

Response To Öko-Institut

regarding the

1st Questionnaire Exemption Request No. 4(e)

“Mercury in metal halide lamps (MH)”

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Name and contact details

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Abbreviations and Definitions

©HID High Intensity Discharge Lamps

Hg Mercury

LEU LightingEurope

MH-lamps Metal halide lamps

Background

The Oeko-Institut has been appointed within a framework contract¹ for the evaluation of an application for granting an exemption to be included in or deleted from Annexes III and IV of the new RoHS Directive 2011/65/EU (RoHS 2) by the European Commission.¹

¹ Contract is implemented through Framework Contract No. ENV.C.2/FRA/2011/0020 led by Eunomia

LightingEurope (LEU) has submitted the above mentioned request for exemption which has been subject to a first evaluation. The information you have referred has been reviewed and as a result we have identified that there is some information missing and a few questions to clarify concerning your request.

Questions

1. Please provide an overview of MH-lamp types (as pictured on page 6, table 1) with a comparison to possible substitute LEDs and their key parameters, like luminous efficacy (lm/W), lamp life, CRI, average price, light fluxes, colour temperature etc.

Answer of LightingEurope: As argued in the exemption renewal request, LightingEurope has no knowledge of the existence of LED replacement lamps. Although on the internet HID lamps are offered with a claim “replacement”, those cannot be considered a one-on-one replacement for existing lamps. The most critical for a replacement lamp is to offer the same light flux as the existing lamp and to fit in the luminaire. A real retrofit lamp should have additionally the same light colour, colour rendering, light beam and should be electrically compatible with the existing drivers in the market (allow lamp replacement without a need for a rewiring. In the absence of comparable replacement lamps we cannot give the required overview.

LED luminaire alternatives for metal halide luminaires can match the efficacy, life, CRI, light flux, and colour temperature of metal halide lamps.

In the work for the One lighting regulation HID retrofit lamps were discussed in reports for task 4,5,6.² Severe comments were made on the assumption that the advertised lamps are replacement lamps for instance by the Danish energy agency.³ *They state the following:*

“LED retrofit for HID-lamps:

In Task 6 the LED-option for HID lamps is obviously some kind of LED-retrofit; however such retrofit options are very sparsely available and will probably never be available for the very common clear HPS and MH lamps as used in road lighting. Therefore it should be clearly explained and shown that the LED-options for HPS and MH lamps are imaginary and only are included only to show that even if a 2020 LED-retrofit option was possible it would not be beneficial.

(Underlining by LightingEurope)

² Preparatory Study on Light Sources for Ecodesign and/or Energy Labelling Requirements ('Lot 8/9/19) Draft Interim Report, Task 4(Technologies), May.2015, VITO, VHK

http://ecodesign-lightsources.eu/sites/ecodesign-lightsources.eu/files/attachments/LightSources_Task4_may2015_Draft.pdf

Preparatory Study on Light Sources for Ecodesign and/or Energy Labelling Requirements ('Lot 8/9/19) Draft Interim Report, Task 5(Environment and economics), May.2015, VITO, VHK

http://ecodesign-lightsources.eu/sites/ecodesign-lightsources.eu/files/attachments/LightSources_Task5_may2015_Draft.pdf

Preparatory Study on Light Sources for Ecodesign and/or Energy Labelling Requirements ('Lot 8/9/19) Draft Interim Report, Task 6(Design options), May.2015, VITO, VHK

http://ecodesign-lightsources.eu/sites/ecodesign-lightsources.eu/files/attachments/LightSources_Task6_rev1_june2015_Draft.pdf

³ The discussion on the existence of LED retrofits for HID lamps is answered by the Danish energy expert in:

<http://ecodesign-lightsources.eu/sites/ecodesign-lightsources.eu/files/attachments/2nd%20Stakeholder%20comments%20from%20DEA%20%20-%2020150615%20.pdf>

The following table shows the replacement lamp used in the VHK/VITostudy (ref 2 task 4 pag. 138) and possible metal halide alternatives. Illustrating the problem with lamp size.

Lamp type	Picture	Diameter	Length
LED		120 mm	300 mm
Ceramic Metal halide		14 mm	40 mm
Quartz Metal halide lamp		20 mm	117 mm

- This exemption covers High Intensity Discharge Lamps (HID) containing metal halides. It is understood that mercury is used in all MH lamps (i.e., ceramic, quartz, sodium etc.), which is why an exemption is needed. Please provide an overview on Hg levels in various MH lamps, where possible providing representative values related to typical wattage range and typical application area.

