

Texte zu den geplanten neuen EU-Regelungen zur umweltgerechten Produktgestaltung und zur Energieverbrauchs-kennzeichnung in der Beleuchtung – Zusammenstellung <sup>[1]</sup> des Umweltbundesamtes (UBA), Deutschland



## Studien der EU-Kommission

### Anträge auf Erneuerung verschiedener Ausnahmeregelungen nach Richtlinie 2011/65/EU (RoHS):

#### **Studie vom 29. Juli 2019**

– Stellungnahme von Energimyndigheten/CLASP <sup>[2]</sup>  
vom 30. Oktober 2019 –

*Hinweis: Bitte beachten Sie, daß der angehängte Text nur in Englisch verfaßt ist.*

**EN:** Information on the coming EU Lighting Regulations – Ecodesign and Energy Labelling – Compilation <sup>[1]</sup> of the Federal Environment Agency (UBA), Germany

## Studies of the EU Commission

### **Requests for renewal of various exemptions under Directive 2011/65/EU (RoHS)**

– Study of 29 July 2018: Comments by Energimyndigheten/CLASP <sup>[2]</sup>  
as of 30 October 2019 –

**FR:** Informations sur les futures réglementations de l'UE concernant l'éclairage – l'écoconception et l'étiquetage énergétique – Compilation <sup>[1]</sup> de l'Agence Fédérale de l'Environnement (UBA), Allemagne

## Études de la Commission européenne

### **Demandes de renouvellement pour diverses exemptions pertinentes accordées par la directive 2011/65/UE (LdSD)**

– Étude du 29 juillet 2019 : Commentaires de Energimyndigheten/CLASP <sup>[2]</sup>  
de 30 octobre 2019 –

*Indication : Veuillez noter que le présent texte n'est disponible qu'en anglais.*

<sup>[1]</sup> <https://www.eup-network.de/de/eup-netzwerk-deutschland/offenes-forum-eu-regelungen-beleuchtung/dokumente/texte/>

<sup>[2]</sup> <https://clasp.ngo/> | <https://www.energimyndigheten.se/en/>

DE: ↓

EN: → page III

FR : → page IV

## Texte im Offenen Forum

(**abc** = vorliegender Text)



Abkürzungen/Erklärungen: • CLASP = Collaborative Labeling and Appliance Standards Program, USA (Kooperationsprogramm für Kennzeichnungs- und Gerätestandards) <https://clasp.ngo/> • EG = Europäische Gemeinschaft • Energimyndigheten ist die staatliche Energieagentur Schwedens; <https://www.energimyndigheten.se/en/> • EU = Europäische Union

## Documents in the Open Forum

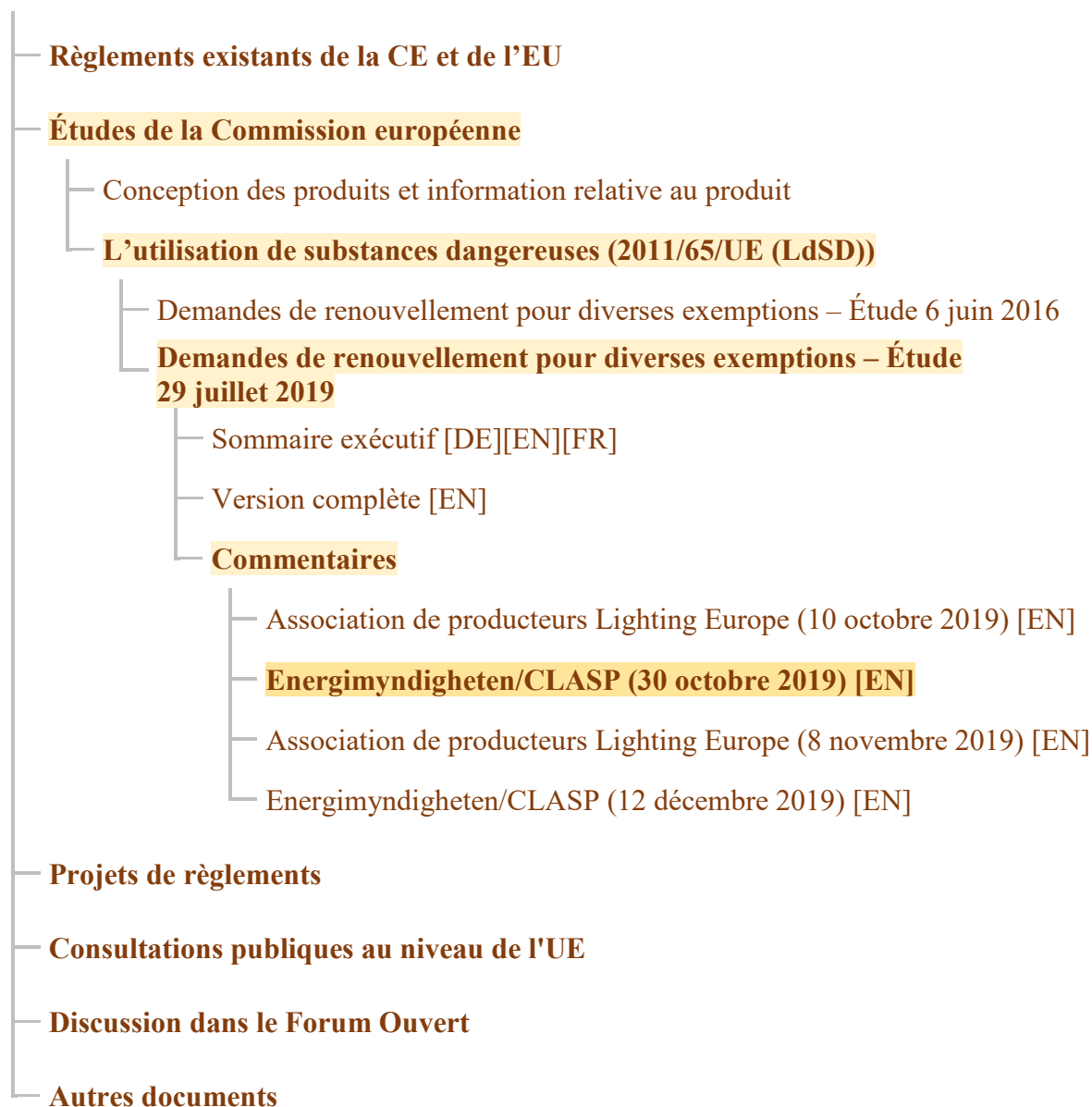
(**abc** = text at hand)



Abbreviations/Explanations: • CLASP = Collaborative Labeling and Appliance Standards Program, USA; <https://clasp.ngo/> • EC = European Communities • Energimyndigheten is the national Energy Agency of Sweden (SEA) • EU = European Union; <https://www.energimyndigheten.se/en/>

## Documents dans le forum ouvert

(abc = présent document)



Abréviations / Déclarations : ● CE = Communauté européenne ● CLASP = Collaborative Labeling and Appliance Standards Program, États-Unis (Programme de coopération pour les normes d'étiquetage et les normes relatives aux dispositifs) <https://clasp.ngo/> ● Energimyndigheten et l'administration nationale suédoise de l'énergie ● UE = Union européenne ; <https://www.energimyndigheten.se/en/>

Es folgt ein unveränderter Originaltext.

EN: The following is an unmodified original text.

FR: Ce qui suit est un texte original.

# Evidence of the availability of mercury-free alternative products to certain fluorescent lamps

Report to the Committee on the Regulation of Hazardous Substances

## Preface

Europe is considering whether to extend the exemptions granted to certain products listed in Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment.<sup>1</sup> The Swedish Energy Agency and CLASP worked together to develop this report in response to Article 6 of Directive 2011/65/EU on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment which addresses the review and amendment of the list of restricted substances exempted under RoHS. There are substitute technologies that can replace products currently exempted in Annex III. We conducted a technical and economic feasibility analysis into mercury-free light-emitting diode (LED) products that can directly replace certain fluorescent lamps which have an exemption.

This report presents the findings of that analysis, including summarising the technological feasibility and economic justification of the mercury-free alternatives to fluorescent lamps. Based on this analysis, the report discusses specific RoHS exemption categories that can be considered for retirement. The authors welcome any comments or suggestions on the analysis presented in this report.

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## Acknowledgements

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<sup>1</sup> Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) (Text with EEA relevance)Text with EEA relevance: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02011L0065-20190722>

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## Summary

The Swedish Energy Agency and CLASP conducted a review of several categories of fluorescent lighting products which are exempted in Annex III of the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment.<sup>2</sup> This review found that there are mercury-free alternative products which can replace these fluorescent lamps, enabling these on-going exemptions from RoHS to be retired.

Through continued investment and on-going breakthroughs in light emitting diode (LED) light sources and drivers alike, the market now enjoys LED retrofit lamps that can be installed directly into existing luminaires without the need for rewiring. These lamps are able to operate on the existing fluorescent ballast, whether it is magnetic (line frequency) or high frequency. Pictures of examples of some of these lamps can be found in Annex A of this report.

The table below summarises our proposals for consideration based on our findings of the existence of alternative LED replacements for the exempted fluorescent lighting in Annex III of the RoHS Directive. These alternative products are cost-effective and can be installed directly into the fluorescent sockets without the need for rewiring.

**Table 1. Proposals for Consideration on the Exemptions for Certain Fluorescent Lamps**

RoHS Annex Exemption	Proposals for consideration
Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):	
1(a) For general lighting purposes < 30 W: 2,5 mg shall be used per burner after 31 December 2012;	Consider setting the exemption to expire on 1 September 2021
1(b) For general lighting purposes ≥ 30 W and < 50 W: 3,5 mg may be used per burner after 31 December 2011;	
1(c) For general lighting purposes ≥ 50 W and < 150 W: 5 mg;	
1(d) For general lighting purposes ≥ 150 W: 15 mg;	
2(a) Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp):	
2(a)(2) Tri-band phosphor with normal lifetime and a tube diameter ≥ 9 mm and ≤ 17 mm (e.g. T5): 3 mg may be used per lamp after 31 December 2011	Consider setting the exemption to expire on 1 September 2021
2(a)(3) Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm (e.g. T8): 3,5 mg may be used per lamp after 31 December 2011	
2(a)(4) Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12): 3,5 mg may be used per lamp after 31 December 2012	
2(a)(5) Tri-band phosphor with long lifetime (≥ 25 000 h): 5 mg may be used per lamp after 31 December 2011	
2(b) Mercury in other fluorescent lamps not exceeding (per lamp):	
2(b)(3) Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9): 15 mg may be used per lamp after 31 December 2011	Consider setting the exemption to expire on 1 September 2021

<sup>2</sup> DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) (Text with EEA relevance) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02011L0065-20190722>

The review is presented around four key questions which explore the technical and economic feasibility of the alternatives to mercury lighting. These four questions and abbreviated answers are shown in the table below. More detail and information underpinning these answers is provided in the body of this report.

