Request to renew Exemption 4(c)

under the RoHS Directive 2011/65/EU

Mercury in High Pressure Sodium lamps

Date: January 15, 2015

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Contents

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2 Reason for application

LightingEurope submits this application to:	*request for extension of existing exemption* ***no. 4(c) in Annex III***
LightingEurope proposes to continue using the existing wording which is:	*Mercury in High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner):* *4(c)-I P<155W: 25 mg per burner* *4(c)-II 155W<P<405W: 30 mg per burner* *4(c)-III P>405W: 40 mg per burner*
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 4(c) 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 4(c) regarding mercury in High Pressure Sodium (vapour) lamps (HPS) for general lighting purposes.

This exemption request explains the technical characteristics and the applications of High Pressure Sodium lamps for General Lighting. It is shown that the total amount of mercury brought on the European market by new lamps of exemption 4(c) is 345 kg per year. The unique and specific function of mercury in these lamps is described in detail.

The recycling practises of HPS lamps are discussed. It is estimated that about 46% of the mercury brought onto the European market is recycled. Hence the netto amount brought onto the European market is 186 kg.

Existing Life Cycle Analysis reports are discussed. They all clearly show that the environmental impact of the use phase is by far the most important. Hence, the critical factor determining the environmental impact of an HPS lamp is the luminous efficacy.

The exemption request evaluates reduction and substitution initiatives for mercury in High Pressure Sodium lamps. It is shown that reduction or omission of mercury inevitably leads to loss of efficacy and consequently to a larger environmental impact of the substation (condition 3 of Article 5(a) of the RoHS Directive).

It is further shown that replacing HPS lamps by LED retrofit lamps with conservation of the specification is not possible and is not expected anytime soon due to thermal limitations and compatibility issues. Hence the substitution in existing luminaires of mercury containing HPS lamps with LED retrofits is scientifically impracticable (condition 1 of Article 5(a) of the RoHS Directive).

Finally, a projection for the replacement of High Pressure Sodium installations by new LED systems is made. It is concluded that this substitution is in process but that due to environmental (vast additional waste due to premature replacement of lighting installations) and financial constraints it will take 15 to 25 years for the substitution to be completed. This estimate is also in line with the roadmap of the European lighting industry[1].

Hence, LightingEurope explains in this report why a natural phase-out of High Pressure Sodium lamps of exemption 4(c) is necessary and what the problems will be if an extension of the exemption is not granted.

For this reason an exemption for mercury in lamps covered by the exemption is required with a maximum validity period and with no expiry date.

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[1] *Consultation Meeting on "A European Lighting Strategy", in preparation of a draft Commission Communication thereof, DG ENER.C.3 and DG CNECT.A.1, 12 March 2014*

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 High Pressure Sodium (HPS) lamps that are member of the High Intensity Discharge Lamps (HID) group. The HPS family contains lamps designed for different purposes in the professional market. These lamps are handled by technically skilled installers and sold by specialized distributors or as part of lighting equipment. The customers are for example governments, installers, specialized wholesalers, designers of lighting equipment etc.

High Pressure Sodium lamps consist of a cylindrical discharge tube made of poly-crystalline alumina (PCA) in which two electrode assemblies are mounted at each side (Figure 1). The electrodes are made of tungsten (W) and consist of a rod with coiled windings containing a mix of oxides, called the emitter. These oxides reduce the work function of the tungsten and hence reduce also the temperature of the electrodes during operation, thereby greatly improving the life time of the lamps. The tungsten electrodes are welded to niobium (Nb) tubes that serve as the electrical feed-through (Figure 2). The discharge tubes are sealed with a sealing frit which is designed such that it has the same expansion coefficient as PCA and niobium. This way there are no thermal stresses during the heating and cooling cycles present during starting and shut-down.

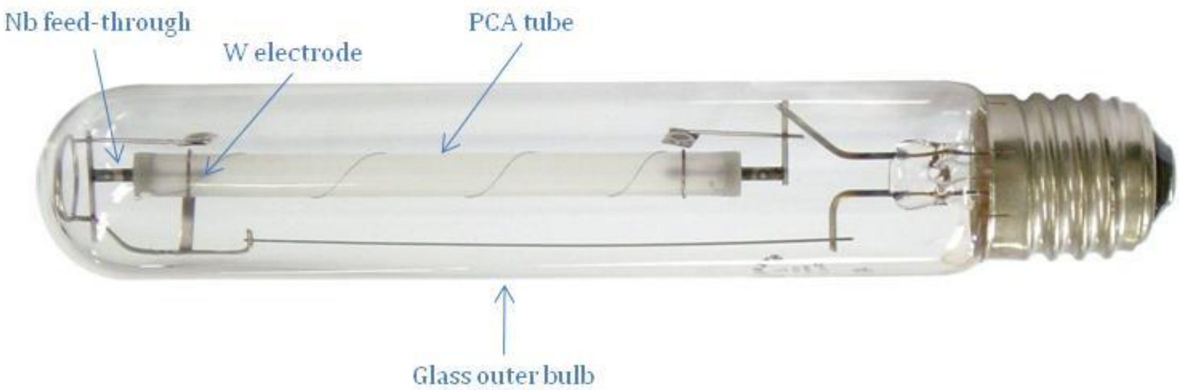

Figure 1: Construction of a High Pressure Sodium lamp

Inside the discharge tube there is a pressure of some 20-500 mbar of xenon under room temperature condition.

Figure 2: Construction of the electrical feed-through of a High Pressure Sodium lamp

Upon starting a high voltage pulse is supplied to the electrodes and this breaks down the xenon gas allowing a current to flow through the resulting plasma. Mercury and sodium are dosed in the burner as an amalgam of mercury and sodium in the form of a pill. After ignition the heat released by the discharge warms up the discharge tube and part of the sodium and mercury evaporates. A liquid pool of sodium-mercury amalgam remains at the coldest spot in the discharge tube during operation.

The discharge tube is mounted in a vacuum glass bulb in order to insulate it thermally from the lamp surroundings.

De Groot and Van Vliet[2] give a comprehensive review of the operation principles of the HPS lamp. Further developments are discussed in a paper by Geens and Wyner [3].

High Pressure Sodium lamps are characterized by very long life (30,000 to 50,000 hours) and very high luminous efficiency (from 80 lm/W to 150 lm/W). They also typically have a lumen maintenance of more than 80% at end of life. Their ability to render colours is low (CRI around 20).

The majority of High Pressure Sodium lamps are single-capped with Edison screw caps (E27 and E40 for Europe) but there exists also a double-capped range with R7s and Rx7s caps. Figure 3 shows different formats. Most manufacturers have both lamps in tubular clear glass format and in ovoid shape with a light diffusing coating. The wattage range is 35W to 1000W.

HPS lamps can only operate on designated drivers that switch the lamp on and regulate the power. These drivers can be an electro-magnetic ballast (inductive/capacitive load) to stabilize the lamp current in combination with a high voltage pulse generator (ignitor) to

[2] *J.de Groot and J. Van Vliet, The High Pressure sodium lamp, Kluwer Techische Boeken B.V. Deventer, ISBN 9020119028 (1986)*

[3] *R. Geens and E. Wyner, Progress in High Pressure Sodium Lamp Technology", IEE Proceedings-A Vol. 140 No. 6, November 1993.*

ignite the lamp. Nowadays, also electronic drivers are used to stabilize the lamp at the correct power.

Figure 3: Different formats of High Pressure Sodium lamps: tubular clear, ovoid coated and clear double-ended

4.1.2 Applications covered by this exemption

The product characteristics make HPS lamps the perfect choice for applications that require long life, high efficacy and very good lumen maintenance but where colour rendering is less important. Typical applications are outdoor lighting: street lighting, parking's, city squares, flood lighting of buildings. Sometimes these lamps are also used indoors, like in warehouses where colour rendering is not important.

A comprehensive study of the current light sources market and the expected evolution in the coming years is given by a study team around VHK and VITO[4]. The study uses data available from a report by McKinesy[5], EuroStat Data and LightingEurope statistics (confidential) and develops a self-consistent overview of the EU28 market size and evolution for all lamp technologies. In the derivation of this data several assumptions had to be made by the study team and the number of lamps sold are finally tabulated (Table 57 in the report) for two different assumptions for the Average Selling Price in the EU28 (low and high ASP). In this report these two results are interpreted as confidence intervals and the average of the two are used. The upper part of Table 1 gives the sales numbers as derived by VHK&VITO for LED and HID as well as the division of all sold lamps over new installations (lamp in a newly installed fixture) and lamp replacements (a new lamp replacing an old one in an existing fixture).

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[4] *Preparatory Study on Light Sources for Ecodesign and/or Energy Labeling Requirements ('Lot 8/9/19'), Prepared by VHK, in cooperation with VITO and JeffCott Associates, 19 November 2014. Available from http://ecodesign-lightsources.eu/documents*

5 *Lighting the way: Perspectives on the global lighting market, McKinsey 2012 second edition*

Confidential statistical data on lamp sales of LightingEurope members shows that the percentage of HPS lamps in HID sales has been around 35% in the last 4 years and seems to be stable. We assume that this fraction can be extrapolated from LightingEurope members to the whole EU28 sales. Knowing that High Pressure Mercury Vapour lamps will be banned in 2015 and assuming that these lamps will be replaced by a different technology than HID (mainly LED) we obtain that the ratio of HPS to HID sales in the EU28 will be 39% after 2015. The second part in Table 1 gives the projected HPS to HID ratio derived in this way.

