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How Many Years Does It Take the European Commission to Change a Toxic Lightbulb?

# **CALCULATING THE COST OF LOST TIME FROM DELAYED ROHS LIGHTING LEGISLATION**

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### Authors

Michael Scholand, Senior Advisor, CLASP

Jenny Mandel, Senior Communications Associate, CLASP

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Executive Summary

**Mercury is a toxic substance that poses high-risk to human health and the environment.** Mercury exposure can affect the nervous, cardiovascular, immune and reproductive systems in populations at all ages, and result in a permanent neurological development alteration in fetuses, babies and children.

**The EU regulates mercury through the Restriction of Hazardous Substances Directive (RoHS), however this regulation** [**exempts certain**](https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32011L0065&from=EN#d1e32-101-1) **widely used mercury containing light bulbs like compact fluorescent lamps (CFLs) and linear fluorescent lamps.** These RoHS exemptions were based on limited availability of alternatives to fluorescent lighting.However, technology advancements over the last decade have established light emitting diode (LED) retrofit bulbs as a cost-effective, mercury-free alternative to fluorescent. Today, LED bulbs are twice as efficient as fluorescent, meaning they produce the same or improved light using half the energy, and LEDs last 2-3 times longer than fluorescent.

**Considering the rapidly changing lighting market, the European Commission asked the Öko-Institut in Germany to analyse the costs and benefits of the RoHS fluorescent lighting exemptions in 2016 and then again in 2020 with a view to ending the exemptions, but in both cases the Commission did not take action.** The 2020 analysis focused on the three most common types of fluorescent lighting and concluded that eliminating the RoHS exemption for these types by June 2021 would save €29.9 billion for European households, businesses and institutions by 2035. It would have also avoided 310 Terawatt-hours (TWh) of electricity use and 2.88 tonnes of mercury in the lamps themselves.

**In 2021 CLASP built on the Öko-Institut analysis and calculated that the longer RoHS exemptions are kept in place, the larger the cost for the European people and businesses.** The net savings lost by European consumers and businesses if product exemptions are delayed by two years (to June 2023) are € 12.23 billion – which equates to **€15.3 million Euro in savings per day being thrown away**. Similarly, additional mercury pollution from fluorescent bulbs will cause long-term harmful effects on peoples’ health and the environment.

**The European Commission must act now to remove RoHS exemptions to mercury-based lighting by 2023 to stop causing unnecessary harm to people’s health, delaying the European economic recovery, while contaminating the environment.** Any further delay in eliminating exemptions on fluorescent lighting is preventing the European Union from advancing a resilient and sustainable economic development. As a result, the European Commission should remove the RoHS exemption to mercury-based lighting now.

1. 1. Losses to European Countries from Delays

The continued use of inefficient, mercury-based lighting for an additional two years wipes out economic savings across the EU of 12.21 billion Euros.

The following figures reflect the expected cost of the continued use of inefficient, mercury-based lighting in terms of cost (million Euro), additional mercury pollution (kilograms mercury), carbon dioxide emissions (kilotonnes of CO2), and excess electricity use (gigawatt-hours, GWh). The impact of two-year delay wipes out economic savings across the EU of 12.23 billion Euros, with the four largest economies - Germany, Italy, France and Spain representing 78% of the lost savings and 63% of the lost mercury savings.