**Table 2. Four Key Questions and Summaries of our Findings**

Key Question	Summary of Findings
Are there alternative mercury-free replacements for fluorescent lamps?	<b>Yes.</b> There are thousands of mercury-free LED replacement lamps available today to replace fluorescent lamps – different sizes, lengths, ballast types (i.e., magnetic/starter and high frequency electronic), colour temperatures, and regular, high output and ultra-high light output levels. Lamps are also available which are “universal” and can operate on a variety of input power configurations. Many of these LED products are designed as direct retrofits into existing fluorescent fixtures to avoid the need to rewire. For example, Philips/Signify states <sup>3</sup> that there is “No need to change drivers or rewire”, noting that they offer “plug and play solution that works straight out of the box”. OSRAM/LEDvance state <sup>4</sup> that their “SubstiTUBE” product is a “Quick, simple and safe lamp replacement without rewiring.” Sylvania lighting advertises that their SubstiTUBE product is “engineered to operate on existing instant start and select programmed rapid start electronic T8 ballasts, these lamps minimise labour and recycling costs.” <sup>5</sup> Tungsram reports that in addition to “the 2.5-3x longer life (compared to T8 fluorescent lamps operated on electro-magnetic gear) and lower wattages, Tungsram LED T8 tubes provide lower system loss while existing fixtures remain intact.” <sup>6</sup>
Will removing the exemption result in a reduction in mercury in the environment?	<b>Yes.</b> Each fluorescent lamp contains several milligrams of mercury and our research has found that more than half of the fluorescent lamps sold in Europe are never recovered and instead end up being discarded in the regular municipal waste, contaminating landfill sites and run-off. A 2014 Commission study on collection rates found that the collection rate was only 12% in 2010 for all lamps under the WEEE Directive. <sup>7</sup> The WEEE Directive sets a target of 80% recycling, however some studies show that the actual rate of separate collection at the end-of-life is less than 50%, thus while reported recycling rates are high, these percentages are not based on total lamps removed from service, but are instead only considering those lamps that are delivered to the correct waste treatment facility. The Minamata Convention encourages the sharing of information around mercury-free alternative products and calls for periodic reviews of the exemptions list. In Europe, by not renewing the exemptions for many of these fluorescent lamps for which there are cost-effective, mercury-free, direct replacement alternatives, RoHS would be aligning with the objective of Minamata and removing 2.6 metric tonnes of mercury from our homes and offices – and ultimately landfills – across Europe.

<sup>3</sup> <https://www.lighting.philips.com/main/support/support/tools/ledtube-selectortool>

<sup>4</sup> <https://www.ledvance.com/professional/products/product-stories/led-tubes-online-special/index.jsp>

<sup>5</sup> <https://assets2.sylvania.com/media/bin/asset-1377974/asset-1377974>

<sup>6</sup> <https://tungsram.com/en/products/led-retrofit/led-tubes>

<sup>7</sup> [https://ec.europa.eu/environment/waste/weee/pdf/Final\\_Report\\_Art7\\_publication.pdf](https://ec.europa.eu/environment/waste/weee/pdf/Final_Report_Art7_publication.pdf)

Key Question	Summary of Findings
Is it cost-effective for LED lamps to replace linear fluorescent lamps?	<p><b>Yes.</b> Economic calculations are presented in section 3 for the most popular lamps. The payback period for replacing a 36W T8 linear fluorescent lamp with an LED retrofit lamp in Europe today is between 5 and 11 months, and the service life of these lamps is 1.5 to 2.5 times longer than fluorescent, saving on replacement costs. LED replacements for T5 fluorescent lamps have longer payback periods of approximately 3 to 3.5 years, however they will operate for approximately 16 years and represent the best option for the end-user, with a net present value life-cycle cost savings of between €55 and €67 for each T5 fluorescent lamp replaced. LED replacements for compact fluorescent lamps not integrally ballasted (CFLni) offer very attractive payback periods of between 1.3 and 3.0 years and will last 2-3 times longer than the fluorescent lamp. For European businesses and households, there is a very strong value proposition in switching to LED, and lighting manufacturer's websites highlight the cost-effectiveness and energy savings potential of LED alternatives to fluorescent lamps.</p>
Are the societal benefits in terms of energy, CO <sub>2</sub> and cost savings significant?	<p><b>Yes.</b> The Commission's consultants (VHK) who prepared the one-lighting regulation review study and impact assessment conducted some new runs of the MELISA market model for this study to help quantify the benefits of phasing out certain fluorescent lamps in 2021. The cumulative benefit through the year 2030 for these specific lamp types are reported as follows:</p> <ul style="list-style-type: none"> <li>• T8 phase-out: Saves 64 TWh electricity, avoids 18.9 MMT CO<sub>2</sub> and has a net saving of €5.0 billion in electricity bills and lamps</li> <li>• T5 phase-out: Saves 60 TWh electricity, avoids 17.8 MMT CO<sub>2</sub> and has a net saving of €4.7 billion in electricity bills and lamps</li> <li>• CFLni phase-out: Saves 14 TWh electricity, avoids 4.2 MMT CO<sub>2</sub> and has a net saving of €2.8 billion in electricity bills and lamps</li> </ul> <p>Taken together, phasing out these three very popular lamp types offers significant societal benefit. In addition, the total electricity savings of 138.3 TWh also avoids the release of mercury from the power stations which burn coal. Using the Commission's estimate of 0.016 mg Hg/kWh of electricity generated in Europe, a further 2.2 metric tonnes of mercury emissions from European power stations would be eliminated.</p>

### Results Summary

If the RoHS exemptions for T8, T5 and CFLni lamps were limited to 1 September 2021, this would move both of those markets to LED earlier than in the business as usual case, enabling the following benefits to accrue across Europe:

**Table 3. Summary of the Benefits from a Scenario where RoHS exemptions for T8, T5 and CFLni Lamps are Limited to 1 September 2021**

Metric for T5, T8 and CFLni compared to Business as Usual*	Savings from limiting RoHS exemption to 1 September 2021 (cumulative through 2030)
<b>Hg Savings:</b> Avoided quantity of mercury put into the lighting supply chain, with the risk of breakage or improper disposal (2.6 metric tonnes) and avoided mercury emitted from power stations due to electricity savings (2.2 metric tonnes).	4.8 metric tonnes Hg
<b>Energy Bill Savings:</b> Billions of Euros saved by businesses and consumers on their lighting bills through the use of more energy-efficient LED lamps	€12.5 billion
<b>Energy Savings:</b> TWh of cumulative energy savings	138.3 TWh electricity
<b>CO<sub>2</sub> Savings:</b> Metric tonnes of CO <sub>2</sub> savings from the avoided generation of electricity for lighting	40.9 million metric tonnes CO <sub>2</sub>

\*Business as Usual is calculated on the basis of the one-lighting ecodesign regulation adopted by the European Commission on 1 October 2019 becoming law and taking effect. The one-lighting regulation will phase-out T8 fluorescent lamps in September 2023, however it was found to be cost-effective to phase-out T8 fluorescent lamps faster than this, thus this analysis considers a scenario phase-out date of September 2021 for T8 (an acceleration of 2 years). T5 and CFLni do not have a phase-out date in the one-lighting ecodesign regulation, however it is also considered for phase-out in September 2021 through the end of its exemption in the RoHS Directive.

The balance of this report provides the data, evidence and analysis to support the summary of findings on the key questions presented in this section.

# 1 Methodology

The Swedish Energy Agency and CLASP decided to work together to develop a report that looks at mercury-free alternatives to some of the lighting products exempted in Annex III of the restriction of the use of certain hazardous substances (RoHS). Due to time and resource constraints, we chose to focus on specific lamp types listed under fluorescent lighting (i.e. Group 1, Group 2a and Group 2b) because these are the most popular mercury-based lamps with the highest volume of sales in Europe – and therefore, are responsible for the largest releases of mercury into the environment. We did not consider the lamps in Group 3 (cold cathode fluorescent lamps) or Group 4 (mercury vapour, high pressure sodium, metal halide), however mercury-free alternatives for these products also exist and may be a topic for future study.

Thus, for this analysis, we started from the list of exempted fluorescent lamps in Annex III of the RoHS Directive:

- Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):
  - 1(a) For general lighting purposes < 30 W
  - 1(b) For general lighting purposes  $\geq 30$  W and < 50 W
  - 1(c) For general lighting purposes  $\geq 50$  W and < 150 W
  - 1(d) For general lighting purposes  $\geq 150$  W
- 2(a) Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp):
  - 2(a)(2) Tri-band phosphor with normal lifetime and a tube diameter  $\geq 9$  mm and  $\leq 17$  mm (e.g. T5)
  - 2(a)(3) Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and  $\leq 28$  mm (e.g. T8)
  - 2(a)(4) Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12)
  - 2(a)(5) Tri-band phosphor with long lifetime ( $\geq 25\,000$  h)
- 2(b) Mercury in other fluorescent lamps not exceeding (per lamp):
  - 2(b)(3) Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9)

Our objective with this work was to prepare a current (October 2019) market and technology assessment that reflected recent innovations in driver technology used in LED lighting which enables (mercury-free) LED lamps to be installed into existing fluorescent luminaires, avoiding the need to rewire and replace luminaires.

We then looked at the market to identify whether mercury-free LED replacements existed for these fluorescent lamps, to determine whether the LED replacements were widely available from multiple retailers in different countries. It was found that LED replacements do exist and are widely available in the European Market, and since LED lamps are now roughly twice as

efficient as fluorescent lighting and last 2-3 times longer than fluorescent lamps, LED replacement lamps also save end-users money while also eliminating mercury.

The authors gathered information on products available on the European market – both fluorescent lamps and LED alternatives to those lamps, and conducted an economic assessment including looking at payback period, life-cycle cost and internal rate of return. We also calculated environmental benefits, such as energy savings and reduction in CO<sub>2</sub> emissions.

To understand the magnitude of the savings potential if these exemptions were rolled-out across Europe, the authors contacted Van Holsteijn en Kemna (VHK), a Netherlands-based private consultancy firm who conducted the regulatory analysis for the Commission on the ecodesign one-lighting regulation which was adopted by the Commission on 1 October 2019. VHK built and maintains a European lighting market model called “MELISA” (Model for European Light Sources Analysis) on behalf of the European Commission. We asked VHK to provide us with shipment estimates of the T5 and T8 lamps that would be avoided, if certain RoHS exemptions were retired on 1 September 2021. VHK responded that they would conduct these runs as a one-time courtesy, on a strictly personal title and not assuming any liability for the data or its use.

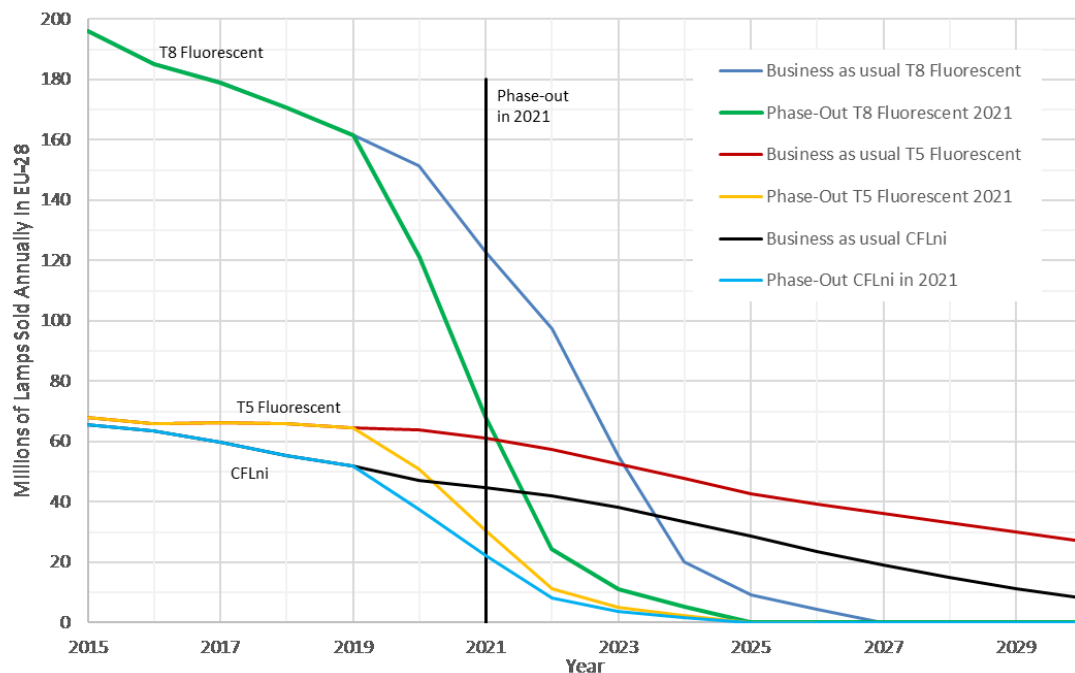
As noted above, on 1 October 2019, the European Commission adopted the one-lighting regulation which scheduled the phase-out of 90% of the T8 lamps in September 2023<sup>8</sup> – however, there are still significant savings to be captured from phasing out these lamps two years earlier in September 2021. VHK prepared calculations of the benefits from accelerating the phase-out of T8 lamps by two years (going from 2023 to 2021) and for phasing-out T5 lamps in 2021 (note: the new ecodesign lighting regulation does not have a phase-out date for T5 fluorescent). In addition, VHK conducted a run that evaluated the phase-out of non-integrally ballasted compact fluorescent lamps (CFLni) which also do not have a phase-out date in the new ecodesign lighting regulation.