The division of HID over new and replacement is calculated from the division for all lamps given by VHK&VITO in the following way: assuming that all LED sold until 2020 are new installations and that the new to replacement ratio is the same for all conventional technologies, the total number of HID lamps can be split in new and replacement (third part in Table 1).

Using the HPS to HID ratio's obtained the number of new and replacement HPS lamps are then calculated.

Finally, assuming a 4-year replacement cycle for HPS lamps, we derive the installed base of HPS light points in the EU28.

From the results derived by this procedure is clear that despite the fact that some new HPS applications are still installed, the installed base is decreasing rapidly in EU28: from 72 million in 2016 to 37 million in 2020 and decreasing rapidly. Also the number of HPS replacement lamps will drop drastically between 2016 and 2020: from 23 million to 12 million.

These numbers show that LED solutions are entering the market rapidly. McKinsey[6] shows that on the world level LED is competing mainly in the initial market of new luminaires (see extract from McKinsey in Tabel 2). It is reasonable to state this is also true in Europe. Replacing HID lamps with LED lamps is limited because fully compatible retrofits are not available and will also not be available in the near future (see section 6.2.1) for efficient High Pressure Sodium and metal Halide installations. The limited retrofits with LED lamps are likely to be for High Pressure Mercury Vapour (HPMV) installations. The limited luminous efficacy of HPMV makes it easier for LED retrofit products of the future to match the specified requirements.

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6 *Lighting the way: Perspectives on the global lighting market, McKinsey 2012 second edition*

Source	Category	2011	2012	2016	2020
VHK & VITO	HID TOTAL	54	63	60	30
	LED TOTAL	30	72	407	634
	New	1075	1158	999	878
	Replacement	2817	2572	1399	728
	LAMPS TOTAL	3892	3730	2397	1606
LE Statistics	HPS/HID Ratio	35%	35%	39%	39%
This work	HID NEW	15	19	18	7
	HID Replacement	39	44	42	22
	HPS NEW	5	6	7	3
	HPS REPLACEMENT	14	15	16	9
	HPS TOTAL	**19**	**22**	**23**	**12**
	HPS INSTALLED BASE	**60**	**68**	**72**	**37**

Table 1. World and European market trend (in million pieces) for HID and HPS lamps according to VHK&VITO report and elaboration thereon (see text)

Lamp type	Million Pieces	2012	2016	2020
World market	Installed base HID	519	541	475
	Annually new installed HID	48	39	24
	Annual replacement HID lamps	201	220	196
	Annual replacement with LED “retrofits”	0	3	10

Tabel 2. World market for HID lamps according to McKinsey. Note the relatively small replacement with LED “retrofit” lamps.

The dynamics behind this change is as follows. Although the lifetime of HPS lamps is very long (18K to 48K hours), the lamps are group replaced about every 4 years (before a certain fraction of the lamps fail). It is not always commercially feasible for the owners of these professional lighting systems to invest in new LED luminaire solutions when lamps need to be replaced. Such a change requires not only changing the light source but the whole lighting system including luminaire, its optics and magnetic or electronic driver system.

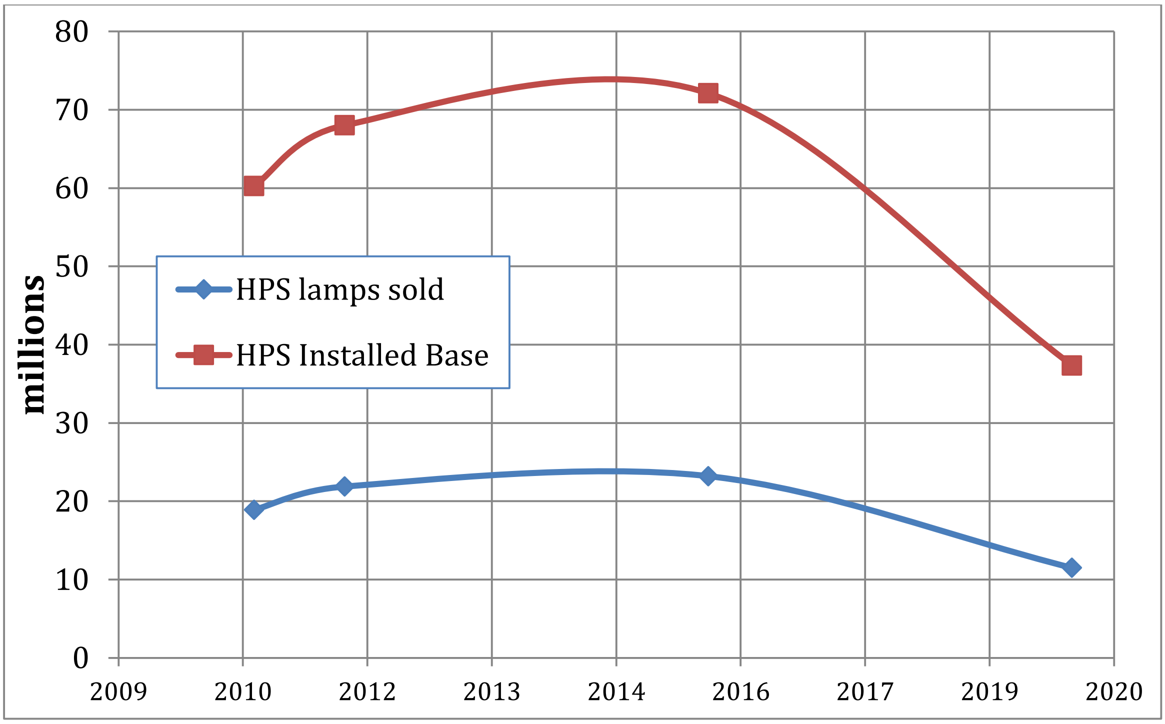

Figure 4. Market trend of HPS according to VHK&VITO report and elaboration thereon (see text)

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: Not applicable, see comment below

Equipment of category 8 and 9: Not applicable, see comment below

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 most are used for general illumination. However, they have some of the characteristics of components (used in luminaires), consumables (finite lifetime and regularly replaced) and spare parts (lamps in luminaires have to be replaced when they cease functioning).

Some manufacturers of electrical equipment in other RoHS categories may install HPS lamps with improved colour rendering 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 5 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 manufacturers it is essential to have legal certainty regarding the possibility to put the products on the market irrespective of the planned application as manufacturers are not able to control the use of the lamps in products falling in other categories in or out of the RoHS scope. In practice, most lamps are installed in buildings or outside 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.

Therefore lamp manufacturers do consider the lamps in scope of this document to belong to category 5 as individual products.

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 High Pressure Sodium lamps

The main role of mercury is to tune the resistance of the plasma in such a way that the efficiency of the combination lamp and driver functions in an optimal way.

High Intensity Discharge lamps generate light in a compact plasma arc with a high brightness. After the lamp is started by a voltage pulse the initial noble gas discharge heats the lamp and evaporates part of the sodium/mercury amalgam pill. At first it is mainly the mercury that goes into the vapour phase. The increasing mercury vapour pressure increases the electrical resistance in the discharge which allows for putting more power into the discharge. As a consequence of more power coupled into the discharge, the discharge tube wall will heat up and sodium and mercury evaporate further until a state of thermal equilibrium is established between the electrical power supplied to the discharge, the heat conducted to the surroundings and the radiation emitted from the discharge. The lamps are designed such that the optimal efficiency is reached at this equilibrium. The mercury is not consumed over life. However, the sodium in the discharge tube does chemically react with the PCA wall and the electrode emitter[7] [8]. As a consequence the fraction of mercury in the amalgam becomes higher and this raises the lamp voltage. At a certain point in time the lamp voltage becomes so high that the mains voltage can no longer sustain the arc and the lamp extinguishes. This is the end of the lamp life. For a given sodium consumption, a certain amalgam dose is required to reach the specified life. If the dose is too small, the ratio of mercury in the amalgam rises rapidly and so does the lamp voltage, leading to a premature end of life.

4.2.3 More functions of mercury

The main role of mercury is to tune the resistance of the plasma in such a way that the efficiency of the combination lamp and driver is optimal. The mercury however has a number of additional essential functions to fulfil:

1. The mercury in the plasma of a High Pressure Sodium lamp does not directly contribute to the spectrum of the lamp because the arc temperature is too low to excite the interesting (optical) energy levels of the mercury atom. However, there is a very significant indirect contribution of the mercury atoms: the proximity of mercury atoms shifts the energy levels of sodium and creates a very large broadening of the sodium resonance line[9] [10]. This broadening shifts the colour of the lamp and by tuning the amalgam composition the colour point of the lamp can be designed to coincide with the Black Body curve.

2. The presence of the mercury vapour also greatly reduces the thermal conduction of the sodium-mercury-xenon plasma[11]. As a consequence, there is less heat loss from the plasma to the discharge tube wall. The efficiency of the lamp is thereby greatly improved by the presence of mercury[12].