**Table 1: IMPACT OF Two YEAR DELAY ON EUROPEAN UNION COUNTRIEs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Impact of Two Year Delay… | Lost Economic Savings by Country | Lost Mercury Savings by Country | Lost CO2 savings | Lost Electricity Savings | Lost Economic Savings per Person |
| Country | *(million Euro)* | *(kilograms mercury)* | *(kilotonnes CO2)* | *(GWh)* | *(Euros/person)* |
| Austria | €219 | 24.6 | 398.0 | 2,784 | €25 |
| Belgium | €265 | 25.4 | 508.0 | 2,872 | €23 |
| Bulgaria | €43 | 8.1 | 538.0 | 919 | €6 |
| Croatia | €44 | 5.6 | 160.0 | 631 | €11 |
| Cyprus | €33 | 1.8 | 98.0 | 208 | €37 |
| Czechia | €85 | 23.4 | 1422.0 | 2,653 | €8 |
| Denmark | €54 | 17.5 | 500.0 | 1,985 | €9 |
| Estonia | €14 | 2.3 | 206.0 | 262 | €10 |
| Finland | €35 | 13.3 | 262.0 | 1,505 | €6 |
| France | €1,359 | 171.5 | 2057.0 | 19,406 | €20 |
| Germany | €4,010 | 230.9 | 10218.0 | 26,134 | €48 |
| Greece | €158 | 18.1 | 986.0 | 2,053 | €15 |
| Hungary | €134 | 19.7 | 592.0 | 2,233 | €14 |
| Ireland | €163 | 11.9 | 325.0 | 1,347 | €33 |
| Italy | €2,986 | 160.8 | 4894.0 | 18,194 | €50 |
| Latvia | €25 | 3.0 | 64.0 | 341 | €13 |
| Lithuania | €28 | 4.6 | 119.0 | 518 | €10 |
| Luxembourg | €15 | 2.6 | 60.0 | 292 | €24 |
| Malta | €14 | 1.1 | 59.0 | 122 | €27 |
| Netherlands | €352 | 53.0 | 1421.0 | 5,995 | €20 |
| Poland | €487 | 65.8 | 4527.0 | 7,446 | €13 |
| Portugal | €237 | 22.8 | 726.0 | 2,585 | €23 |
| Romania | €135 | 19.6 | 786.0 | 2,214 | €7 |
| Slovakia | €143 | 11.6 | 285.0 | 1,318 | €26 |
| Slovenia | €35 | 5.1 | 204.0 | 578 | €17 |
| Spain | €1,043 | 101.8 | 2915.0 | 11,521 | €22 |
| Sweden | €117 | 30.7 | 240.0 | 3,477 | €11 |
| Total (EU-27) | **€12,231** | **1,056.8** | **34,570** | **119,596** | €27 |

1. 2. Introduction

Fluorescent lighting is a significant route of mercury exposure for people and the environment, and is especially dangerous to babies and children.

Mercury is a toxic substance that is dangerous to human health. For babies, young children, and infants in utero, it can permanently limit neurological development. Exposure among people of all ages can lead to brain, heart, and other organ damage. The health effects of mercury have been well-known for decades, but not enough action has been taken to address the problem: research shows that 1.8 million babies are born in Europe every year with methylmercury levels in their blood of 0.58 μg/g and approximately 200,000 births exceed the higher level (2.5 μg/g) proposed by the World Health Organisation.[[1]](#footnote-1)



Fluorescent bulbs and tubes are a common source of lighting found in tens of millions of homes and office buildings across Europe, but they all contain mercury which is a hazardous neurotoxin. Fluorescent lighting technology was first commercialized in the 1930’s, and at its peak around 2014 was responsible for approximately 70% of the artificial light produced worldwide.[[2]](#footnote-2) It was once an environmentally preferred lighting option thanks to its lower electricity use compared with technologies like incandescent bulbs. However, it is now a comparatively wasteful technology and the mercury contained in fluorescent lights poses a risk to people and the environment. The vast majority of fluorescent lamps are not disposed of properly, leading to mercury contamination of the soil and water and presenting a threat to public health, especially for developing fetuses, infants and children.