VHK provided<sup>9</sup> shipment forecasts in terms of unit sales for T5, T8 and CFLni lamps, as illustrated in the figure below. When preparing these shipment forecasts, VHK used the same assumptions in their analysis as they did for the Commission – in other words, that the decision to phase-out in a future year triggers a small part of the market (10 to 15%) to move earlier to the mercury-free alternatives. The dark blue line depicts the anticipated shipments of T8 fluorescent lamps under the business as usual scenario, including the new EU lighting regulation (adopted 1 October 2019). The green line depicts shipments of T8 fluorescent lamps if there is a two-year acceleration of the phase out, if the RoHS exemption for T8 is limited to September 2021 instead of September 2023. The red line shows the projected sales of T5 fluorescent lamps, which have no phase-out date in the new EU ecodesign regulation for lighting. The yellow line depicts how those shipments will reduce if their RoHS exemption is limited to September 2021. The black line projects shipments of CFLni lamps under business

<sup>8</sup> On 1 October 2019, the European Commission adopted a package of regulations, including new requirements on lighting which will phase out 2 foot, 4 foot and 5 foot lengths of T8 linear fluorescent lamps in September 2023. See: COMMISSION REGULATION (EU) .../... of 1.10.2019 laying down ecodesign requirements for light sources and separate control gears pursuant to Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulations (EC) No 244/2009, (EC) No 245/2009 and (EU) No 1194/2012 (Text with EEA relevance) [Implementing Measure](#) and [Annexes](#).

<sup>9</sup> Personal communication and analysis conducted by VHK using the MELISA lighting market model (which was also used for the Impact Assessment for the Ecodesign one-lighting regulation) --as a one-time courtesy, on a strictly personal title and not assuming any liability for the data or its use-- to provide estimates of the savings potential of various scenarios. Communication on 16 October 2019.”

as usual (again, no phase-out date in the new lighting regulation), and the bright blue line shows the shipments if the RoHS exemption is limited to September 2021.



**Figure 1. EU-28 shipment forecast T8, T5 and CFLni fluorescent lamps, assuming RoHS phase-out in 2021 (VHK MELISA model)**

With the support of a colleague, the authors then looked at the study of the WEEE Directive and studies that had been conducted looking at waste streams and products covered by the WEEE Directive. Taking all of the findings and the evidence into consideration, we arrived at four key questions which we wanted to answer. These four key questions are listed below:

- Are there alternative mercury-free replacements for fluorescent lamps?
- Will removing the exemption result in a reduction in mercury in the environment?
- Is it cost-effective for LED lamps to replace linear fluorescent lamps?
- Are the societal benefits in terms of energy, CO2 and cost savings significant?

The balance of this report presents our responses to each of these key questions, including the evidence we found and the analysis we conducted to answer them.



## 2 Are there alternative mercury-free replacements for fluorescent lamps?

Yes. According to the Design Lights Consortium Quality Products List in the US, there are literally thousands of different models of linear LED replacement lamps for T5 and T8 installations<sup>10</sup>, and over eight hundred compact fluorescent lamps not integrally ballasted CFLni products. Even though we don't have access to a similar database for EU, random sampling on the EU market make us convinced it's fair to assume a similar market situation here in Europe.



**Figure 2. Examples of LED replacements for fluorescent lamps**

These mercury-free alternative LED retrofit lamps are designed to fit into existing fluorescent fixtures, to minimise inconvenience and avoid the need for rewiring. These are the types of LED retrofit tubes available now:

- Installed into a fixture using a magnetic ballast and starter
- Installed into a fixture using a high-frequency electronic ballast
- Installed into a fixture where the old ballast is bypassed and mains-voltage is wired directly to the G5 (T5) or G13 (T8) sockets
- Installed into a fixture where an LED driver has been retrofitted into an existing fluorescent luminaire

In addition to these, manufacturers also operate “universal” lamp replacements, which can operate on several of these combinations of power supplies. Here's a quote<sup>11</sup> from OSRAM about their new T8 lamps:

*OSRAM SUBSTITUBE T8 UNIVERSAL: ONE FOR ALL*

*With OSRAM SubstiTUBE T8 Universal, you no longer need to give any thought to the driver technology being used. The innovative all-in-one LED tube can be operated with*

<sup>10</sup> The Design Lights Consortium (DLC) in the United States maintains a [qualified products list database](#) that represents a large percentage of the LED lamps and luminaires offered on the market in North America. In the categories of T5 and T8 LED replacement lamps, the DLC database contains 26,224 models. While it is recognised that the DLC database does not cover Europe, it is presumed that the European market will have a similarly large sample of models for sale.

<sup>11</sup> <https://www.ledvance.com/professional/products/product-stories/led-tubes-online-special/osram-substitube-t8-universal/index.jsp>



*ECG, CCG and AC mains. It not only makes it much easier for users to operate, but also eliminates the need to keep a double amount of lamps on hand. SubstiTube T8 Universal is suitable for a range of different applications thanks to a selection of three different types: Advanced Ultra Output, Advanced and Value. With a long lifetime up to 60,000 hours and a lumen output up to 3,700 lm, the Advanced Ultra Output and the Advanced models are especially suitable for supermarkets, offices, industrial and public buildings, as well as the illumination of production areas.*

Philips/Signify makes similar claims in their website<sup>12</sup> about the universal appeal and application of their LED Lamps for every installation and application in the market:

*Philips Lighting*

*The perfect tube for every application with MASTER LEDtubes. From offices to retail stores, car parks to industry, every customer has their own unique lighting requirements. Now you can find the right LEDtube every time with the Philips MASTER LEDtubes portfolio. From optimized energy efficiency to the highest light output for the most demanding applications. A simple switch, our LEDtubes come in a choice of lengths and color temperatures, with the option of rotating end caps. We've repositioned the way that our lamps are labelled into three new categories of light output – Standard, High and Ultra output. So with Philips, you have the right LEDtube every time.*

In Figure 3, GE / Tungsram highlight the wide range of pin-based LED retrofit products they offer, enabling the end-user to “replace inefficient CFL lighting without the need for tools or a costly upgrade.”<sup>13</sup> On that same page, GE / Tungsram note that their “LED Plug-In 2Pin range is designed with a universal base (G24d) to replace G24d-1, G24d-2, G24d-3 CFL Plug-In base types at once Easily plugs into existing relevant CFL Plug-In sockets without the need for tools or costly upgrades.” In this way, existing CFL pin-base luminaires can continue to be used, but simply the light source is upgraded to (mercury-free) LED, saving the end-user money.

<sup>12</sup> <https://www.lighting.philips.co.uk/products/led-tube>

<sup>13</sup> <https://tungsram.com/en/products/led-retrofit/led-plug-in>

# LED Plug-in & LED 2D

The new LED Plug-In and LED 2D replacement lamps from GE enable you to replace inefficient CFL lighting without the need for tools or a costly upgrade. GE's LED retrofit lamps provide up to 4x the life of an average CFL and use less than half the energy, delivering a more targeted light that requires less lumens and reduces waste. The result is a dramatic reduction in operating cost, coupled with equally impressive improvements in the quality of light.

The current range includes LED replacement lamps for following CFL Plug In lamps:

- 26/32W CFL 4Pin Plug In with G24-q3 or GX24q-3 base
- 16W 2D 2Pin with GR8 base
- 28W 2D 4Pin with GR10q base
- 18W CFL 4Pin Plug-In with G24q-2 or GX24q-2 base
- 13/18/26W CFL 2Pin Plug In with G24d-1, 2, 3 base types



**Figure 3. GE/Tungsrn offer direct retrofit pin-based LED replacements for CFLs with 4x longer life and save money**

Figure 4 presents some market material from Sylvania who offer a T8 retrofit solution<sup>14</sup> they describe as “ideal for upgrading fluorescent fixtures to LED.” There is a long list of benefits and features (see the link and the document for the full list), but the key ones to point out in this section are the fact that it is able to operate “with a ballast or directly on line voltage” for a high degree of flexibility, making these lamps ideal for upgrading fluorescent installations to LED.

<sup>14</sup> <https://assets2.sylvania.com/media/bin/asset-7401814/asset-7401814>

## SYLVANIA Lamps

### DUALescent™ T8 Universal Lamp

UL Type A+B

#### Application

Product is ideal for upgrading fluorescent fixtures to LED, which provides energy savings. DUALescent provides flexibility for the distributor and contractor with one lamp to satisfy either operation with a ballast or directly on line voltage.

#### Benefits and Features

- Utilizes either fluorescent ballast or operates directly on line voltage providing flexibility in installation
- Lamps operate on shunted and non-shunted lampholders thereby reducing installation costs.
- DLC listed allows for rebates in areas where applicable, saving on overall project cost
- No polarity; can be installed in either direction, saving time (costs) in installation
- Low wattage lamp providing for maximum energy savings

**Figure 4. Sylvania offers products that are ideal for upgrading fluorescent fixtures to LED**

Philips Lighting also highlights the fact that their products offer a lighting service that is equivalent to the fluorescent lamps being replaced, noting that end-users will not be able to distinguish the LED lamps from the fluorescent ones:

*MASTER LEDtube EM/Mains - The Philips MASTER LEDtube integrates a LED light source into a traditional fluorescent form factor. Its unique design creates a perfectly uniform visual appearance which cannot be distinguished from traditional fluorescent. This product is the ideal solution for up lighting in general lighting applications.*

The figure below from LEDvance / OSRAM highlights eight compelling reasons why mercury-free alternatives (LED tubes) “outperform conventional T8, T5 and T9 fluorescent lamps”. They are simple to replace without rewiring, last up to 3 times longer, are twice as energy-efficient (cutting energy bills in half), start immediately at full brightness and are flicker-free, and pay back in as little as four months.

## OSRAM SUBSTITUBE: OUR TOP BENEFITS FOR YOUR LIGHTING PROJECTS

Radiant illumination, singular technology: The new OSRAM SubstiTUBE LED tubes outperform conventional T8, T5 and T9 fluorescent lamps in many ways.