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7 Luijks G.M.J.F., Sodium-PCA interaction in unsaturated HPS lamps, paper submitted for the LS6 conference in Budapest, Sept. 1992

8 Itoh, A. and Okamura, K., Evaluations of the sodium reduction in HPS lamps, paper submitted for the LS6 conference in Budapest, Sept. 1992

9 Woerdman, J.P, Schleyen, J., Korving, J., Van Hemert, M.C, De Groot. J.J. and Van Hal, R.P.M., Analysis of satellite and undulation structure in the spectrum of Na+Hg continuum emission, J. Phys. B : At.Mol.Phys.,vol.18, pp4204-4221 (1985)

10 J.de Groot and J. Van Vliet, The High Pressure sodium lamp, Kluwer Techische Boeken B.V. Deventer, ISBN 9020119028 (1986), p. 141 to 145

11 J.de Groot and J. Van Vliet, The High Pressure sodium lamp, Kluwer Techische Boeken B.V. Deventer, ISBN 9020119028 (1986), p. 130 to 131

12 J.de Groot and J. Van Vliet, The High Pressure sodium lamp, Kluwer Techische Boeken B.V. Deventer, ISBN 9020119028 (1986), p. 149 to 153

3. The high pressure of mercury limits evaporation of the hot tungsten electrode. The low evaporation helps to maintain the light flux over lifetime, a high evaporation rate of tungsten would lead to blackening of the arc tube and a reduced transmission of light and thus a lower lumen maintenance.

4.2.4 Location of mercury in lamps

Mercury is present in the so-called discharge tube. In a cold lamp it is present in an amalgam with sodium and the amalgam forms a pill in the solid state. During lamp operation part of the mercury is in the vapour phase, creating a pressure around 1 Bar, and part forms a liquid Na/Hg amalgam located at the coldest spot in the discharge tube.

4.2.5 Amount of mercury

Mercury is dosed in the discharge tube during lamp manufacturing as sodium/mercury amalgam with an Hg/Na fraction of 75 to 97%. The amount of mercury dosed per lamp depends on aspects like lamp power and optical performance. For high pressure sodium lamps in the scope of the Exemptions 4(c) the maximum dosed mercury amounts vary between 1 and 40 mg.

There are three types of HPS lamps on the market:

1. HPS lamps with saturated amalgam dose (i.e. only part of the mercury and sodium is vaporized in the operational lamp) and optimized to yield the highest possible efficacies. We call these lamps "standard dosed".
2. Lamps with an unsaturated amalgam dose (i.e. all the mercury and (almost) all the sodium is evaporated in the operational lamp). These lamps are mostly marketed in the USA. We call these lamps "mercury poor"[13]
3. Lamps without dosed mercury: "Mercury Free" HPS lamps[14]

For types 1 and 2 the amalgam dose increases with lamp power (=lamp size). Figure 5 graphs the dose versus the lamp power.

The total amount of mercury brought to the European market in High Pressure Sodium lamps is calculated in the following way: an estimated 23 million HPS lamps will be brought onto the European market in 2016 (see section 4.1.2). The highest volumes are sold in 70W and 150W Standard dose lamps. The volumes of Mercury Free are low and

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[13] *R. Geens and E. Wyner, Progress in High Pressure Sodium Lamp Technology", IEE Proceedings-A Vol. 140 No. 6, November 1993, par. 4*

[14] *R. Geens and E. Wyner, Progress in High Pressure Sodium Lamp Technology", IEE Proceedings-A Vol. 140 No. 6, November 1993, par 5*

the Mercury Poor lamps are not on the market in Europe (because of non-compliance with ErP regulation, see section 8.1). So, from Figure 5 we estimate an average of 15 mg per lamp. Hence the total amount of mercury brought yearly on the market in Europe is 345 kg, of which 159 kg is recycled mercury (see section 5.2.1).

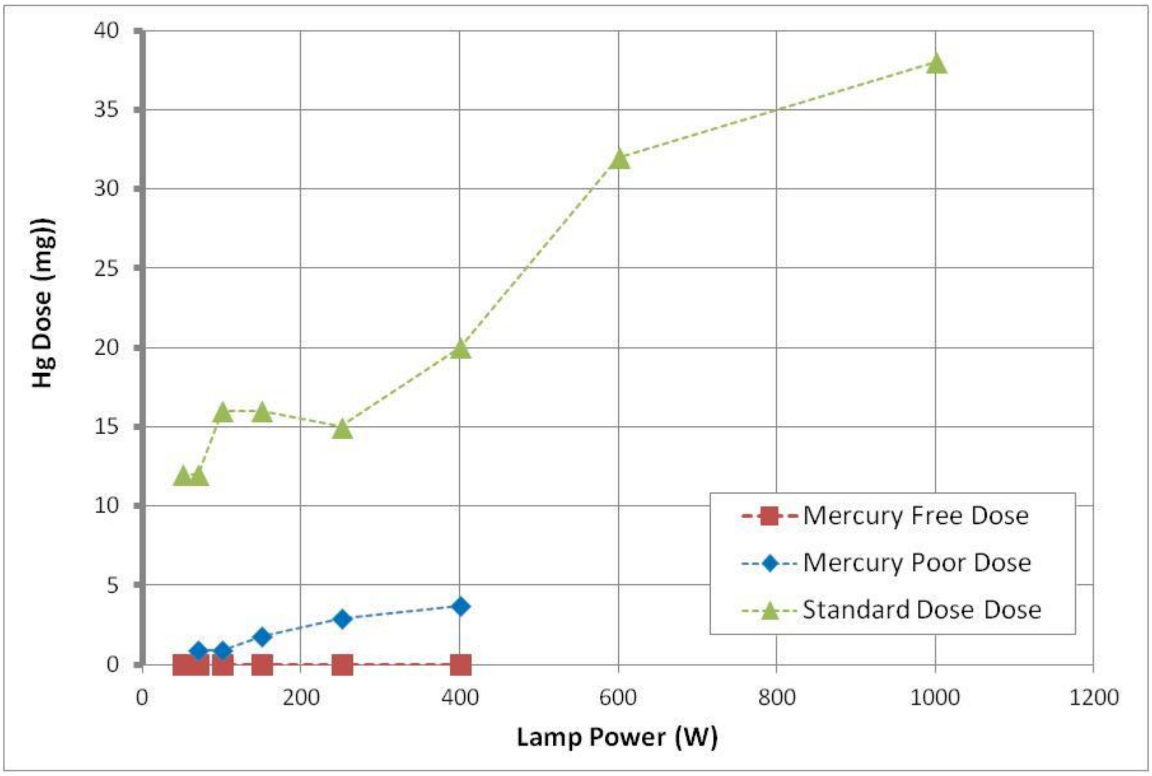

Figure 5: Amalgam doses of the different types of HPS lamps on the market.

4.2.6 Environmental assessments, LCAs

There are several independent 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.[15] Since all attempts to remove mercury have led to a reduced efficiency (see sections 6, 7 and 8) the effect of removing mercury increases the total environmental impact.

Apart from company internal LCA's, three public LCA's have been published for HID lamps[16] [17] [18]. Figure 5 shows the ecological impact of different light sources including

[15] Enlighten report, Section 5, Ch. 3 fig. 4 & 5

[16] Department for Environment Food and Rural Affairs (DEFRA), Life Cycle Assessment of Ultra-Efficient Lamps. Navigant Consulting Europe Ltd. 2009

[17] A.T. Dale, MM. Bilec, J. Marriott, D. Hartley, C. Jurgens, E. Zatcoff, Preliminary comparative life-cycle impacts of streetlight technology. Journal of Infrastructure Systems193— 199,(2011).

[18] Preparatory Study for Eco-Design Requirements of EuP, Lot 9, Public Street Lighting, P. Van Tichelen, T. Geerken, B. Jansen , M. Vanden Bosch (Laborelec), V. Van Hoof, L. Vanhooydonck (Kreios) and A. Vercalsteren

LED and Ceramic metal Halide (CMH). Since HPS and CMH have very similar material usage, production methods and efficacy, the results for CMH can also be extrapolated to HPS. The graph shows that at the time of publication the environmental impacts of HID were still less than LED replacement lamps ("int LED" in Figure 6) and LED luminaires ("ded. LED" in Figure 6). Meanwhile the performance of LED has improved but it is not clear yet to which extent this influences the LCA.

Since there is no direct replacement lamp for a failed HPS lamp, the LCA should in fact be done by comparing the situation where a failed lamp can be replaced with a new HPS lamp with the alternative case where a failed lamp leads to replacement of the whole luminaire, including the lamp driver, which is then replaced by a LED system + luminaire. This replacement system might include an active cooling fan to get rid of the excess heat from the compact luminaire.

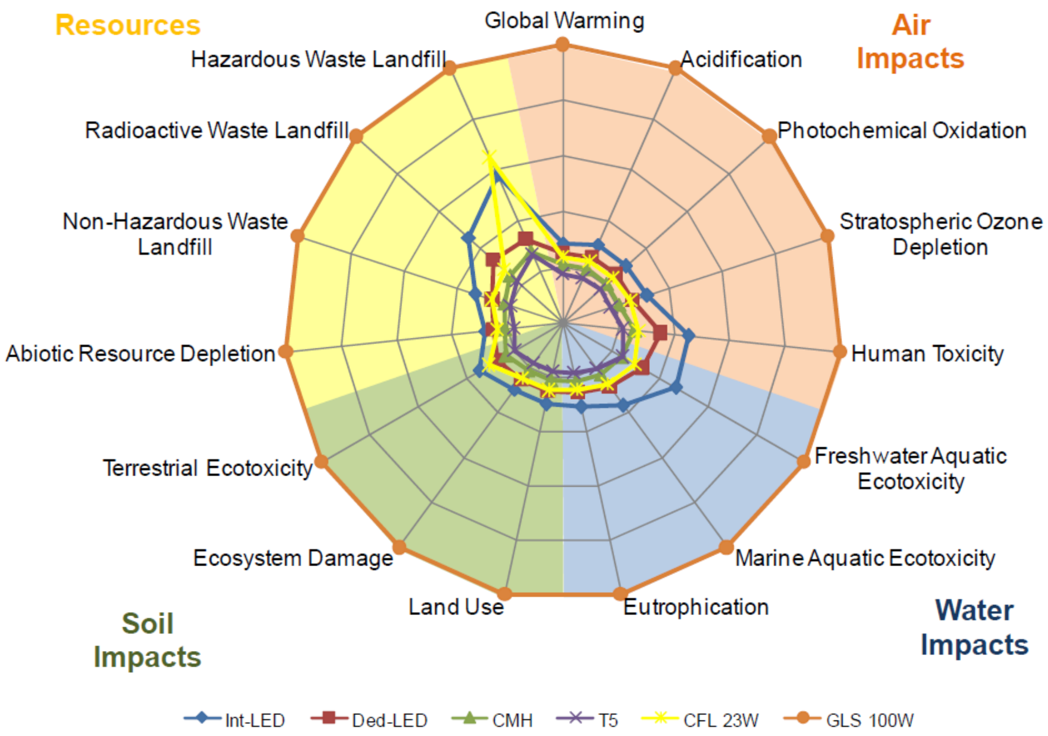

Figure 6: Figure from the Navigant report [5]. LCA of different light sources

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

High Pressure Sodium 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. High Pressure Sodium lamps are collected separately from general household waste and separately from other WEEE waste.