**The EU regulates mercury in lighting through the Restriction of Hazardous Substances Directive (RoHS), but the RoHS regulations for lighting are out of date.**

The [RoHS Directive](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02011L0065-20210401) limits the use and sale of products with mercury and other toxic substances. For mercury-added products for which there are no substitutes available, RoHS makes exemptions with the requirement that those exemptions end as soon as possible:

*“The decision on exemptions and on the duration of possible exemptions should take into account the availability of substitutes and the socioeconomic impact of substitution. […] Exemptions from the restriction for certain specific materials or components should be limited in their scope and duration, in order to achieve a gradual phase-out of hazardous substances in [electrical and electronic equipment] (EEE), given that the use of those substances in such applications should become avoidable.[[3]](#footnote-3)”*

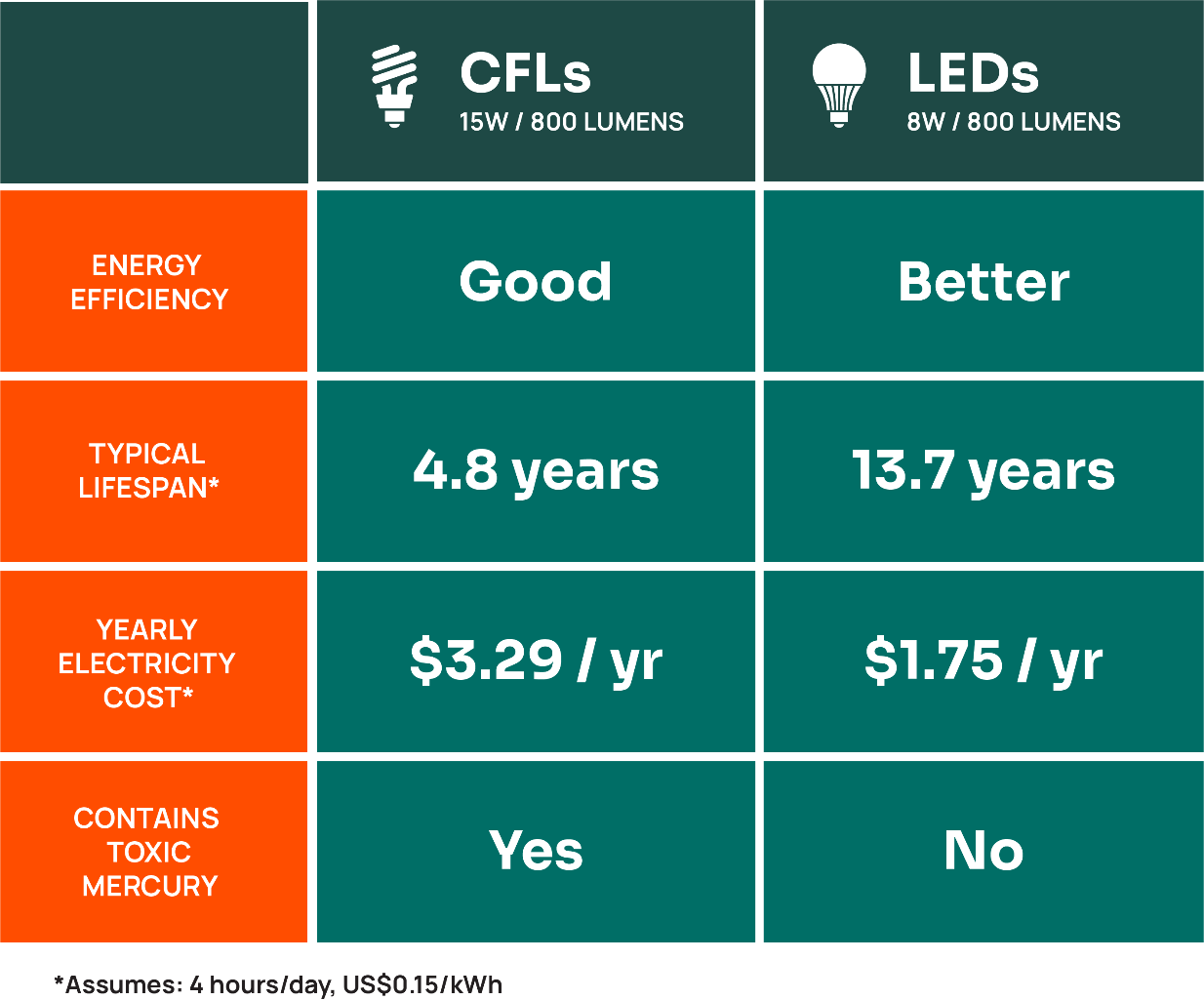
Currently, nearly all types of fluorescent lighting are exempted from control under the RoHS directive on this basis – however, careful examination of the exemption criteria shows that these exemptions no longer apply. Today, safe and efficient alternatives to fluorescent lighting are widely available. Bulbs using light-emitting diode (LED) technology can cost-effectively substitute for the common shapes and types of fluorescent lighting.