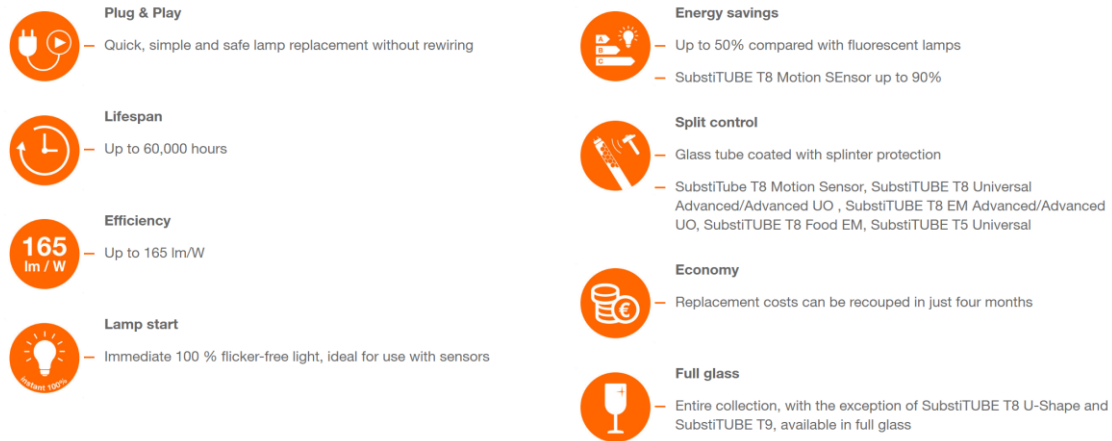


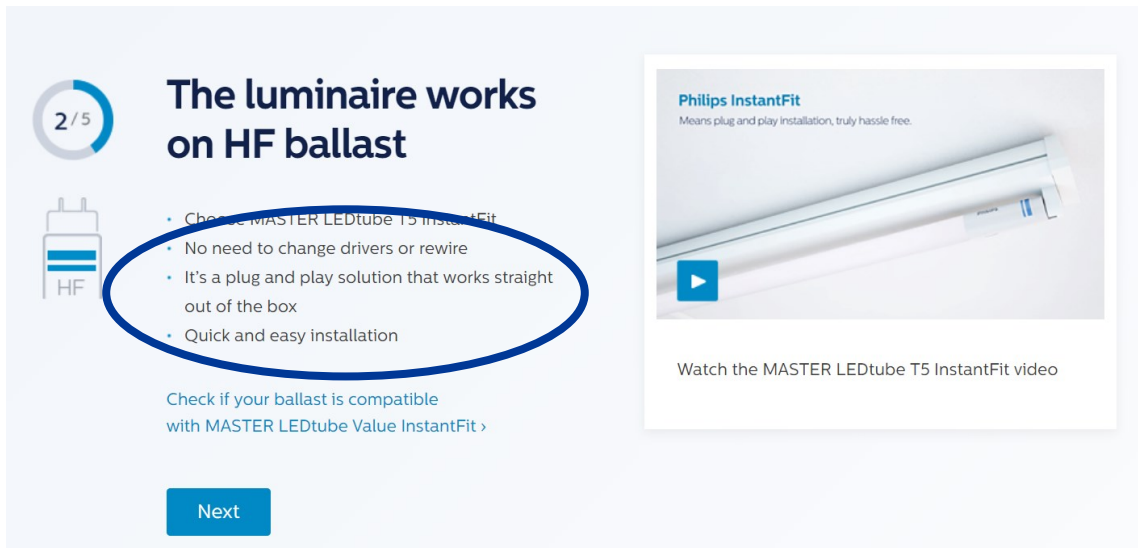
Figure 5. OSRAM notes that LED tubes “outperform conventional T8, T5 and T8 fluorescent lamps”

While the final report<sup>15</sup> of the “Study to assess socio-economic impact of substitution of certain mercury-based lamps currently benefitting of RoHS 2 exemptions in Annex III” cites expensive rewiring costs associated with the retrofit of LED linear tubes, it would appear that this information may be out of date because it fails to capture information about the products on the market in 2019. While the findings of the exemption review study may have been valid in 2016 when their research appears to have been conducted, there have been substantial investments made by the lighting industry partners and suppliers into improving the driver electronics used with retrofit LED lamps. Ultimately, the industry has been pursuing a “plug and play” retrofit solution, and those products are now – in 2019 – being introduced into the market.

The following are some screen captures from LightingEurope members that specifically refer to the convenience of installation, that there is no need for rewiring, and that the new LED Lamps being offered represent a “plug and play” solution into existing fluorescent fixtures across the market. According to Philips Lighting<sup>16</sup>, there is “No need to change drivers or rewire” they offer a “plug and play solution that works straight out of the box.”

<sup>15</sup> <https://op.europa.eu/en/publication-detail/-/publication/9f8f7878-b72a-11e9-9d01-01aa75ed71a1/language-en/format-PDF>

<sup>16</sup> <https://www.lighting.philips.com/main/support/support/tools/ledtube-selectortool>



The luminaire works on HF ballast

- Choose MASTER LEDtube T5 InstantFit
- No need to change drivers or rewire
- It's a plug and play solution that works straight out of the box
- Quick and easy installation

Check if your ballast is compatible with MASTER LEDtube Value InstantFit >

Next

Philips InstantFit  
Means plug and play installation, truly hassle free.

Watch the MASTER LEDtube T5 InstantFit video

Figure 6. Philips offers “InstantFit” solutions, no need to change the driver or rewire

According to OSRAM<sup>17</sup>, they offer the potential to easily upgrade fluorescent luminaires to LED “without doing the least bit of rewiring”. They note that with “their integrated ECG, the innovative LED tubes with a diameter of 16 mm are true plug-&-play replacements for conventional T5 fluorescent lamps with 49 W and 80 W”.

## OSRAM SUBSTITUBE T5 PLUG & PLAY REPLACEMENT OF FL T5 TUBES



T5 luminaires can now be easily upgraded to the latest energy-saving LED technology without doing the least bit of rewiring – thanks to OSRAM SubstiTUBE Advanced T5. With their integrated ECG, the innovative LED tubes with a diameter of 16 mm are true plug-&-play replacements for conventional T5 fluorescent lamps with 49 W and 80 W. The splinter protection makes them ideal for use in particularly sensitive production areas.

Figure 7. OSRAM offers T5 lamps with integrated drivers that are “plug and play” replacements

<sup>17</sup> <https://www.ledvance.com/professional/products/product-stories/led-tubes-online-special/osram-substitube-t5/index.jsp>



In Figure 8, Tungsram advertises<sup>18</sup> that their products operate on “both magnetic and electric gear” and can offer lower system loss while “existing fixtures remain intact.” Their website notes that these lamps are energy efficient (e.g., >60% energy saving), contain no lead or mercury, and fit directly into standard T8 linear fluorescent G13 sockets.

Convert your existing linear fluorescent fixture to LED lighting with a simple switch. LED T8 tubes from Tungsram offer safe, reliable and affordable energy saving alternatives to standard fluorescent T8 lamps both on magnetic and electronic gear. Besides the 2.5-3x longer life (compared to T8 fluorescent lamps operated on electro-magnetic gear) and lower wattages, Tungsram LED T8 tubes provide lower system loss while existing fixtures remain intact.

**Savings through decreased energy costs**

Low power consumption of 9-27 watts offer even >60% energy saving versus 18-58W LFL tubes.

**Low maintenance costs**

L70 50000hours long life results in 1-2 less maintenance cycles vs standard T8 fluorescent tubes.

**Environmentally Conscious**

These lamps are energy efficient, contain no lead or mercury, and are compliant with material restriction requirements of RoHS.

**Reliable quality light**

Instant on, with CRI 80+.

**Quick, and easy installation**

Fits directly into standard T8 linear fluorescent G13 sockets.

Figure 8. Tungsram advertisement noting the “quick and easy installation” of their LED retrofit lamps

Lighting manufacturers around the world have worked hard to develop “plug and play” solutions which enable rapid and easy retrofit of LED lighting into existing linear fluorescent lamps. These alternative products are mercury free and can easily be installed, improving lighting performance, removing mercury and saving energy and CO<sub>2</sub> emissions.

<sup>18</sup> <https://tungsram.com/en/products/led-retrofit/led-tubes>

### 3 Will removing the exemption result in a reduction in mercury in the environment?

Yes. The installation of mercury-free alternatives for mercury-containing products will reduce the presence of mercury in our living spaces and landfills. At the end of its useful life there is always a risk that fluorescent lamps will not be recovered and recycled, but instead will simply be discarded into the general waste where they go on to contaminate landfills, soil, streams, rivers and ultimately the oceans with mercury. Our research has indicated that **half** of the mercury content of T5 and T8 lamps are not collected properly.

The Waste Electrical and Electronic Equipment (WEEE) Directive<sup>19</sup> sets a target for countries across Europe at 80% recycling for gas discharge lamps. This target is far from sufficient to guarantee that no mercury will leak from the lamps to the environment. Indeed, the Directive sets the minimum annual collection rate to “65 % of the average weight of EEE placed on the market in the three preceding years in the Member State concerned, or alternatively 85 % of WEEE generated on the territory of that Member State” but does not set specific collection targets for individual categories. Based on a 2016 evaluation study on the collection rates of WEEE<sup>20</sup>, the Commission concluded that it is not appropriate to set individual collection targets in the WEEE Directive at this stage<sup>21</sup>, while recognising that the generic collection target of 85 % will likely “be reached mostly by increasing the collection of heavy and easily accessible WEEE that has a positive economic value and is less expensive (or more profitable) to treat”. Lamps are not heavy compared to other equipment covered under WEEE.

A 2014 Commission study<sup>22</sup> on collection rates found that the collection rate of the lamps covered under the WEEE Directive was only 12% in 2010. This study projected that the collection rate for lamps to reach 16% in 2019 in the absence of a specific collection target for this category. While the collection targets set by Directive 2012/19/EU are expected to increase the overall collection rate of WEEE, the impact on the collection of lamps is believed to be very limited. Indeed, their light weight and the fact that they are relatively difficult to collect and transport makes them largely irrelevant for Member States to reach their national collection targets, and small size of lamps makes them easier than other WEEE to dispose of with the general waste. The following table<sup>23</sup> is taken from the 2014 study and shows lamps as Category 3, with a current (2010) collection rate of 12% and a projected (2019) collection rate of 16% in the absence of specific targets for lamps.

<sup>19</sup> Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast) (Text with EEA relevance) <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1571396988961&uri=CELEX:02012L0019-20180704>

<sup>20</sup> [https://www.researchgate.net/profile/Jaco\\_Huisman/publication/297453161\\_Study\\_on\\_Collection\\_Rates\\_of\\_Waste\\_Electrical\\_and\\_Electronic\\_Equipment\\_WEEE\\_possible\\_measures\\_to\\_be\\_initiated\\_by\\_the\\_Commission\\_as\\_required\\_by\\_Article\\_74\\_75\\_76\\_and\\_77\\_of\\_Directive\\_2012/19/EU\\_on\\_Waste\\_El/links/56df1cf408aee77a15fcf2c5/Study-on-Collection-Rates-of-Waste-Electrical-and-Electronic-Equipment-WEEE-possible-measures-to-be-initiated-by-the-Commission-as-required-by-Article-74-75-76-and-77-of-Directive-2012-19-EU-on-Was.pdf](https://www.researchgate.net/profile/Jaco_Huisman/publication/297453161_Study_on_Collection_Rates_of_Waste_Electrical_and_Electronic_Equipment_WEEE_possible_measures_to_be_initiated_by_the_Commission_as_required_by_Article_74_75_76_and_77_of_Directive_2012/19/EU_on_Waste_El/links/56df1cf408aee77a15fcf2c5/Study-on-Collection-Rates-of-Waste-Electrical-and-Electronic-Equipment-WEEE-possible-measures-to-be-initiated-by-the-Commission-as-required-by-Article-74-75-76-and-77-of-Directive-2012-19-EU-on-Was.pdf)

<sup>21</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017DC0171>

<sup>22</sup> [https://ec.europa.eu/environment/waste/weee/pdf/Final\\_Report\\_Art7\\_publication.pdf](https://ec.europa.eu/environment/waste/weee/pdf/Final_Report_Art7_publication.pdf)

<sup>23</sup> Source: Study on collection rates of waste electrical and electronic equipment (WEEE) - Possible measures to be initiated by the commission as required by article 7(4), 7(5), 7(6) and 7(7) of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) Cat 3 represents lamps and scenario 1 represent the actual current situation with no individual target per category. Scenario 2 represents a 85% target for each category.