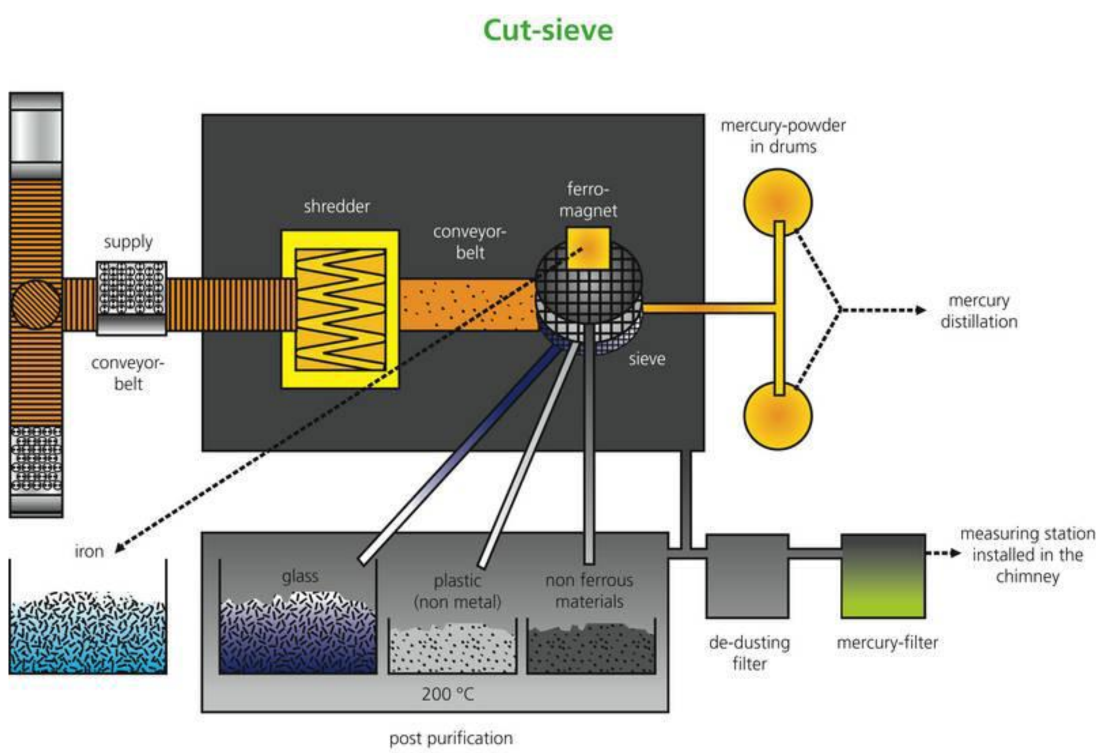

Figure 7: Recycling steps of fluorescent lamps in Indaver (Belgium).

Source:www.indaver.be/waste-treatment/recycling/mercurial-waste.html

The collection efficiency with these more professional customers is reasonably high. A dedicated recycling process exists for lamps because; according to legislation the mercury shall be removed from the gas discharge lamps. Mercury in treatment facilities is recovered by distillation and captured as Mercury Sulphide (Figure 7). In almost all the installations CFL lamps and HID lamps are processed together (separating is difficult), this makes it impossible to report the recycle percentage for HID High Pressure Sodium lamps separately. The process is running with the machine on under pressure to prevent exposure of the workforce to mercury. The recycling percentage for the combination of house hold and non-household waste combined is 45% and is audited each year externally.

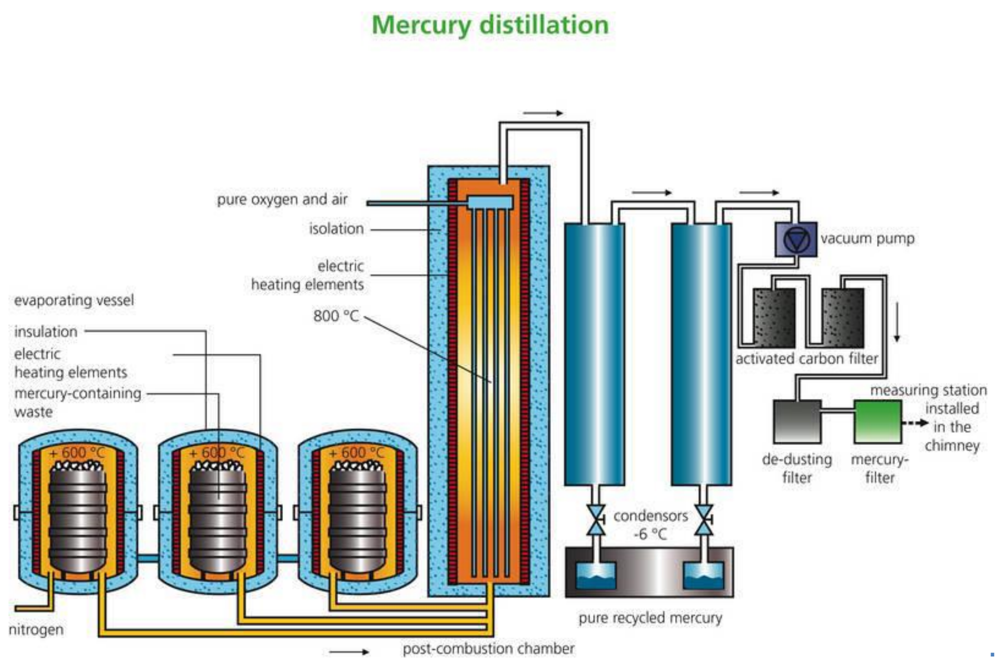

Figure 8. Specific recyclcing steps of mercury in Indaver (Belgium)

Source:www.indaver.be/waste-treatment/recycling/mercurial-waste.html

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

5.2.1 Amount of mercury recycled from failed HPS lamps

To calculate the amount of mercury that is recovered by the recycling we do the following:

In the installation of the recycler CFL-integrated, CFL-non-integrated, LED lamps and HID are recycled together (household and non-household). The total return percentage is monitored at least for one of the lighting companies and independently reviewed and published publicly (see Figure 9). If we assume that the return percentage is the same for all categories, also for High Pressure Sodium lamps, we estimate that 46% of 345 Kg this means 159 Kg is recovered. This number is audited at Philips and published annually.

5.2.2 How does the industry encourage an increase in recycling efficiency?

European legislation on Waste Electrical and Electronic Equipment makes producers responsible for end of life products within this category as from August 13th, 2005. 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.

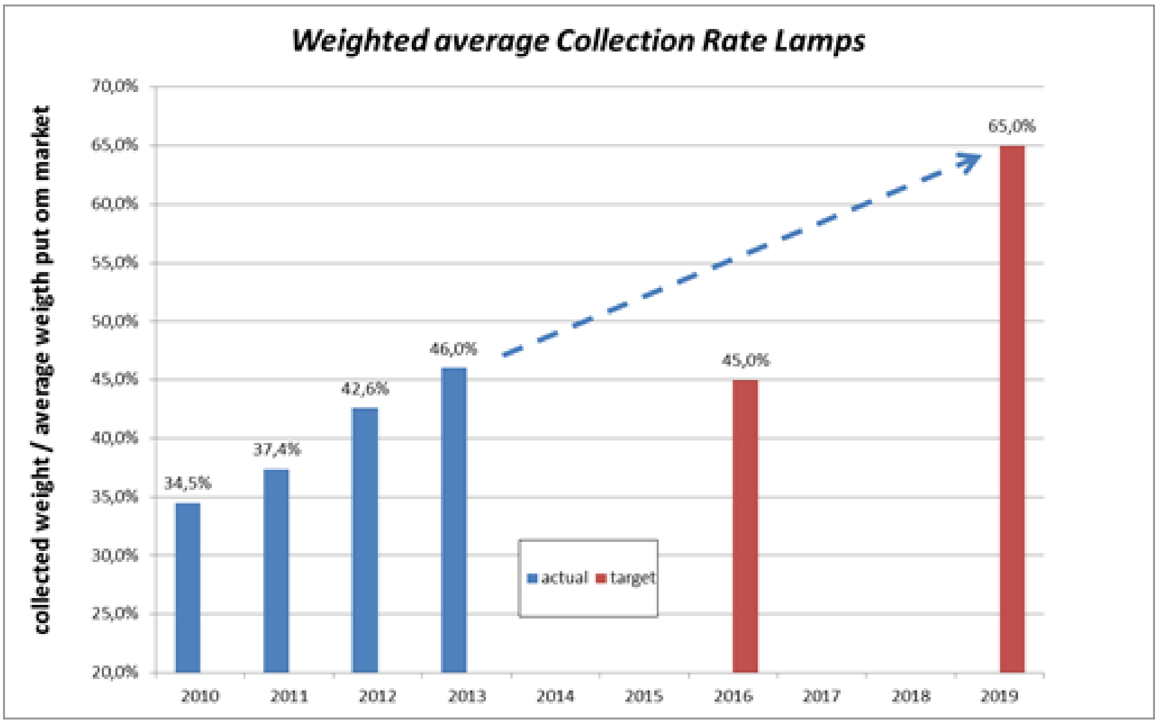

Figure 9. Recovery of mercury from mercury containing lamps

In general however we can conclude that the following channels have been established in the respective member-states providing country wide coverage:

1. 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.