Answer of LightingEurope: The main function of mercury in metal halide lamps is to give the lamp the right lamp voltage. The amount of mercury needed depends strongly on the power of the lamp (higher power need more mercury) but also on the application requirements: a lamp that needs to produce a focussed beam needs to realise the lamp voltage in the short electrode distance of these optical lamps. This requires more mercury. The mercury dose is publically available on the websites of the different companies⁴. Since the diversity of metal halide lamps is high and the performance of the lamps is highly differentiated an aggregated table does not give the comprehensive information as an equivalent table for the fluorescent lamp families.

- You have stated that MH lamps are designed for different applications and the shape and size varies within the 20-2000 Watt power range. Please provide an overview of MH-lamps (for example in table form) specifying available shape and size sub-groups within the Watt power range of the product range. Respectively please provide details for available LED and Xenon alternatives within this format, so that it is clear for what part of the application range substitutes are not available.

Answer of LightingEurope: For all of the applications substitutes are not available so the column of substitutes will remain empty. The metal halide family is a very diverse family with

⁴ The catalogues for Metal Halide lamps can be found on the company websites:

- http://www.lighting.philips.com/main/home#pfpath=0-EP01_GR
- http://www.osram.com/osram_com/products/lamps/high-intensity-discharge-lamps/index.jsp
- <http://catalog.gelighting.com/lamp/high-intensity-discharge/d=0/?r=emea>
- <http://www.havells-sylvania.com/product/en-int/category/light-sources/hid/families/?1=1>

hundreds of lamp types. All geometrical information can be found on the website of the different companies⁵. We cannot give this information on the geometry of the LED replacement lamps since no one - to - one LED replacements exist.

In Section 4.2.3, LEU details various functions, which are enabled through the use of Hg in MH-lamps.

- a. Please clarify how each of these aspects contributes to the total amount of Hg needed.

Answer of LightingEurope: The roles mercury play's in the metal halide lamps, as described in the renewal application for the exemption, are the consequences of the properties of the mercury atom itself. The high vapour pressure is due to the relativistic behaviour of the inner core electrons of the atom that makes the mercury behave "noble gas like"⁶. Properties like the high cross section for elastic collisions with electrons (lamp voltage), the atom's polarizability giving the van der Waals interaction (red emission), its low diffusion speed because of the high mass are all pure properties of the atom itself. The contribution to the different plasma properties are not a simple addition. The mercury gas itself has all these properties. We cannot make the division asked for.

- b. As it can be understood that some functions are not relevant to all MH-lamps, please detail if the irrelevance of such function allows for lower amounts of Hg to be used in certain application sub-groups (for example "warm colour" is explained to be irrelevant for lamps with high colour temperature (>5000K) – would this influence the amount of Hg needed in such lamps.

Answer of LightingEurope: The main properties of mercury are: one the high vapour pressure at elevated wall temperatures and second the high cross section for elastic collisions with electrons. The combination of both properties produces enough lamp voltage. Lamps with high colour temperature (>5000K) are mainly used in projection systems. Indeed the amount of red radiation needed is not large at these high correlated colour temperatures (but important for the colour rendering). Since these lamps are use in optical systems the brightness of the arc is the most important lamp property. This means that the lamp has a short electrode distance and needs a high mercury pressure to get a high enough lamp voltage. So also in the case of high colour temperature lamps a high mercury pressure is needed. Indeed not all properties of mercury are equally

⁵ data on the geometry of the Metal halide lamps are available at for instance:

Ceramic MH Lamps:

- (1) http://www.osram.com/osram_com/products/lamps/high-intensity-discharge-lamps/metal-halide-lamps-with-ceramic-technology/index.jsp,
- (2) <http://www.ecat.lighting.philips.de//professionelle-lampen/entladungslampen/keramische-metallhalogendampflampen/19252/cat/>
- (3) <http://catalog.gelighting.com/lamp/high-intensity-discharge/metal-halide-lamps/d=0/?r=emea>

Quartz MH lamps:

- (1) http://www.osram.com/osram_com/products/lamps/high-intensity-discharge-lamps/metal-halide-lamps-with-quartz-technology/index.jsp
- (2) <http://www.ecat.lighting.philips.de//professionelle-lampen/entladungslampen/metallhalogendampflampen-mhn-hpi/19254/cat/>
- (3) <http://catalog.gelighting.com/lamp/high-intensity-discharge/metal-halide-lamps/d=0/?r=emea>

Speciality MH lamps:

- (1) http://www.osram.com/osram_com/products/lamps/specialty-lamps/metal-halide-lamps/index.jsp

⁶ „Evidence for Low-Temperature Melting of Mercury owing to Relativity“, F. Calvo, E. Pahl, M.Wormit and P. Schwerdtfeger, Angewandte Chemie International Edition Volume 52, pages 7583–7585, July 15, 2013

relevant in all applications but there is not one gas that can replace mercury in the current lamp families.