**Table 4. Collection Rates in 2019 for the Two Scenarios Analysed (2014 Commission Study)**

Categories	Current collection rate	Collection rates to be achieved for the considered general collection target in scenario 1	Collection rates to be achieved for the considered individual targets in scenario 2
Cat 1	38%	95%	85%
Cat 2	47%	95%	85%
Cat 3	12%	16%	85%
Cat 4 exc. PV	38%	95%	85%
Cat 5	26%	70%	85%
Cat 6	49%	70%	85%
PV Panels	3%	85%	85%
Total	37%	85%	85%

**Table 13: Collection rates in 2019 for the two scenarios analysed.**

A large share of the non-collected gas discharge lamps may be compact fluorescent lamps, more common in residential use than T5 and T8 lamps. However, according to the MELISA model, developed by VHK for the Commission, the share of linear fluorescent lamps in the lamps covered by the WEEE Directive was 38% in 2009.<sup>24</sup> Considering a case where 16% of those lamps were collected (the Scenario 1 projected 2019 collection rate in the 2014 study), then 22% of these 38% would not be collected, which corresponds to 58% of the linear fluorescent lamps not collected. Extractions from Eurostat<sup>25</sup> show that although the situation seems to have improved since 2010, the collection rate of gas discharge lamps is estimated to be only a third to a half of all gas discharge lamps reaching their end of life. Thus, it is understood that **at least half** of these mercury-containing lamps (and possibly more) are simply discarded in the general waste.

The 2016 Study to assess renewal requests for 29 RoHS 2 Annex III exemptions<sup>26</sup> reports contributions from Member States that confirm those concerns. In particular, Belgium and Denmark report that a significant share of the mercury containing lamps are not treated correctly. The following is an extract from the contribution of the Belgian Federal Public Services for Health, Food Chain Safety and Environment<sup>27</sup>:

<sup>24</sup> We selected 2009 because according to the MELISA model it represents the lowest share of T5 and T8 amongst the lamps covered by the WEEE Directive, as we had to use the share of sales as a proxy for the share of waste. Therefore, by considering that all properly collected lamps in 2009 were T5 and T8, we calculated the most optimistic scenario in terms of properly collected and recycled T5 and T8 lamps.

<sup>25</sup> <https://ec.europa.eu/eurostat/web/waste/key-waste-streams/weee>

<sup>26</sup> [https://rohs.exemptions.oeko.info/fileadmin/user\\_upload/RoHS\\_Pack\\_9/RoHS-Pack\\_9\\_Part\\_LAMPS\\_06-2016.pdf](https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/RoHS-Pack_9_Part_LAMPS_06-2016.pdf)

<sup>27</sup> [https://rohs.exemptions.oeko.info/fileadmin/user\\_upload/RoHS\\_Pack\\_9/Contribution\\_Exemption\\_1-4/Ex\\_1-4\\_FPS\\_Health\\_Food\\_chain\\_safety\\_and\\_Environment\\_Be\\_position\\_Hg\\_lamps\\_20151016.pdf](https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Contribution_Exemption_1-4/Ex_1-4_FPS_Health_Food_chain_safety_and_Environment_Be_position_Hg_lamps_20151016.pdf)



In reference to the obligation in the WEEE Directive 2012/19/EU to collect and recycle lamps, including CFL, we note the following in relation to the collection phase of the process: No specific obligation exist to achieve a total (100%) collect ratio of the CFL, therefore we think that the actual ratio of collect achieved by the European operators should be identified to evaluate the level of efficacy of the system in place. Indeed - even if significant efforts have been implemented by the operators - indications that below 50% of CFL lamps was achieved in 2014 in Belgium. We recommend thus a thorough evaluation of these rates around EU to evaluate the mercury lost (i.e. potentially emitted to the environment) and ensuing consequences.

In Denmark, the Danish Environment Protection Agency reported on a survey of Danish household disposal of light bulbs. The table below is an extract from that report.

**Table 5. Survey of Danish Households on Bulb Disposal (2016 Study in Denmark)**

**Table 4-4: Survey of Danish households on bulb disposal**

Responses of Danish households to the question "Think of the last time you had to discard one of the following worn out bulbs. How did you discard the bulb?"	Energy saving bulb (i.e. CFLs)	LED bulb	Fluorescent tube	Special bulb (halogens or incandescent bulbs)
I delivered it at the recycling station	38%	26%	39%	31%
I delivered it as bulky waste	4%	3%	4%	3%
I put it into the bin for domestic waste	18%	10%	8%	19%
I delivered it as hazardous waste	11%	6%	9%	8%
I delivered it as small electronic waste	9%	7%	7%	8%
I delivered it as glass	3%	2%	3%	4%
Other	2%	2%	2%	2%
I never put a bulb like that to waste	5%	36%	15%	7%
I do not remember/I do not know	10%	17%	15%	17%
<b>Correct disposal behavior total</b>	<b>38%</b>	<b>33%</b>	<b>39%</b>	
<b>Incorrect disposal behavior total</b>	<b>30%</b>	<b>10%</b>	<b>16%</b>	

Source: Provided by DEPA (2016a), referencing data from the EPINION 2014 survey.

And while these collection rates are low – 38% for CFLs and 39% for fluorescent lamps – the following extract from the report indicates that the estimated rate of collection of lamps in Denmark is significantly higher than the European average reported in the Commission's 2014 study on collection rate:

"In Denmark DPA-system administers the mandatory producer responsibility system. According to the **2014 statistics of the DPA-system** 1547 tons of bulbs (the various types of bulbs are not specified) were put on the market for consumers and 199 tons for professionals, for a total of 1746 tons of bulbs<sup>35</sup>. Concerning collection 765 tons of bulbs were collected from consumers and 12 tons from professionals, amounting to 777 tons and corresponding to a collection percentage of 45%.<sup>36</sup> According to **statistical data from the DPA system for 2006**, in 2006 Denmark achieved an overall collection rate of 36%<sup>37</sup>. Data from 2010 shows an overall collection rate of 43%.

All of these data seem to contradict the fact that the majority of Member States report having met the target of 80% for the re-use/recycling of gas discharge lamps<sup>28</sup>, sometimes reporting recycling rates greater than 100%. The reason for these very high recovery rates has to do with the what is meant by "recycling rate" in the regulation, which only includes those lamps which have been correctly disposed of. Thus, high percentages of recycling are only considering those lamps which are delivered to a recycling centre. Unfortunately, the majority of

<sup>28</sup> Cf. pp.189 and 2010-211 of the [Implementation report for Directives 2002/96/EC and 2012/19/EU on WEEE- Period 2013-2015](#) (published in September 2018)

fluorescent lamps in Europe are not disposed of correctly and thus the mercury in those lamps ends up not being properly treated, polluting the environment and posing a health risk.

Figure 9 depicts our best estimate of the flow of fluorescent lamps in Europe, based on the data sources indicated in this footnote.<sup>29</sup> Unfortunately it seems that more than half of the fluorescent lamps which are installed in Europe are not recovered and recycled at the end of life.

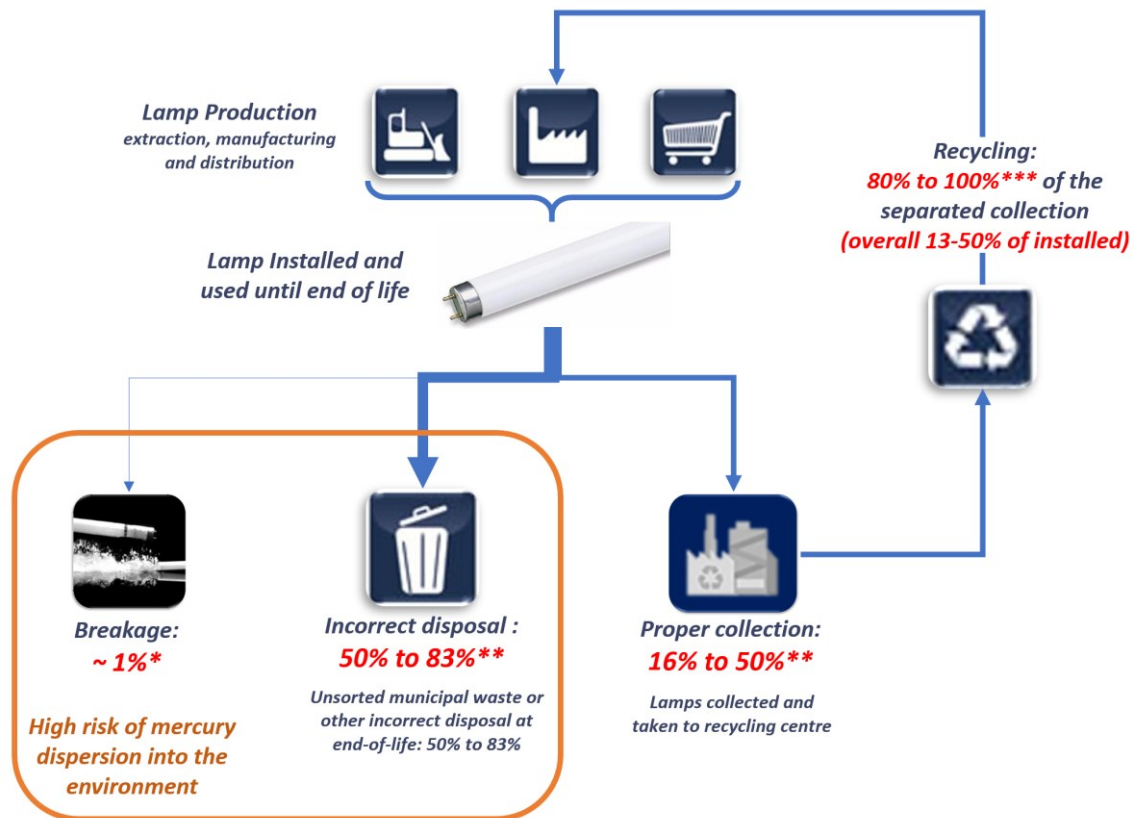


Figure 9. Life-Cycle flow diagram of fluorescent lamps in Europe

Following our review of the above-mentioned sources we are concerned that **about a half of the mercury content of T5 and T8 fluorescent lamps seems to not follow the appropriate waste treatment.** Given the technical and economic analysis of mercury-free alternative

<sup>29</sup> Sources: \* Danish Ministry of the Environment, Environmental Protection Agency, Survey of Chemical Substances in Consumer Products, No. 104 2010 - *Survey and health assessment of mercury in compact fluorescent lamps and straight fluorescent lamps*, quoting Defra, 2009. Department for Environment, Food and Rural Affairs.  
<http://www.defra.gov.uk/environment/business/products/roadmaps/lightbulbs.htm>

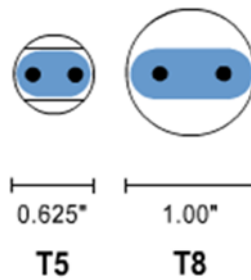
\*\* Study on collection rates of waste electrical and electronic equipment (WEEE) - Possible measures to be initiated by the commission as required by article 7(4), 7(5), 7(6) and 7(7) of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), 2014-

[https://ec.europa.eu/environment/waste/weee/pdf/Final\\_Report\\_Art7\\_publication.pdf](https://ec.europa.eu/environment/waste/weee/pdf/Final_Report_Art7_publication.pdf); Eurostat - <https://ec.europa.eu/eurostat/web/waste/key-waste-streams/weee>; Belgian estimate reported in Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment: Study to assess renewal requests for 29 RoHS 2 Annex III exemptions, 2016 - [https://rohs.exemptions.oeko.info/fileadmin/user\\_upload/RoHS\\_Pack\\_9/RoHS-Pack\\_9\\_Part\\_LAMPS\\_06-2016.pdf](https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/RoHS-Pack_9_Part_LAMPS_06-2016.pdf)

\*\*\* Final Implementation Report for Directives 2002/96/EC and 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE): 2013 – 2015 - [https://ec.europa.eu/environment/archives/waste/reporting/pdf/Final\\_Implementation\\_Report\\_2013\\_2015\\_WEEE.pdf](https://ec.europa.eu/environment/archives/waste/reporting/pdf/Final_Implementation_Report_2013_2015_WEEE.pdf)

products that provide the same (and in many cases better) lighting service, we propose to seriously consider the phase-out of mercury-containing lamps in 2021.