2. Collection through distribution: Wholesale and Retail place collection means at their premises respectively in their shops.

3. Collection upon notification.

4. 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.

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 discharge technology

If a sodium discharge lacks mercury, the energy radiated is considerably smaller[19] [20]. The lamp with mercury radiates more between 600 and 700 nm and also in the blue the lamp produces more light (Figure 10). The decrease in visible radiation in a lamp without mercury is due to the higher thermal losses of the Na-plasma as compared to a Na-Hg plasma. The loss of luminous efficacy is about 14 lm/W.

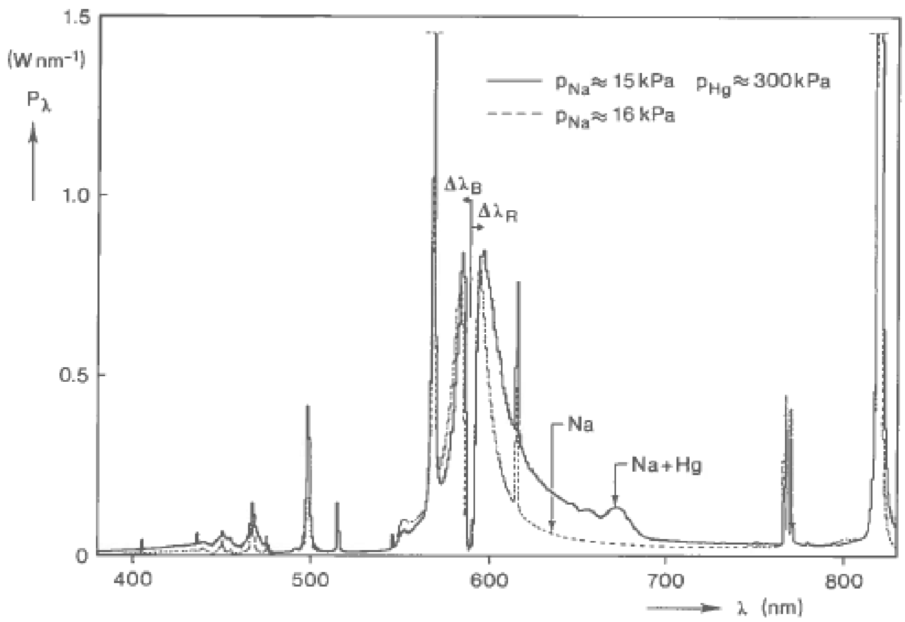

Figure 10: Spectra of a Hg containing and a Hg free HPS lamp (from [16])

[19] J.de Groot and J. Van Vliet, The High Pressure sodium lamp, Kluwer techische boeken B.V. Deventer, ISBN 9020119028 (1986), Chapter 5 Influence of buffergas on discharge properties. Page 128-169

[20] R. Geens and E. Wyner, Progress in High Pressure Sodium Lamp Technology", IEE Proceedings-A Vol. 140 No. 6, November 1993, par. 5

By replacing the mercury pressure by an equivalent xenon pressure, the thermal losses can be kept constant (Figure 11). However, because the electrical conductivity of xenon is higher than that of mercury, a longer and narrower arc tube (Figure 12) is required to bring the lamp voltage back to the specified value. The use of this type of tube decreases the luminous efficacy as compared to the standard lamps[21].

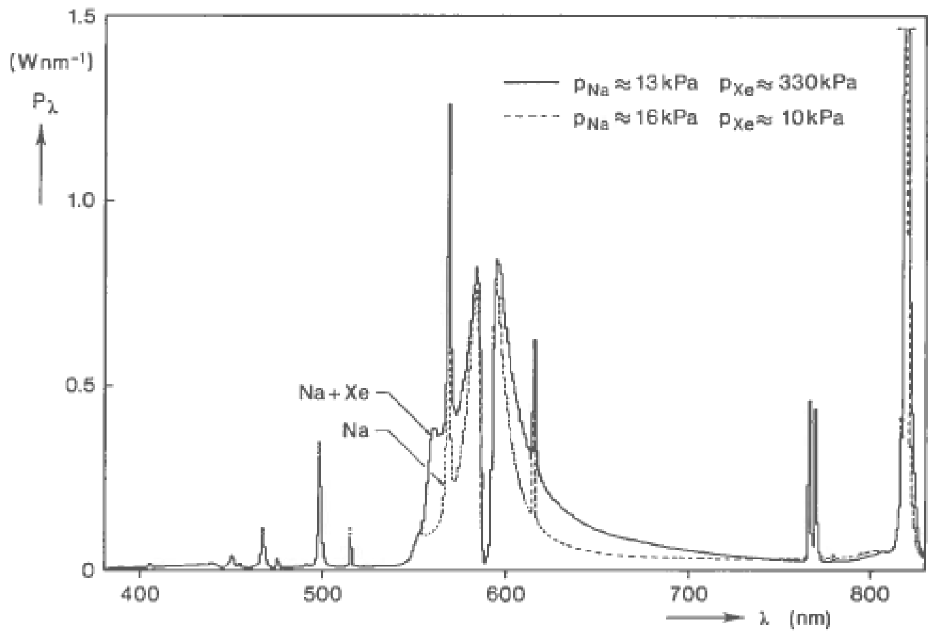

Figure 11: Spectra of a Hg-free HPS lamp with increased Xe pressure (from [16])

Figure 12: A Hg-free High Pressure sodium lamp with a longer and narrower arc tube

Mercury is condensed in the amalgam when the lamp is cold. Ignition of this lamp requires a relatively low peak voltage pulse (2 kV). As xenon is not condensed when the lamp is switched on, starting a lamp with a high xenon pressure is more difficult. A higher voltage pulse is needed to cause breakdown in the high pressure xenon and this voltage pulse alone is not enough: a special antenna needs to be provided to enhance the

[21] *Waymouth, J.F. and Wyner, E.F., Analysis of factors affecting efficacy of high pressure sodium lamps, J. Illum. Eng. Soc. (USA), 10, p.237 (1981)*

electric field during ignition[22]. Even with the antenna, the pressure of xenon which can be used is limited by the requirement that ignition on all installed conventional ballasts is guaranteed. To reach equivalent lumen output a higher sodium pressure would be required but the high temperature needed to evaporate the sodium limits the lifetime of the lamp[23]. In practice the mercury free lamps are approximately 5% less efficient, have a reduced lumen maintenance (-5%) and a shorter lifetime (4 years of operation instead of 6 years), see also Figure 13.

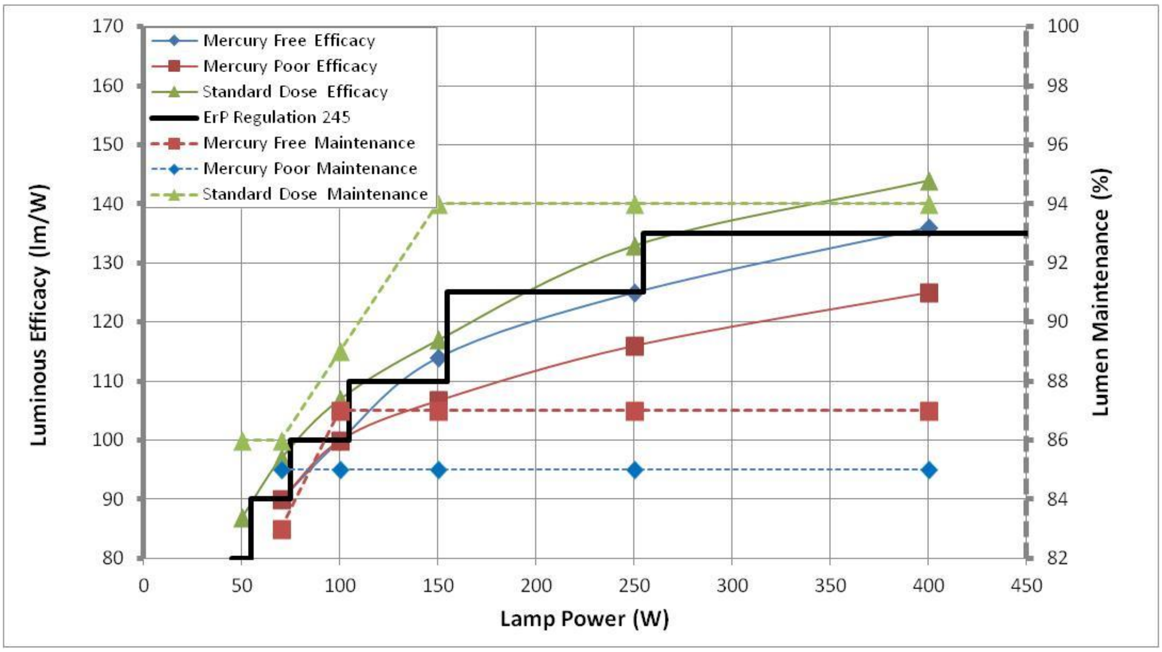

Figure 13: Luminous efficacy and lumen maintenance of three types of HPS lamps as defined in section 4.2.5: type 2 is mercury poor, type 3 is mercury free

Hg-free HPS lamps have been on the market for nearly 20 years. As shown in Figure 13 the luminous efficacy and lumen maintenance of mercury free and mercury poor (see section 8.1) HPS lamps are today still lacking versus the standard dosed types. Mercury poor lamps are also not compliant with ErP Regulation 245/2009. While progress in efficiency, reliability and lumen maintenance has been made, the mercury containing counterparts have seen the same trend. It is not expected that Hg-free or mercury poor HPS will catch up on the performance of the highest performing Hg-containing HPS products, especially since R&D resources are more and more shifted to LED developments.

