 Links to REACH, according to RoHS Directive Article 5(1)(a)

Do any of the following provisions apply to the application described?

no

☐ Authorisation
- ☐ SVHC
- ☐ Candidate list
- ☐ Proposal inclusion Annex XIV

☐ Restriction
- ☐ Annex XIV
- ☐ Annex XVII
- ☐ Registry of intentions

☐ Registration

Provide REACH-relevant information received through the supply chain.

Not Applicable

7 Removal of mercury from lamps

Can mercury be eliminated?

- ☐ Yes.
- ☒ No, , as explained in 6.1.

8 Reduction of mercury content of lamps

In paragraph 6.1 is explained that various attempt have been made in the industry to reduce the mercury content in fluorescent technology. These attempts have been successful, because the amount of mercury has been drastically reduced in the last decades. At the same time, the fluorescent technology can only operate when a certain limited amount of mercury is used. As stated before, there is interdependency between the amount of mercury, the light output per wattage (energy efficiency) and the lifetime of the lamp. To be able to keep this fine balance, it is uncertain if the amount of mercury as stated currently in RoHS can be further reduced while keeping the requirements of lifetime and energy efficiency.

9 Other relevant information

Not submitted.

10 Information that should be regarded as proprietary

LightingEurope provides to the European Commission under confidentiality a comprehensive list of lamps with average mercury content, which are in the scope of the obligation to publish such data according to the ErP Directive Implementing Measures 244/2009, 245/2009, 1194/2012 and produced by LightingEurope member companies

List of abbreviations

ADCO	Administrative Cooperation Group
BASI	Bioanalytical Systems, Inc
BSP	Barium Synthetic (Pb^{2+}) phosphor
CCG	Conventional Control Gear
CDM	Ceramic Discharge Metal Halide
CDV	Committee Draft for Voting
CFL	Compact fluorescent lamp
CRI	Color rendering index
CRSO	Collection & Recycling Service Organization
DEFRA	Department for Environment Food and Rural Affairs
DOE	Department of Energy
ECG	Electronic Control Gear
EEE	Electrical and Electronic Equipment
ELC	European Lamp Companies Federation
EM	Electromagnetic: lamp control gear based on a magnetic coil (= CCG)
EMC	Electro Magnetic Compatibility
ERP	Energy related Products; Directive 2009/125/EC establishing a framework for the setting of eco design requirements for energy-related products
FTE	Full Time Equivalent, indicates the workload of an employed person
HF	High frequency: lamp control gear based on high frequency (= ECG)
HID	High intensity discharge lamps
HPS	High Pressure Sodium (vapor) lamps
Hz	Hertz
K	Kelvin: Unit of color temperature (2700 K warm color, 5600K cool daylight)
Lm	Lumen
LFL	Linear Fluorescent Lamps
LCA	Life cycle assessment
LED	Light Emitting Diode
LPD	Low Pressure Discharge lamp
LVD	Low Voltage Directive

mg	Milligram
MH	Metal halide lamps
OEM	Original equipment manufacturer
OLED	Organic Light-Emitting Diode
PCA	Poly-crystalline alumina
PLL	Pi shaped Long Length, compact fluorescent lamp
R&D	Research and Development department(s)
REACH	Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals, 1907/2006/EC
RoHS	EU Directive 2011/65/EU on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
SSL	Solid State Lighting
SVHC	Substances of Very High Concern
TF	Task Force
UMICORE	global materials technology group which focuses on application areas where its expertise in materials science, chemistry and metallurgy makes a real difference.
UNEP	United Nations Environnent Programme
UV	Ultraviolet
VDE	German Association for Electrical, Electronic and Information Technologies
W	Watt unit of (electrical) power
WEEE	Waste Electrical and Electronic Equipment
ZVEI	German Electrical and Electronic Manufacturers´ Association