The product groups we are focusing on in this analysis include linear fluorescent lamps and pin-based CFLs.



- “T” stands for tubular lamp shape
- T5 lamps are 5/8 inch diameter
- T8 lamps are 1 inch diameter
- Double-ended contacts



- Single-ended contact, 2 and 4 pin configurations including for example G24q-1 and 2GX7
- Ballast is incorporated into the fixture

**Figure 10. Picture and description of T5 and T8 fluorescent lamps and pin-based CFLs**

These mercury-containing fluorescent lamps are now rapidly being replaced across Europe with alternative products based on light emitting diode (LED) technology which is mercury-free, cost-effective, longer-lasting and provides the same or better lighting service compared to fluorescent. Figure 11 is from Philips Lighting/Signify<sup>30</sup> who market LED lighting to businesses as “A green choice”, noting that “LED tubes are a mercury-free alternative to traditional fluorescent tubes, a responsible choice that can also contribute towards your green credentials.”

<sup>30</sup> [Link to the LED lighting brochure](#) published by Philips Lighting/Signify.

#### The right tube, right now

Our portfolio of LED tubes is now available with a range of options in High and Ultra Output.

#### Save on energy costs

LED tubes are up to 65% more efficient than TL-D lamps, so you can save on energy costs without compromising on light quality.

#### Long-lasting and reliable

With a lifetime of 50,000 hours they outshine TL-D lamps by 25,000 hours for lower maintenance and operation costs.

#### High quality of light

Our LED tubes won't flicker or cause glare. The 100% instant light has a high colour consistency and uniform visual appearance in a choice of colour temperatures.

#### NEW Ultra output, ultra efficient

Choose Ultra Output for ultra efficiency of 148 lm/W and exceptional light quality. Philips has a long history of ground-breaking innovation in lighting technologies. Our Ultra Output LED tubes are specially designed for demanding applications that require a high light output to comply with ergonomic norms. In fact they raise the bar in lighting efficiency and comfort by meeting all office, supermarket and healthcare standards.

#### A green choice

LED tubes are a mercury-free alternative to traditional fluorescent tubes, a responsible choice that can also contribute towards your green credentials.

#### 100% safe installation

LED tubes are the fastest and easiest way to upgrade existing luminaires to LED technology. Installation is 100% safe and 0% hassle with a simple lamp-for-lamp replacement.



**Figure 11. Philips Lighting/Signify highlighting the mercury-free alternative to fluorescent lighting**

As discussed in Chapter 1 (Methodology), the authors contacted VHK and asked if they would conduct some runs of various phase-out scenarios for T8, T5 and CFLni lamps. VHK conducted those runs and provide the shipment forecasts and energy and financial savings. Table 6 presents the cumulative total number of fluorescent lamps that are not sold, and total mercury avoided from the European market. It is expected that these values represent minimum levels of avoided mercury, as the increased market-demand for LED lamps driven by the retirement of these exemptions will further help to accelerate the global investment and development of LED products and accelerate the phase-out of fluorescent products around the world.

**Table 6. Shipment Forecast for T8, T5 and CFLni Lamps in Europe; RoHS phase-out in 2021**

Year	T8 LFL Sales			T5 LFL Sales			CFLni Sales		
	BAU, phase-out in 2023*	RoHS phase-out in 2021	Avoided T8 lamps	BAU, no phase-out*	RoHS phase-out in 2021	Avoided T5 lamps	BAU, no phase-out*	RoHS phase-out in 2021	Avoided CFLni lamps
	(millions)	(millions)	(millions)	(millions)	(millions)	(millions)	(millions)	(millions)	(millions)
2015	196	196	-	68	68	-	66	66	0
2016	185	185	-	66	66	-	64	64	0
2017	179	179	-	66	66	-	60	60	0
2018	171	171	-	66	66	-	55	55	0
2019	162	162	-	65	65	-	52	52	0
2020	151	121	30	64	51	13	47	38	9
2021	123	68	54	61	30	31	45	22	22
2022	97	24	73	57	11	46	42	8	34
2023	55	11	44	53	5	48	38	4	34
2024	20	5	15	48	2	45	33	2	32
2025	9	-	9	43	-	43	29	0	29
2026	4	-	4	39	-	39	23	0	23
2027	-	-	-	36	-	36	19	0	19
2028	-	-	-	33	-	33	15	0	15
2029	-	-	-	30	-	30	11	0	11
2030	-	-	-	27	-	27	8	0	8
<b>Total</b>			<b>231</b>			<b>391</b>			<b>237</b>

\* Under the new ecodesign one-lighting regulation which was adopted by the Commission on 1 October 2019, T8 fluorescent lamps are phased-out in September 2021. T5 fluorescent lamps and CFLni lamps do not have a phase-out date, thus shipments continue through 2030 (the last year of shipment forecasts in the MELISA model).

To calculate an estimate of the total mercury avoided through the retirement of the RoHS exemptions for these three popular lamp types, the RoHS limits were multiplied by the volume of lamps: T8 lamps contain 3.5 mg of mercury, the T5 lamps contain 3.0 mg of mercury and the CFLni lamps contain 2.5 mg of mercury.

$$(231 \text{ million T8 lamps}) \times (3.5 \text{ mg Hg}) + (391 \text{ million T5 lamps}) \times (3.0 \text{ mg Hg}) +$$

$$(237 \text{ million CFLni lamps}) \times (2.5 \text{ mg Hg}) = \mathbf{2574 \text{ kilograms Hg}}$$

Thus approximately 2.6 metric tonnes of mercury could be avoided in Europe if the RoHS determines that technologically feasible, economically justified non-mercury containing alternatives to T8, T5 and CFLni fluorescent lamps exist and the extension is not necessary anymore. The exemptions could therefore simply be extended so that they expire on 1 September 2021.

If the RoHS Committee were to take this decision, it would be fully in alignment with the objectives of the Minamata Convention and objectives of the Regulation of Hazardous Substances Directive.

Minamata Convention, Article 1: Objective:

*The objective of this Convention is to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.*

Minamata Convention, Article 4: Mercury Added Products, paragraphs (4) and (7):

*4. The Secretariat shall, on the basis of information provided by Parties, collect and maintain information on mercury-added products and their alternatives, and shall make such information publicly available. The Secretariat shall also make publicly available any other relevant information submitted by Parties.*

*7. Any Party may submit a proposal to the Secretariat for listing a mercury-added product in Annex A, which shall include information related to the availability, technical and economic feasibility and environmental and health risks and benefits of the non-mercury alternatives to the product, taking into account information pursuant to paragraph 4.*

Limiting the extension for T5 and T8 linear fluorescent lamps is also consistent with protecting human health and the environment, as stated in the objective of the RoHS Directive:

*Article 1: Subject matter*

*This Directive lays down rules on the restriction of the use of hazardous substances in electrical and electronic equipment (EEE) with a view to contributing to the protection of human health and the environment, including the environmentally sound recovery and disposal of waste EEE.*



## 4 Is it cost-effective for LED lamps to replace linear fluorescent lamps?

**Yes.** The phase-out of linear fluorescent lamps is cost-effective today, with many payback periods shorter than one year. The following screen capture from the OSRAM/LEDVANCE website<sup>31</sup> points to the fact that payback periods can be as short as four months. This is due to the long operating hours for these installations and the fact that direct-replacement LED retrofit tubes are now more than twice as efficient as the traditional, mercury-containing fluorescent lamps.




**Figure 12. OSRAM/LEDvance Literature Highlighting Benefits of LED Tubular Retrofit Lamps**

The authors prepared a calculation of a socket-for-socket replacement of a T8 fluorescent lamp with two different LED tubes to check if OSRAM's reported four-month payback period is applicable in Europe. The table below presents our findings in relation to this assessment. We compared a €3.68 OSRAM 36W T8 linear fluorescent lamp (20 000 hours life) with Philips' CorePro (entry-level, 30 000 hours life) LED replacement and Philips' MasterLED (professional-grade, 50 000 hours life) LED retrofit models. Assuming operation for 10 hours per day, the entry-level LED offers a payback of 4.9 months compared to the fluorescent (and will last 1.5 times longer than the fluorescent lamp) and the professional grade lamp offers a payback of 11 months (and will last 13 years, which is 2.5 times longer than the linear fluorescent lamp).

<sup>31</sup> <https://www.ledvance.com/professional/products/product-stories/led-tubes-online-special/index.jsp>

**Table 7. Life-Cycle Cost Economic Analysis of T8 Lamp Replacement in Europe**

<b>Europe</b>  <i>Spreadsheet to look at cost-effectiveness of efficient lighting policy measures.</i>	Lamp is on for hours/day:	10	hours/day
	Electricity price:	0.11	EUR/kWh
	Annual change in price of Electricity	4.0%	percent (MEErP)
	Electricity CO <sub>2</sub> intensity:	0.296	kg CO <sub>2</sub> /kWh
	Discount Rate	4.0%	percent



Lamp type	T8 LFL	LED T8 - 1	LED T8 - 2	
Lamp wattage:	36	18	12.5	Watts
Rated lamp lifetime:	20000	30000	50000	Hours
Price for one lamp (EUR):	3.68	6.77	12.74	EUR/lamp
<b>Electricity consumption and savings calculations</b>				
Annual electricity consumption for each lamp type:	131	66	46	kWh/year
Annual electricity savings compared to T8 fluorescent lamp:	---	66	86	kWh/year
Percent electricity savings compared with T8 fluorescent lamp:	---	50%	65%	percent
Electricity cost for operating the lamps each year:	15.10	7.55	5.24	EUR/year
Financial savings of electricity costs per year vs. fluorescent:		7.55	9.86	EUR/year
<b>Life-Cycle Cost (LCC) of one lamp over analysis period shown</b>				
LCC time period of analysis:	13.0	13.0	13.0	years
LCC of operating lamp for 13 years, discounted to 2019:	205.46	109.85	80.89	EUR (NPV, 2019)
LCC savings of more efficient lamp compared with a fluorescent T8:	---	95.61	124.57	EUR (NPV, 2019)
Percent LCC savings compared with a fluorescent T8 lamps:	---	47%	61%	percent
LCC savings are (X) times larger than LED Tube -1 LCC savings:	---	---	1.3	times greater
<b>Payback period and Internal Rate of Return calculations</b>				
Simple Payback period in years, compared with T8 fluorescent:	---	0.41	0.92	years
Simple Payback period in months, compared with T8 fluorescent:	---	4.9	11.0	months
Internal Rate of Return (IRR), compared with T8 fluorescent:	---	259%	118%	percent
<b>CO<sub>2</sub> emissions calculations</b>				
CO <sub>2</sub> emissions due to electricity for one lamp operating for 13 years:	505.3	252.6	175.4	kg CO <sub>2</sub> /13 yrs
CO <sub>2</sub> savings compared with a T8 fluorescent lamp:	---	252.6	329.8	kg CO <sub>2</sub> /13 yrs
CO <sub>2</sub> savings is (X) percent more than LED Tube 1 CO <sub>2</sub> savings:	---	---	31%	percent

Notes: 10 hours/day represents 3650 hours per year, or about 42% on time per year. Electricity price of €0.1149/kWh from Eurostat for non-domestic sector<sup>32</sup>. Electricity price escalation rate of 4% is applied (following the MEErP methodology). CO<sub>2</sub> intensity of 295.8 g CO<sub>2</sub>/kWh from European Environment Agency<sup>33</sup>.