1. 3. Background

Over the past decade, the RoHS Directive has not kept pace with changes in the lighting market. Cost-effective, energy-efficient and mercury-free retrofit LED bulbs can replace fluorescents in all applications.

Light bulbs based on light-emitting diode (LED) technology were first introduced around 2005 and after achieving technological breakthroughs over the intervening 15 years, are now widely available in all shapes, wattages, color temperatures, color rendering indices and price points. The biggest companies in the lighting industry, as well as a wide range of smaller companies, have introduced LED products designed to replace older, more energy-intensive incandescent and halogen lighting options, as well as all shapes and types of fluorescents serving 100% of European market needs. These new lighting products have quickly gained market share because they produce high quality light, cost less to operate due to energy savings, last twice as long as fluorescents, and require no special handling because they do not contain toxic mercury.

**TABLE 2: COMPARISON OF COMMON COMPACT FLUORESCENT LIGHTING (CFL) TO LED OPTIONS**



Source: Clean Lighting Coalition

**First Öko-Institut Review (2016)**

The European Commission has a process, delegated to its environmental department (DG Environment), to periodically review the products that are exempt from controls under RoHS, and update those exemptions to keep pace with market change. In 2015, DG Environment requested that the independent research group Öko-Institut review the exempted lighting products to guide an update in 2016. The [Öko-Institut review](https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/RoHS-Pack_9_Part_LAMPS_06-2016.pdf) concluded that mercury-free substitutes for certain types of fluorescent lighting (including CFLs and T5, T8 and T12 linear fluorescent lamps) were easily available on the market, with cost savings for consumers and public health benefits from mercury reduction.

The DG Environment never acted on the recommendation from the review.

**Second Öko-Institut Review (2020)**

In July 2020, the Öko-Institut [published an update](https://rohs.exemptions.oeko.info/fileadmin/user_upload/reports/RoHS_SEA_Lamps_2020_Revision-Final_10072020.pdf) to its analysis for three of the most widely used fluorescent lighting products, using [new market data](https://www.clasp.ngo/research/all/assessing-annex-iii-fluorescent-lamp-exemptions-in-the-light-of-scientific-and-technical-progress/) published by the Swedish Energy Agency and CLASP. The new analysis found significant socioeconomic benefits from phasing-out three common fluorescent lighting products (i.e., CFL pin-base, and T5 and T8 linear fluorescent lamps) which can all now be easily replaced by readily available LED bulbs. The analysis calculated €29.9 billion in savings for European households, businesses and institutions by 2035. [[4]](#footnote-4) Phasing-out these lamps would also avoid 310 Terawatt-hours (TWh) of electricity use – equivalent to the total annual electricity consumption of Italy[[5]](#footnote-5) - and 2.88 tonnes of mercury in the light bulbs, all very significant financial and public health benefits.

Nearly a year after that study was published, DG Environment has yet to update its requirements for mercury-based lighting products. By allowing lower-efficiency fluorescent lighting to persist in the market, the Commission has foregone significant cost savings for European households and businesses.

DG Environment has yet to act on the 2020 Öko-Institut report. When they launch an update to the list of mercury-containing product exemptions, it will take more than a year for that revision to become law. As a result it is no longer possible to enact the scenario modeled by Öko-Institut.