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[22] *T. G. Steere, G. C. G. M. Manders, G. M. J. F. Luijks, C. Sweegers, J. L. V. Hendrix, P. A. H. J. Huijbrechts, W. J. J. Welters, High-pressure sodium vapour discharge lamp with hybrid antenna, Patent WO 2010004472*

[23] *G C Wei, Transparent ceramic lamp envelope materials, J. Phys. D: Appl. Phys. Vol. 38 p. 3057 (2005)*

The Preparatory Study for Eco-Design Requirements of ErP's for Public Street Lighting[24] shows that there is an almost linear relationship between environmental impact and energy efficiency (p. 212) of different lighting scenarios. The authors conclude that due to the lower efficiency of mercury free HPS lamps the studied scenario of replacing all installed HPS lamps with mercury free HPS has a negative overall environmental impact (p. 227) and is therefore not recommended.

Hence, referring to Article 5(a) of the RoHS Directive, the total negative environmental impact caused by substitution is likely to outweigh the total environmental benefit thereof.

6.2 Substituting High Pressure Sodium technology by LED technology

6.2.1 Feasibility of the alternatives

6.2.1.1 LED retrofit lamps

Numerous LED replacement lamps for HPS are proposed by a large variety of suppliers. However, each and every case of these substitutes lacks one or more aspects for acceptable retrofitting:

1. The lumen output of the substitute is much lower than the HPS lamp it should replace (in the order of 25% of the HPS luminous flux)
2. The replacement lamp is much larger than the HPS lamp and will not fit in the vast majority of the luminaires
3. The optical characteristics of the substitute lamp are completely different leading to distorted beam patterns of the luminaires

A typical example of advertised "retrofit" solutions is given in Figure 14. In street lighting applications the light levels are strictly regulated and replacement with lamps with much lower luminous flux can cause dangerous situations in traffic. So at least for these regulated applications the use of these LED "retrofits" is not possible.

The reasons why LED cannot replace HPS lamps on a one to one replacement basis as fully retrofit lamps and the reasons why it is not expected that such replacements will appear on the market soon are detailed below.

High intensity discharge lamps are compact and are in general high power lamps. In the application it is required that HID lamps operate in closed luminaires. Since over 90% of the power supplied to the HID lamp leaves the burner as radiation (visible light, infrared

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[24] *Preparatory Study for Eco-Design Requirements of EuP, Lot 9, Public Street Lighting, P. Van Tichelen, T. Geerken, B. Jansen , M. Vanden Bosch (Laborelec), V. Van Hoof, L. Vanhooydonck (Kreios), A. Vercalsteren*

radiation and some UV) the temperature of the luminaire and the lamp is stabilized without the need for heat sinking.

Figure 14. Typical advertised LED retrofit lamp for replacement of HPS lamps

The glass surface of the outer bulb of the lamp is heated by conduction of the heat generated in the burner (10% of total supplied power) and by absorption of about half of the infrared radiation from the burner. In total the glass envelope is heated by approximately 40% of the lamp power[25] [26].

For a currently available 120 lm/W LED lamp the power that is transformed into light is about 40% and there is no IR or UV. So 60% of the power is transformed into heat that has to be removed by convection/radiation to the surrounding air in the closed luminaire.

Let us consider a future LED lamp with an efficiency of 150lm/W. To generate the same amount of light this lamp requires only 80% of the power of the 120 lm/W HPS (120/150*100%). For this LED the radiation is now 50% of the input power and the heat generation is the other 50%. So, the heat that needs to be removed by

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25 *Jack, A.G. and Koedam, M., "Energy Balances For Some High Pressure Gas Discharge Lamps," Ilium. Eng. Soc., July 1974 (other reference needed: Thesis A. Rijke)*

26 *Janssen, J.F.J., Rijke, A.J., Nijdam, S., Haverlag, M., Dijk, J. van, Mullen, J.J.A.M. van der & Kroesen, G.M.W. (2012). A comparison between simulated and experimentally determined energy balances for HID lamps. In R. Devonshire & G. Zissis (Eds.), Poster : Poster presented at the 13th International Symposium on the Science and Technology of Lighting (LS-13 2012), june 24-29, 2012, Troy, New York, USA, (pp. CP040-175/176). Sheffield: FAST LS ltd.*

convection/radiation is now 40% of the input wattage to the 120 lm/W HPS.

Since a typical HPS lamp of intermediate power also has an efficacy of 120 lm/W, the power to be removed is now almost equal to the heat loss from the current HPS glass bulb. So for this hypothetical, very efficient LED lamp that might exist in the future, the envelope temperature will be approximately be the same as for the current HID lamp. The question is now: can this efficient LED lamp operate in the hot lamp envelope?. LED lamps can have a long lifetime, above 25000 hrs, as long as the junction temperature of the LED is not above 100ºC. So we need to know in which environment the LED will operate. As argued above the heat loss to the envelope of 150lm/W LED and for a HPS lamp are the same. So measurement of the envelope temperature of the HPS lamps in a luminaire will predict the temperature of the envelope of the future LED lamp with the same size.

Since the transport of heat in a lamp via the lamp base is limited, the only path for the heat to disappear is via conduction to the air surrounding the lamp. In a closed luminaire, warm air limits the transport, but even if the lamp would operate in open air, the compact size needed to fit as a retrofit lamp in the closed luminaire limits the cooling opportunities.

Figure 15 gives an indication of the measured surface temperature HPS lamps of different power. The LED retrofit lamps will reach at least the same temperature. This surface temperature from 160-400ºC is much higher than the optimal LED junction temperature of 100ºC. This means that LED replacement lamps with the same size as the current HPS lamps cannot exist in the coming decades or that the emitted light flux is lower and/or the lifetime is limited.

Moreover, there is an issue with safety and responsibility of a luminaire where the HPS lamp is “retrofitted” with an LED lamp. HPS lamps are operated on electrical systems that generate high voltage pulses to ignite the lamps. These ignition pulses are typically 1800V-3300V. The igniters have to be taken out of the system (if not integrated in the electronic driver) and rewiring in the luminaire is needed if LED’s would be designed to replace the HID lamps. The installer needs to take the responsibility for safe replacement and needs to label the luminaire accordingly.

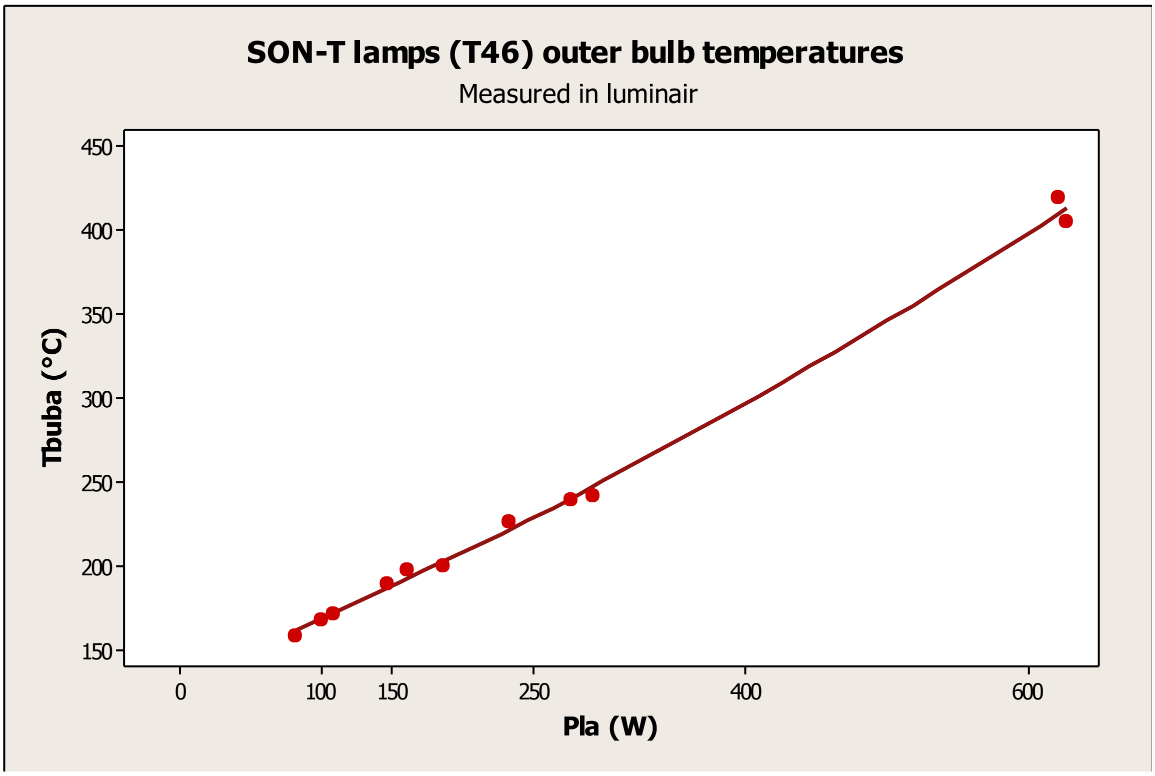

Figure 15. Measured surface temperature for HPS

6.2.1.2 LED luminaires

In principle, it is technically possible to replace the complete HPS installation by an LED solution (Figure 16). While this replacement has many advantages there are also significant drawbacks and challenges[27].