All of the economics presented in this analysis indicate that the replacement of T8 fluorescent lamps is highly cost-effective. On a life-cycle cost basis, discounted to its net present value, end-users will save €95.61 (CorePro) or €124.57 (MasterLED) for each T8 fluorescent lamp replaced in their ceilings. These findings are based on October 2019 market prices and 2018 electricity prices and are indicative of the findings reported by VHK in their review study prepared for the one lighting regulation. VHK's original proposal recommended a phase-out of T8 linear fluorescent lamps in September 2020 based on their technical and economic analysis. However the final regulation adopted delayed that phase-out date by three years to September 2023, foregoing the significant benefits discussed in this report (see Annex B) – including the removal of mercury from offices and homes across Europe.

Conducting the same calculation for a T5 replacement, the payback periods are longer than T8, however they are still positive, and end-users will easily recover the investment made in the more energy-efficient, mercury-free LED replacements. In addition, if there were to be a phase-out, T5 LED lamp prices would become more competitive with the higher volumes and thus payback periods would get shorter. There isn't an LED entry-level and professional-grade option in T5, thus a single calculation comparison is performed, comparing a 28-Watt linear fluorescent T5 with an LED direct replacement lamp from OSRAM/LEDvance. The results are presented in Table 3, which shows a payback period of between 3.2 and 3.4 years. The net

<sup>32</sup> [https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity\\_price\\_statistics#Electricity\\_prices\\_for\\_non-household\\_consumers](https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics#Electricity_prices_for_non-household_consumers)

<sup>33</sup> [Link to European Environment Agency](#) graphic depicting the 2016 CO<sub>2</sub> intensity value of 295.8g CO<sub>2</sub>/kWh.



present value of the life-cycle cost savings is still strongly positive, offering European businesses €67.30 with the OSRAM product or €54.93 with the Philips product for each lamp replaced in terms of electricity savings.

**Table 8. Life-Cycle Cost Economic Analysis of T5 Lamp Replacement in Europe**

Europe

Lamp is on for hours/day:

Electricity price:

Annual change in price of Electricity

Electricity CO2 intensity:

Discount Rate

10

0.11

4.0%

0.296

4.0%

hours/day

EUR/kWh

percent (MEErP)

kg CO2/kWh

percent

Spreadsheet to look at cost-effectiveness of efficient lighting policy measures.

OSRAM LFL

OSRAM LED T5-1

OSRAM LED T5-2


Lamp type	T5 LFL	LED T5 - 1	LED T5 - 2	
Lamp wattage:	28	16	16.5	Watts
Rated lamp lifetime:	24000	60000	50000	Hours
Price for one lamp (EUR):	2.83	19.99	18.12	EUR/lamp
Electricity consumption and savings calculations				
Annual electricity consumption for each lamp type:	102	58	60	kWh/year
Annual electricity savings compared to T5 fluorescent lamp:	---	44	42	kWh/year
Percent electricity savings compared with T5 fluorescent lamp:	---	43%	41%	percent
Electricity cost for operating the lamps each year:	11.74	6.71	6.92	EUR/year
Financial savings of electricity costs per year vs. fluorescent:	---	5.03	4.82	EUR/year
Life-Cycle Cost (LCC) of one lamp over analysis period shown				
LCC time period of analysis:	16.0	16.0	16.0	years
LCC of operating lamp for 16 years, discounted to 2019:	194.65	127.35	139.72	EUR (NPV, 2019)
LCC savings of more efficient lamp compared with a fluorescent T5:	---	67.30	54.93	EUR (NPV, 2019)
Percent LCC savings compared with a fluorescent T5 lamps:	---	35%	28%	percent
Payback period and Internal Rate of Return calculations				
Simple Payback period in years, compared with T5 fluorescent:	---	3.41	3.17	years
Simple Payback period in months, compared with T5 fluorescent:	---	40.9	38.0	months
Internal Rate of Return (IRR), compared with T5 fluorescent:	---	32%	35%	percent
CO2 emissions calculations				
CO2 emissions due to electricity for one lamp operating for 16 years:	483.7	276.4	285.0	kg CO2/16 yrs
CO2 savings compared with a T5 fluorescent lamp:	---	207.3	198.7	kg CO2/16 yrs

Note: See notes above under Table 7 for some of the input assumptions used in this calculation.

Conducting the same calculation for a CFLni replacement, the payback periods vary with the LED installed. In this calculation, an OSRAM 2D GR10q 28W is compared with a General Electric LED 2D shaped lamp and a Kosnic LED planar retrofit with the same socket (GR10q). Both LED replacements last more than twice as long as the fluorescent lamp, and the payback periods vary from 1.3 to 3.0 years. The results are presented in Table 9 which shows positive life-cycle cost savings for end-users, offering European businesses €63.25 with the GE product or €24.02 with the Kosnic retrofit lamp.

**Table 9. Life-Cycle Cost Economic Analysis of CFLni Lamp Replacement in Europe**

<b>Europe</b>  <i>Spreadsheet to look at cost-effectiveness of efficient lighting policy measures.</i>	Lamp is on for hours/day:	10	hours/day
	Electricity price:	0.11	EUR/kWh
	Annual change in price of Electricity:	4.0%	percent (MEErP)
	Electricity CO2 intensity:	0.296	kg CO2/kWh
	Discount Rate	4.0%	percent



Lamp type	CFLni - GR10q	LED EM-GR10q	GR10q 2D	
Lamp wattage:	28	12.5	18.0	Watts
Rated lamp lifetime:	13000	40000	30000	Hours
Price for one lamp (EUR):	4.08	12.56	16.60	EUR/lamp
<b>Electricity consumption and savings calculations</b>				
Annual electricity consumption for each lamp type:	102	46	66	kWh/year
Annual electricity savings compared to CFLni fluorescent lamp:	---	57	37	kWh/year
Percent electricity savings compared with CFLni fluorescent lamp:	---	55%	36%	percent
Electricity cost for operating the lamps each year:	11.74	5.24	7.55	EUR/year
Financial savings of electricity costs per year vs. fluorescent:		6.50	4.19	EUR/year
<b>Life-Cycle Cost (LCC) of one lamp over analysis period shown</b>				
LCC time period of analysis:	10.0	10.0	10.0	years
LCC of operating lamp for 10 years, discounted to 2019:	128.24	64.98	104.22	EUR (NPV, 2019)
LCC savings of more efficient lamp compared with a fluorescent CFLni:	---	63.25	24.02	EUR (NPV, 2019)
Percent LCC savings compared with a fluorescent CFLni lamps:	---	49%	19%	percent
<b>Payback period and Internal Rate of Return calculations</b>				
Simple Payback period in years, compared with CFLni fluorescent:	---	1.30	2.99	years
Simple Payback period in months, compared with CFLni fluorescent:	---	15.7	35.8	months
Internal Rate of Return (IRR), compared with CFLni fluorescent:	---	90%	38%	percent
<b>CO2 emissions calculations</b>				
CO2 emissions due to electricity for one lamp operating for 10 years:	302.3	135.0	194.3	kg CO2/10 yrs
CO2 savings compared with a CFLni fluorescent lamp:	---	167.3	108.0	kg CO2/10 yrs

The economics of LED direct retrofit lamps for T8, T5 and CFLni fluorescent lamps are all cost effective and beneficial to end-users. The installations considered in these calculations do not require rewiring or modification to the existing fluorescent fixtures, the lamps are all direct retrofits that can be installed and will operate on the existing fluorescent ballast.

European companies and European end-users alike would benefit from the phase-out of mercury lighting in Europe, not to mention the avoided mercury emissions to the environment from the power stations in Europe. According to the DG Joint Research Centre, the generation of 1 kWh emits 0.016 mg of mercury to air, assuming that 31 % of the electricity used in the EU comes from coal.<sup>34</sup> Thus every kWh of electricity saved by moving the market from inefficient fluorescent lighting to more energy-efficient LED lighting will reduce electricity and thereby avoid the burning of coal and emission of mercury at the power station.

In addition to the avoided mercury at the power station, there is an additional benefit from the reduction in greenhouse gas emissions. The tables in this section show that each LED lamp installed will contribute to 100kg or more of avoided CO2 emissions over its lifetime. For the 36W T8 lamp, the savings are approximately 250-335 kg of CO<sub>2</sub> avoided for every 36W T8 fluorescent lamp replaced with an LED tube. For T5 (28W) lamps, the savings is approximately 200 kg of CO<sub>2</sub> avoided for every lamp replaced. And for the CFLni lamp (28W 2D shape), the savings is 108 – 167 kg for each fluorescent lamp retrofitted with an LED.

<sup>34</sup> [https://ec.europa.eu/health/scientific\\_committees/opinions\\_layman/mercury-in-cfl/en/mercury-cfl/1-2/3-emissions-risk-environment.htm](https://ec.europa.eu/health/scientific_committees/opinions_layman/mercury-in-cfl/en/mercury-cfl/1-2/3-emissions-risk-environment.htm)

## 5 Are the societal benefits in terms of energy, CO<sub>2</sub> and cost savings significant?

**Yes.** The societal benefits in terms of energy and financial savings, as well as avoided risk of mercury release and greenhouse gas emissions are very significant. This section provides analysis of the savings for T8, T5 and CFLni lamps separately, with the overall total savings presented at the end. In addition, this section prepares a calculation of the avoided emission of mercury at the power station using the JRC's estimate of mg of mercury emitted per kWh of electricity generated.

### Benefits from Phase-Out of T8 Fluorescent Lamps

According to VHK, approximately three-quarters of the energy savings potential of the ecodesign single lighting regulation<sup>35</sup> is derived from the phase-out of three most popular lengths of T8 linear fluorescent lamps: 2 foot, 4 foot and 5 foot lengths. This is primarily to the fact that LED lamps can reduce electricity use for fluorescent lamps by 50%, and because fluorescent lighting is the single largest user of electricity for lighting in Europe.

Table 10 shows the total energy savings associated with the one-lighting regulation, with the phase-out of T8 fluorescent lamps presented in four different years – from 2020, when it was originally proposed by VHK through until 2023, when it was adopted by the Commission. The total savings from the measure in 2030 are presented, along with the cumulative energy savings between 2015 and 2030. There are two scenarios presented in this table – one where the T8 lamps are phased out as originally proposed by VHK in September 2020 and one where the T8 lamps are phased out in September 2021 (potentially by the RoHS Directive).

**Table 10. Electricity and Cost Savings from the Phase-Out of T8 fluorescent lamps in Europe<sup>36</sup>**

Electricity Savings	Savings			
	2021	2022	2023	Cumulative (2015-2030)
T8 fluorescent lamps phase-out in <b>2020</b> (TWh)	1.4	3.5	6.1	98 TWh (29 MT CO <sub>2</sub> )
T8 fluorescent lamps phase-out in <b>2021</b> (TWh)	0.0	2.1	4.7	64 TWh (18.9 MT CO <sub>2</sub> )
<b>Energy Bill Savings</b>				
T8 fluorescent lamps phase-out in <b>2020</b> (billion €)	€0.6	€1.2	€1.8	€7.0 billion
T8 fluorescent lamps phase-out in <b>2021</b> (billion €)	€0.0	€0.6	€1.2	€5.0 billion

<sup>35</sup> COMMISSION REGULATION (EU) .../... of 1.10.2019 laying down ecodesign requirements for light sources and separate control gears pursuant to Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulations (EC) No 244/2009, (EC) No 245/2009 and (EU) No 1194/2012 (Text with EEA relevance) [Implementing Measure](#) and [Annexes](#).

<sup>36</sup> Personal communication and analysis conducted by VHK using the MELISA lighting market model (which was also used for the Impact Assessment for the Ecodesign one-lighting regulation) --as a one-time courtesy, on a strictly personal title and not assuming any liability for the data or its use-- to provide estimates of the savings potential of various scenarios. Communication on 16 October 2019.