4. LEU describes in the application that the “switch on” function can only be fulfilled through the use of Hg.

- a. Please provide a more detailed technical explanation of this function and why only Hg can be used to obtain it in lamps falling under this exemption;

Answer of LightingEurope: The ignition function is made possible by the fact that the pressure in a cold lamp is dominated by the ignition gas: low pressure argon. In the low pressure gas, electrons can be accelerated between collisions with the gas atoms. The generated fast electrons then enable the ignition of the lamp. The mercury that provides the high pressure when the lamp is hot, is condensed when the same lamp is cold and needs to be ignited. The ignition is even made easier by the so called “Penning” effect of the mixture of argon and the low mercury vapour pressure at room temperature. This effect lowers the breakdown voltage even further.

Alternative gases for mercury that could provide the high pressure when the lamp is hot (neon, argon, krypton and xenon) do not condensate in a cold lamp. Their high pressure in a cold lamp makes ignition difficult. For example in the mercury free automotive lamp a very high voltage is needed to ignite the lamp.

- b. In this regard, please provide quantitative data to clarify the Hg function in relation to the function of other candidate substitutes that have been tested (e.g. Xenon, etc.) so that it is clear why the tested alternatives did not provide the minimal performance required in relation to the switch-on function;

Answer of LightingEurope: The noble gases neon, argon, krypton and xenon make ignition very difficult e.g. the gas xenon in an automotive Xenon metal halide lamp needs 25.000V for ignition. This means not only a very expensive ignition device is needed but also other insulation measures to provide protection to persons and equipment from the high voltage pulses. The electrical drivers in existing luminaires provide up to 5000V ignition pulses and therefore cannot ignite the lamps with high noble gas pressures.

5. You have claimed on the one hand that LED technology performance is developing and entering the market rapidly and on the other hand you have stated that there are no replacement lamps for the HID family available. It can be understood from your argumentation that there are no one-to-one replacements when lamps fail in existing installations, however the relevance of this statement is not clear when installations fail, in which case it is understood that they can be replaced with LED installations.

- a. Please clarify if the exemption could be limited for use of lamps in installations placed on the market in the past, or if such limitations could apply to certain parts of the product range.

Answer of LightingEurope: At the moment mercury containing lamps are still used in new installations. Once the lamps are sold to the customer the industry cannot guarantee their use in existing luminaires only. So surveillance and enforcement will be very difficult. The market is regulating itself since new (LED) luminaires for the

current HID applications are not backwards compatible with traditional lamps. And the LED luminaires enter the market rapidly.

- b. If the exemption cannot be limited for use in lamps in installations placed on the market in the past, please provide a roadmap for substitution of relevant application sub-groups:
 - i. What stages can be identified in relation to the development and coming on the market of substitutes?

Answer of LightingEurope: LightingEurope is not able to share the individual roadmaps the member companies have planned for their LED portfolio. There is no general roadmap to develop LED replacements for all existing applications. The expectation is that the penetration of LED's in the market of metal halide lamps will happen via the route of new luminaires. There are no metal halide retrofit lamps on the horizon yet (see also the answer to question 2). The market for metal halide lamps is declining as is indicated in the exemption renewal request in figure 3 on page 8. However since the existing professional luminaires are fully functional and have a long lifetime the customer needs replacement lamps on a regular basis.

The metal halide lamps are also needed for customers with luminaires form high pressure mercury lamps. These lamps are banned from the market. The energy saving replacement lamps cannot be banned.⁷

- ii. Please provide an estimated time-frame for each stage along with a short explanation as to why the estimated time is needed;

See answer to i.

- iii. Where relevant, please state what stages could run in parallel and what stages need to take place on a linear basis.

See answer to i.

Please note that answers to these questions are to be published as part of the available information relevant for the stakeholder consultation to be carried out as part of the evaluation of this request. If your answers contain confidential information, please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked.

⁷ These lamps have an integrated control gear and save 20% energy. See par. 5.17.2 pag 135 , par. 5.19.1 and table 44 (note 2) Preparatory Study on Light Sources for Ecodesign and/or Energy Labelling Requirements ('Lot 8/9/19) Draft Interim Report, Task 4(Technologies), May.2015, VITO, VHK
http://ecodesign-lightsources.eu/sites/ecodesign-lightsources.eu/files/attachments/LightSources_Task4_may2015_Draft.pdf