A study[28] [29] from the Renselaer Polytechnic Institute in Troy, NY, comparing street layouts with several HPS and LED light points finds that, in order to guarantee uniformity and sufficient illuminance levels in accordance with the relevant regulations, the poles on which the fixtures are mounted also have to be replaced and the spacing changed. The spacing has to be

[27] *M. Valentová, M. Quicheron and P. Bertoldi, LED PROJECTS AND ECONOMIC TEST CASES IN EUROPE, JRC Scientific and Policy Reports, 2012. Available from http://iet.jrc.ec.europa.eu/energyefficiency/publication/led-projects-and-economic-test-cases-europe*

[28] *National Lighting Product Information Programme. 2010. Streetlights for Collector Roads. Rensselaer Polytechnic Institute. Available from http://www.lrc.rpi.edu/programs/NLPIP/PDF/VIEW/SRStreetlights.pdf (August 2011)*

[29] *National Lighting Product Information Programme. 2011. Streetlights for Local Roads. Rensselaer Polytechnic Institute. Available from http://www.lrc.rpi.edu/programs/NLPIP/PDF/VIEW/SR_StreetlightsLocal.pdf (August 2011)*

decreased so that more poles are required. The reason for this is basically that LED luminaires are efficient or available below 6000 lumens only (Figure 17).

Figure 16. LED street lighting

Under these conditions the LED streetlight layouts on average resulted in a slightly lower power demand than the average HPS streetlight layouts. The LED layout with the lowest power demand had 81% of the power demand of the HPS layout with the lowest power demand. However, the power demand per kilometre of street for individual layouts varied significantly. Only 2 of the 8 LED luminaires gave a power reduction when compared to the best HPS luminaire.

Regarding life cycle cost calculated over a period of 27 years and 113,000 burning hours (average life of an HPS installation) the authors find that even when the LED luminaires have a life of 100,000 hours the cost to own and operate the LED installation is still twice as large as an HPS installation. This life cycle cost is heavily influenced by their initial capital costs, due mostly to the increased number of poles per kilometre.

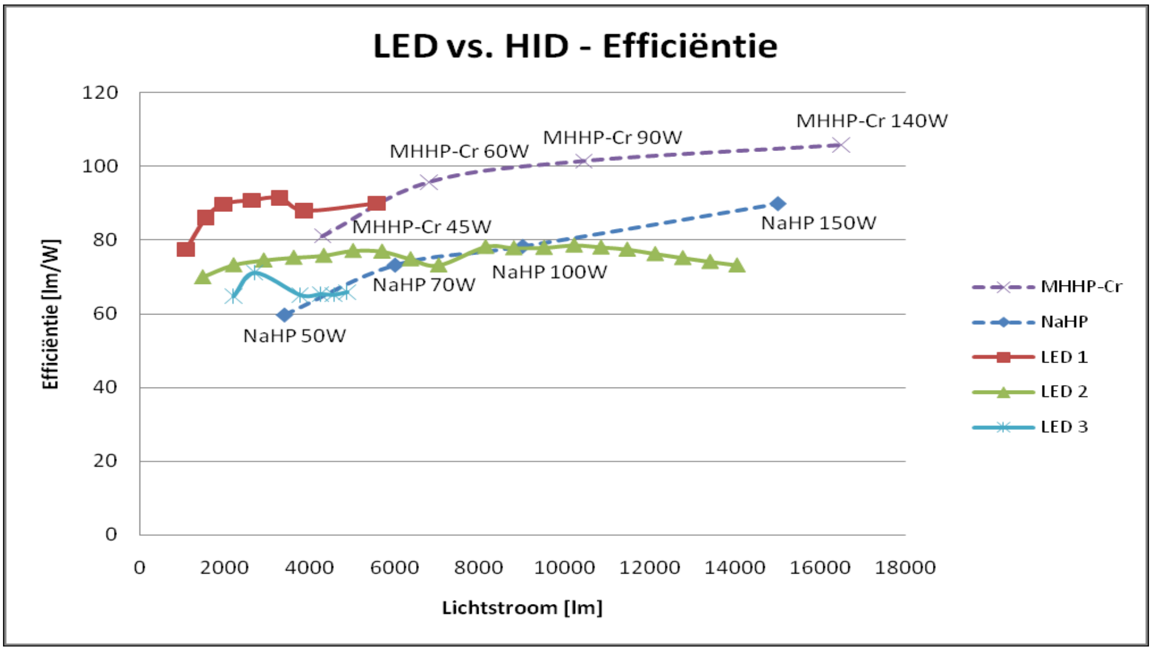

Figure 17. Luminaire efficiency of HPS (NaHP), Ceramic Metal Halide (MHHP-Cr) and LED. (source: EANDIS presentation at Energiedag VVSG Openbare Verlichting[30])

To provide acceptable pay-back time many LED applications therefore reduce the number of poles per kilometre thereby reducing the street illuminance and the uniformity.

[30] *J. Delandtsheer and K. Putteman, Energiedag VVSG Openbare Verlichting, 19 march 2013. Available from* *http://www.vvsg.be/Omgeving/Documents/AV%20d4906_VVSG_Energiedag2013_S26_OpenbareVerlichting_JeroenDelandtsheer.pdf*

This is one of the major drawbacks of LED installations reported [27].

6.2.2 Availability of substitutes

As explained before, there are no one-to-one true replacement lamps for the HID family available. There are LED lamps that are claimed in advertisements to be retrofits. These lamps are easily available (can be ordered from dozens of websites) but they never supply the required lumen output and are too large to be a universal solution. Moreover, the price for these claimed retrofits presents a problem as they are often priced as high as a full LED luminaire.

Hence, referring to Article 5(a) of the RoHS Directive, we can state that the substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable for LED "retrofits".

On system level, LED luminaire layouts are available. To provide a reasonable payback illuminance levels and uniformity are often compromised, leading is some cases to complaints[27]. Also poor quality of LED fixtures are reported and considered as a major drawback for implementing a full change-over to LED installations.

6.2.3 Impacts of substitution

6.2.3.1 Environmental impact of substitutes

In section 4.2.6 a relevant LCA for HPS lamps was discussed. Figure 6 shows that at the time of publication (2009) the overall environmental impacts of LED replacement lamps and LED luminaires were still higher than that of HID systems. Meanwhile the performance of LED has improved but it is not clear yet to which extent this influences the LCA.

6.2.3.2 Health and safety impact of substitutes

There are no known health and safety impacts of the substations discussed in this exemption request.

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:

Substitution of mercury would inevitably lead into the changeover to a new light source technology, like LED. In section 6.2.1.1 it is shown that there is no satisfactory direct lamp replacement for replacing HID lamps with LED lamps. As a consequence, involved luminaires and drivers need to be replaced completely resulting in high investments for customers and governments while the installed equipment is still capable to be used for many years when replacement lamps would remain available (typical life cycle for professional luminaires is around 10-15 years for indoor use and 25-30 years in outdoor[31]). As a consequence the society has the extra burden of the investment in new luminaires and the environment will be spoiled unnecessarily with additional waste. The industry produces approximately 23 million HPS lamps (section 4.1.2) per year for use in Europe. The largest part of these lamps is nowadays replacement of lamps for existing luminaires. The HPS luminiare park is estimated to be 72 million luminaires (section 4.1.2). The replacement of these installations by professional LED luminaires (500 €) and poles (2000 €) is an investment of 180 Billion €. If the illuminance characteristics have to be maintained the number of poles per km needs to go up increasing the investment costs even higher. In the case of a ban on mercury containing replacement lamps this huge investment will have to be made in the short time span of the replacement cycle of an HPS lamp (4 years).

The environmental impact of trashing prematurely millions of still operational HID installations has to our knowledge not been quantitatively assessed. However, it is reasonable to assume that the total negative environmental impact caused by this forced substitution is likely to outweigh the total environmental benefits (ref. Article 5(a) of the RoHS Directive). In view of the natural life of HPS installations, natural replacement of end-of-life installations by LED solutions will take 15 to 25 years. Referring to Figure 4 and extrapolating the installed HPS base, it is projected that if HPS lamps keep being available the replacement of HID installations by LED will take approximately 12 years.

A rapid and full substitution of HPS lamps will also have social consequences. There will be loss of jobs due to the premature shut down of manufacturing sites for High Pressure Sodium lamps in Belgium and Hungary. It is far from certain that the replacement LED systems in this case will be (partly) manufactured in Europe. Due to the Employment Multiplier effect every one of these jobs represent an additional 1.8 jobs lost in the

[31] *Lighting the way: Perspectives on the global lighting market, McKinsey 2012 second edition*

EU28[32].