In terms of lost savings on energy bills, the three-year delay to the phase-out of 2/4/5 foot T8 linear fluorescent lamps wiped out €7 billion Euro of net savings (taking into account lamp purchase cost) for European homes and businesses. And if the lamps are phased out in 2021, €5 billion Euro of net savings would be captured.

### Benefits from Phase-Out of T5 Fluorescent Lamps

VHK prepared an analysis using the MELISA European Lighting market model to estimate the energy and economic impact of a phase-out of T5 fluorescent lamps. Two of the scenarios are presented below, namely a phase-out in 2021 and one in 2023. Due to the fact that the market will start correcting in advance of the phase-out effective date, VHK projects a small impact and some energy savings already appearing in 2020 from a September 2021 phase-out date.

Please see Table 11 for an estimate of the savings potential for phasing out T5 lamps. The energy bill savings are slightly negative in the first year of adoption due to a higher first-cost of lamps, however the model goes on to show that the energy savings from a T5 phase-out are significant, completely off-setting the first cost and saving between 60 TWh of electricity on a cumulative basis, worth €4.7 billion Euro in net savings (including lamp purchase cost) if fluorescent T5 lamps are phased-out in 2021. The numbers are slightly lower, but still significant if T5 lamps are phased-out in 2023: 40 TWh of electricity and €3.1 billion.

Using the same level of carbon intensity (0.296 kg/kWh), the avoided CO<sub>2</sub> emissions would be 17.8 MT of CO<sub>2</sub> for a T5 phase out in 2021 and 11.8 MT of CO<sub>2</sub> for a phase out in 2023.

**Table 11. Energy and Financial Savings from Phase-Out of T5 fluorescent lamps in Europe<sup>37</sup>**

Electricity Savings	Savings			
	2020	2025	2030	Cumulative (2015-2030)
T5 fluorescent lamps phase-out in 2021 (TWh)	0.4	5.9	9.6	60.2 TWh (17.8 MT CO <sub>2</sub> )
T5 fluorescent lamps phase-out in 2023 (TWh)	0.0	3.4	8.2	40.0 TWh (11.8 MT CO <sub>2</sub> )
<b>Energy Bill Savings</b>				
T5 fluorescent lamps phase-out in 2021 (billion €)	€-0.3	€0.3	€1.9	€4.7 billion
T5 fluorescent lamps phase-out in 2023 (billion €)	€0.0	€-0.1	€1.5	€3.1 billion

### Benefits from Phase-Out of CFLni Fluorescent Lamps

VHK prepared an analysis using the MELISA European Lighting market model to estimate the energy and economic impact of a phase-out of CFLni fluorescent lamps. Two of the scenarios

<sup>37</sup> Personal communication and analysis conducted by VHK using the MELISA lighting market model (which was also used for the Impact Assessment for the Ecodesign one-lighting regulation) --as a one-time courtesy, on a strictly personal title and not assuming any liability for the data or its use-- to provide estimates of the savings potential of various scenarios. Communication on 18 October 2019.

are presented below, namely a phase-out in 2021 and one in 2023. Due to the fact that the market will start correcting in advance of the phase-out effective date, VHK projects a small impact and some energy savings already appearing in 2020 from a September 2021 phase-out date.

Please see Table 11 for an estimate of the savings potential for phasing out CFLni lamps. The energy bill savings are slightly negative in the first year of adoption, however the model goes on to show that the savings from a CFLni phase-out are significant, saving 14.1 TWh of electricity on a cumulative basis and €2.8 billion Euro if fluorescent CFLni lamps are phased-out in 2021. The numbers are slightly lower, but still significant if CFLni lamps are phased-out in 2023: 9.5 TWh of electricity and €1.5 billion.

Using the same level of carbon intensity (0.296 kg/kWh), the avoided CO<sub>2</sub> emissions would be 4.2 MT of CO<sub>2</sub> for a CFLni phase out in 2021 and 2.8 MT of CO<sub>2</sub> savings for a phase out in 2023.

**Table 12. Energy and Financial Savings from Phase-Out of CFLni fluorescent lamps in Europe<sup>38</sup>**

Electricity Savings	Savings			
	2020	2025	2030	Cumulative (2015-2030)
CFLni fluorescent lamps phase-out in 2021 ( <i>TWh</i> )	0.1	1.7	1.5	14.1 TWh (4.2 MT CO <sub>2</sub> )
CFLni fluorescent lamps phase-out in 2023 ( <i>TWh</i> )	0.0	0.9	1.5	9.5 TWh (2.8 MT CO <sub>2</sub> )
<b>Energy Bill Savings</b>				
CFLni fluorescent lamps phase-out in 2021 ( <i>billion €</i> )	€-0.02	€0.23	€0.58	€2.8 billion
CFLni fluorescent lamps phase-out in 2023 ( <i>billion €</i> )	--	€0.07	€0.49	€1.5 billion

<sup>38</sup> "Personal communication and analysis conducted by VHK using the MELISA lighting market model (which was also used for the Impact Assessment for the Ecodesign one-lighting regulation) --as a one-time courtesy, on a strictly personal title and not assuming any liability for the data or its use-- to provide estimates of the savings potential of various scenarios. Communication on 26 October 2019."

The total savings potential from this analysis is given in Table 13 below, noting a cumulative energy savings potential of 138.3 TWh which is more than five times the annual energy consumption of Scotland (a country of 5 million people). The cumulative net savings to households and businesses across Europe (taking into account both lamp purchase costs and energy savings) would be €12.5 billion and the CO<sub>2</sub> emissions would be reduced by 40.9 million metric tonnes.

**Table 13. Net Benefits from Phase-Out of T5 and T8 Lamps in September 2021**

Electricity Savings	Cumulative (2015-2030) Savings for:			
	T8	T5	CFLni	Sum
Electricity Savings ( <i>TWh</i> )	64.0	60.2	14.1	138.3
Energy Bill Savings ( <i>€ billion</i> )	€5.0	€4.7	€2.8	€12.5
CO <sub>2</sub> Savings ( <i>million metric tonnes</i> )	18.9	17.8	4.2	40.9

In addition to these savings, it is also important for the RoHS Committee to note that by reducing electricity demand, the mercury released to the environment from the burning of coal at European power stations will also be avoided. Research by the DG Joint Research Centre estimates that the generation of 1 kWh emits 0.016 mg of mercury to air, assuming that 31 % of the electricity used in the EU comes from coal.

If we therefore calculate that 138.3 TWh of electricity are being avoided through the energy saved by retiring the exemptions for these three popular fluorescent lamps, then an additional:











$$138.3 \times 10^9 \text{ kWh} \times 0.016 \text{ mg Hg} = \mathbf{2212.8 \text{ kg Hg emissions avoided}}$$

In other words, an additional 2.2 metric tonnes of mercury emissions to the environment can be avoided by phasing out the exemption for these lamp types. This is nearly the same quantity of mercury that is contained in the lamps that would be installed in the European homes and offices. Thus, by phasing-out these fluorescent lamps in favour of cost-effective, technologically mature LED lighting products – which are both mercury-free and more energy-efficient – Europe can double its savings in mercury.

## Annex A. Images of Mercury-Containing Lighting and LED Replacement

Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):

- 1(a) For general lighting purposes < 30 W:  
2,5 mg shall be used per burner after 31 December 2012;
- 1(b) For general lighting purposes  $\geq 30$  W and < 50 W:  
3,5 mg may be used per burner after 31 December 2011;
- 1(c) For general lighting purposes  $\geq 50$  W and < 150 W: 5 mg;
- 1(d) For general lighting purposes  $\geq 150$  W: 15 mg;
- 1(e) For general lighting purposes with circular or square structural shape and tube diameter  $\leq 17$  mm: 7 mg may be used per burner after 31 December 2011; and
- 1(f) For special purposes: 5 mg.

RoHS Exemption	Compact Fluorescent Lighting	LED Lighting (zero Hg)
1(a)		
1(b)		
1(c)		
1(d)		
1(e)		



2(a) Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp):

2(a)(1) Tri-band phosphor with normal lifetime and a tube diameter < 9 mm (e.g. T2):

4 mg may be used per lamp after 31 December 2011

2(a)(2) Tri-band phosphor with normal lifetime and a tube diameter ≥ 9 mm and ≤ 17 mm

(e.g. T5): 3 mg may be used per lamp after 31 December 2011

2(a)(3) Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm

(e.g. T8): 3,5 mg may be used per lamp after 31 December 2011

2(a)(4) Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12):

3,5 mg may be used per lamp after 31 December 2012

2(a)(5) Tri-band phosphor with long lifetime (≥ 25 000 h):

5 mg may be used per lamp after 31 December 2011

2(b) Mercury in other fluorescent lamps not exceeding (per lamp):

~~2(b)(1) Linear halophosphate lamps with tube > 28 mm (e.g. T10 and T12): 10 mg Expires on 13 April 2012 (banned)~~





~~2(b)(2) Non-linear halophosphate lamps (all diameters): 15 mg Expired on 13 April 2016 (banned)~~

2(b)(3) Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9):

15 mg may be used per lamp after 31 December 2011

2(b)(4) Lamps for other general lighting and special purposes (e.g. induction lamps):

15 mg may be used per lamp after 31 December 2011

RoHS Exemption	Double-Capped Fluorescent Lighting	LED Lighting (zero Hg)
2(a)(2)		
2(a)(3)		



## Annex B. WEEE Glossary of Key Terms

Directive 2012/19/EU on waste electrical and electronic equipment (WEEE Directive) sets targets for the collection, recovery and recycling of WEEE. It refers to Directive 2008/98/EC for the definition of the terms ‘hazardous waste’, ‘collection’, ‘separate collection’, ‘prevention’, ‘re-use’, ‘treatment’, ‘recovery’, ‘preparing for re-use’, ‘recycling’ and ‘disposal’.

The terms ‘collection’, ‘separate collection’, ‘re-use’, ‘treatment’, ‘recovery’, ‘preparing for re-use’, ‘recycling’ and ‘disposal’ are relevant to this report, so we have copied the definitions below from Directive 2008/98/EC.

**‘collection’** means the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport **to a waste treatment facility**;

**‘separate collection’** means the collection where a waste stream is kept **separately** by type and nature so as to facilitate a **specific treatment**;

**‘re-use’** means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived;

**‘treatment’** means **recovery** or **disposal** operations, including preparation prior to recovery or disposal;

**‘recovery’** means any operation the principal result of which is **waste serving a useful purpose** by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Annex II sets out a non-exhaustive list of recovery operations<sup>39</sup>;

**‘preparing for re-use’** means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing;

**‘recycling’** means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and

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<sup>39</sup> Recovery operations as per Annex II: R1 Use principally as a fuel or other means to generate energy [\(1\)](#); R2 Solvent reclamation/regeneration; R3 Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes) [\(2\)](#); R4 Recycling/reclamation of metals and metal compounds; R5 Recycling/reclamation of other inorganic materials [\(3\)](#); R6 Regeneration of acids or bases; R7 Recovery of components used for pollution abatement; R8 Recovery of components from catalysts; R9 Oil re-refining or other reuses of oil; R10 Land treatment resulting in benefit to agriculture or ecological improvement; R11 Use of waste obtained from any of the operations numbered R 1 to R 10; R12 Exchange of waste for submission to any of the operations numbered R 1 to R 11 [\(4\)](#); R13 Storage of waste pending any of the operations numbered R 1 to R 12 (excluding temporary storage, pending collection, on the site where the waste is produced) [\(5\)](#)

the reprocessing into materials that are to be used as fuels or for backfilling operations;

**'disposal'** means any operation which is not recovery, even where the operation has as a secondary consequence the reclamation of substances or energy. Annex I sets out a non-exhaustive list of disposal operations;