6.2.3.4 *Impact of substitution on innovation*

Not Applicable

6.2.4 Future trends of substitution

LED technology performance is developing rapidly. However, as shown in section 6.2.1.1 direct replacement of HPS lamps with LED retrofits of the same specification and size is technically not feasible and will likely not happen in the coming years. The future trend will be the replacement of end-of-life HPS installations by LED installations. As discussed in section 4.1.2 and 6.2.3.3, this trend is already set and will lead to a natural phase out of HPS installations.

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.

The effects of removing mercury from a High Pressure Sodium lamp without substitution have been discussed in the first part of section 6.1. The conclusion was that because of a loss in luminous efficacy of about 5% and the dominant effect on all environmental parameters of the electricity consumption in the use phase, the overall environmental

32 *Study on Monitoring of Sectoral Employment, N. Foster, D. HAnzl, S. Leitner, S. Leitner, F. Sanoussi and N. Rabemiafara, available from* http://ec.europa.eu/social/BlobServlet?docId=7418&langId=en

effect is negative.

8 Reduction of mercury content of lamps

8.1 Lamps with unsaturated vapour dosing

Ever since the introduction of the HPS lamp in the 1960's, the possibility of operating this lamp in an unsaturated vapour mode -just as high pressure mercury lamps- has been suggested and discussed[33]. In this mode all the Hg/Na amalgam is vaporised during operation, in contrast to the standard HPS types where only a fraction of the amalgam dose is vaporised.

The unsaturated vapour mode offers a number of advantages over the saturated lamp: better voltage and power stability, no cycling at end-of-life, substantially reduced Hg dose and faster warm-up. However, the very low sodium dose (20-100 μg) makes this lamp extremely vulnerable for sodium loss reactions.

Nevertheless, several practicable applications of unsaturated technology were introduced on the market[34] [35].

Reduction of the sodium loss reactions is realised by employing different emitters[36] [37] on the electrodes and by reducing the maximum PCA wall temperature. The latter change has the consequence that the luminous efficacy decreases. This effect can be seen in Figure 13.

For the same arguments as given in section 6.1 the reduced luminous efficacy has an overall negative environmental impact. It is therefore not a suitable initiative to replace normally dosed HPS lamps with mercury-poor products.

Hence, referring to Article 5(a) of the RoHS Directive, the total negative environmental

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[33] Schmidt, K. , *High pressure sodium vapour lamp*, United States Patent 3,248,590 (1966)

[34] Hida, Y.,Furukubo, H., Takeji, Y., Takatsuka, K., *High pressure sodium lamp of unsaturated vapour pressure type*, GS News 38, vol. 2, p. 92 (1979)

[35] Ravi, J. and Luijks, G.M.J.F, *Characteristics of unsaturated HPS lamps on mercury ballasts*, paper submitted for the IES conference in San Diego, Aug. 1992

[36] Goodman D.A. and Snellgrove R.A., *New emissive materials for unsaturated vapor sodium lamps*, paper submitted for the LS6 conference in Budapest, Sept. 1992

[37] Goodman, D.A., Plumb, J.L., Geens, R.E.A, Snellgrove, R.A. and Wyner, E.F., *Vapor discharge device with electron emissive material*, United States Patent 5,111,108 (1992)

impact caused by reduction is likely to outweigh the total environmental benefit thereof.

8.2 R&D efforts to reduce mercury in saturated vapour HPS lamps

With the recent disruptive effect of the introduction of LED lamps and luminaires on the lighting market the volume of all other technologies, including the exempted mercury containing lamps, is rapidly decreasing. The bulk of R&D efforts from lighting companies are directed towards acceleration of the Solid State Lighting (SSL) revolution and R&D aimed at decreases in mercury dose of mercury containing lamps have virtually stopped. Also for the reduction of the total volume of mercury in lamps this is a positive development: faster replacement of mercury containing lamps by LED lamps or luminaires reduces mercury in the environment more than marginal decreases in the dose of mercury containing lamps. In view of the long life of HPS lamps, this marginal environmental benefit also requires long life testing, making it impossible to introduce on a short term.

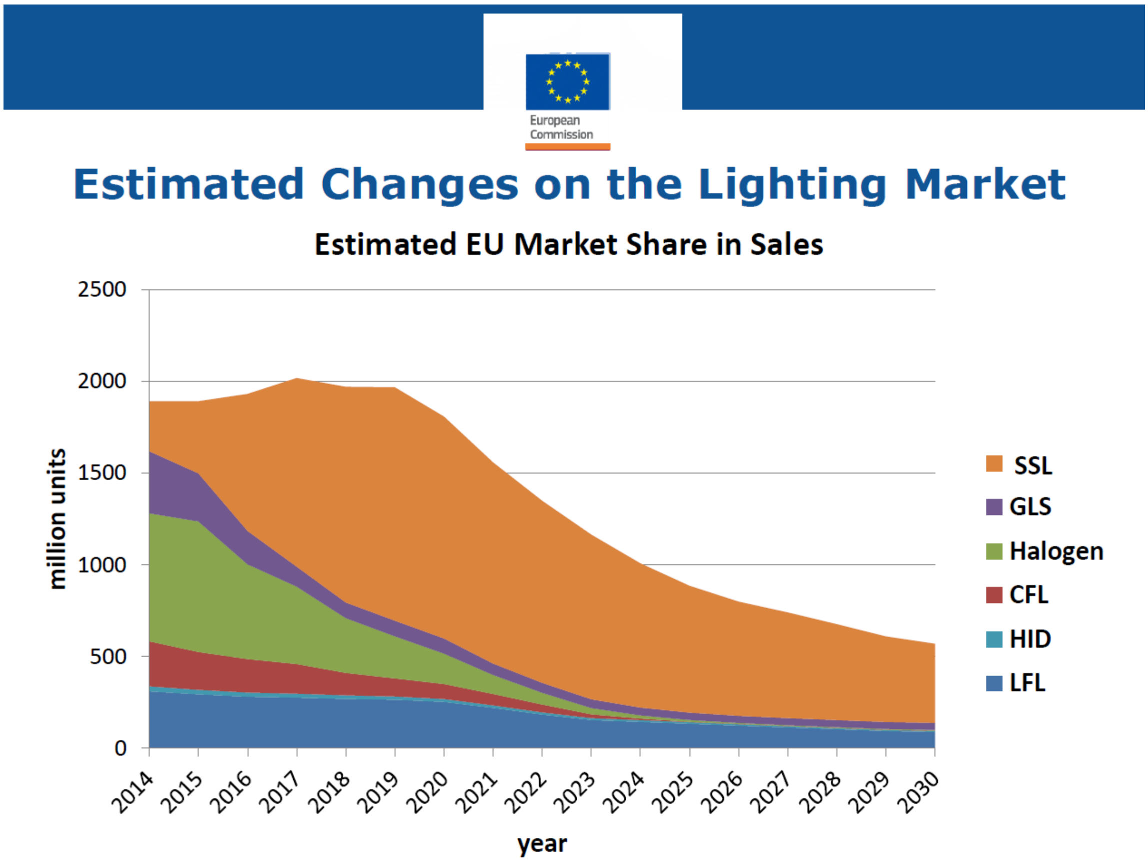

Figure 18: Road Map for lighting (source: Consultation Meeting on "A European Lighting Strategy", in preparation of a draft Commission Communication thereof, DG ENER.C.3 and DG CNECT.A.1, 12 March 2014

The European Commission has drafted a European Lighting Strategy[38] which predicts the evolution of the lighting market in the next 15 years. This study is based on the current evolution of technology and market trends which are the results of the current allocation and distribution of resources and investment in R&D. From Figure 18 it is clear that the gradual decrease in LFL, CFL and HID lamps put in the market will also decrease the amount of mercury. However, the study also implicates that a sudden stop in the sales of mercury containing lamps is not a viable scenario.

Hence, the EC study clearly shows that the renewal of the mercury exemptions 1-4 of the RoHS Annexes III is absolutely necessary in order to realize the switch to non-mercury SSL lighting.

9 Other relevant information

During the UNEP Minamata Convention on Mercury end 2013 in Japan agreements have been made on limitation of mercury in various products, including linear fluorescent. This treaty has been agreed upon and signed by 94 countries around the globe. For High Pressure Sodium lamps no limits have been agreed.

Mercury-added products	**Date after which the manufacture, import or export of the product shall not be allowed (phase-out date)**
Compact fluorescent lamps (CFLs) for general lighting purposes that are ≤ 30 watts with a mercury content exceeding 5 mg per lamp burner	2020
Linear fluorescent lamps (LFLs) for general lighting purposes: (a) Triband phosphor < 60 watts with a mercury content exceeding 5 mg per lamp; (b) Halophosphate phosphor ≤ 40 watts with a mercury content exceeding 10 mg per lamp	2020
High pressure mercury vapour lamps (HPMV) for general lighting purposes	2020
Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for electronic displays: (a) short length (≤ 500 mm) with mercury content exceeding 3.5 mg per lamp (b) medium length (> 500 mm and ≤ 1500 mm) with mercury content exceeding 5 mg per lamp (c) long length (> 1500 mm) with mercury content exceeding 13 mg per lamp	2020

Tabel 3. UNEP Minamata Convention agreements.

[38] *Consultation Meeting on "A European Lighting Strategy", in preparation of a draft Commission Communication thereof, DG ENER.C.3 and DG CNECT.A.1, 12 March 2014*

10 Information that should be regarded as proprietary

Some confidential data from LightingEurope is used in section 4.1.2. This data should be regarded as proprietary.

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