In light of this continued delay, CLASP analyzed the cost to European households and businesses from the continued use of higher-cost, mercury-based fluorescent lighting.

1. 4. CLASP’s 2021 Analysis

With new product exemptions announced in June 2021, the earliest possible phase-out is July 2023. CLASP’s study assumes the continuation of an ongoing but steady market transformation to LED lighting.

This study updates the cost-benefit analysis for banning mercury-based lighting if new product exemptions are announced by July 2021, with an earliest possible effective date of July 2023. Our analysis assumes the continuation of an ongoing steady but slow market transition from the use of fluorescent lighting to LED, driven by factors including better product performance and lower lifecycle costs by LED products. Factors that inhibit that transition include slightly higher initial purchase costs for some types of LEDs (though any initial cost difference is recovered through lower energy costs for LED operation within a matter of months), and the continued availability of fluorescent lighting – the status quo replacement option for some buyers – within the European market.

**Types of Lighting Addressed in this Report**

Annex III of the RoHS regulation lists more than a dozen varieties of fluorescent lamps, many of them with narrow use cases and small market shares. We focus here on the three major types of fluorescent lamps that the Öko-Institut addressed in its July 2020 report, and which account for most fluorescent bulbs sold in Europe: one type of compact fluorescent lamp (CFL) and two types of tubular fluorescent lamps (see table below). For each of the three fluorescent lighting types in question, the July 2020 Öko-Institut report shows that a RoHS exemption is no longer warranted because mercury-free LED retrofits exist today which are cost-effective (see below) and can be installed directly into the same fixtures by a non-expert and without the need to rewire. It’s a simple plug and play solution, installing a new LED lamp where the same fixture was previously running a fluorescent.

There are literally 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[[6]](#footnote-6) that there is “No need to change drivers or rewire”, noting that they offer a “plug and play solution that works straight out of the box”. OSRAM/LEDvance state[[7]](#footnote-7) 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.”[[8]](#footnote-8) 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.”[[9]](#footnote-9)

**Table 3 Types of lamps included iN CLASP’s 2021 analysis**

| **Lamp type description** | **Fluorescent Examples** | **Mercury-free LED Alternatives** |
| --- | --- | --- |
| **Pin-based CFL**  These are a type of compact fluorescent lamp (CFL) where the ballast that drives the lamp is in the fixture instead of being part of the bulb. These include bulbs that can be a few parallel bars, a circular shape or a “2-D” shape. |  |  |
| **T5 Linear Fluorescent Lamps**  Linear fluorescent lamps (LFLs) are the long, tubular strip lights that are used in residential, commercial and industrial buildings. These have a diameter of 5/8 inch, hence the name “T5”. |  |  |
| **T8 Linear Fluorescent Lamps**  Another type of linear fluorescent lamp used in the same applications as T5. This lamp has a diameter of one inch (or 8/8 inch), hence the name “T8”. |  |  |

**Cost-effectiveness of mercury-free LED replacement lamps**

Replacing fluorescent lamps with LED retrofit tubes is highly cost-effective. According to the [website of OSRAM/LEDvance](https://www.ledvance.com.au/products/product-knowledge/led-tubes/index.jsp), “Replacement costs can be recouped in just four months”.

In Table 2, the authors calculate the payback period replacing a 36W T8 linear fluorescent lamp with two different LED retrofit lamps – an economy grade LED tube and a high quality LED tube. The results indicate that the payback period is between 4 and 10 months, even before taking into consideration the labour savings from not needing to change the LED tubes as often as the fluorescent. The service life of LED retrofit lamps in this example below is 1.5 to 2.5 times longer than fluorescent, offering further saving on replacement costs.

Considering a typical T8 fluorescent lamp installation in Europe, Table 2 presents the comparison of a €3.68 OSRAM 36W T8 linear fluorescent lamp (declared 20,000 hours lifetime) with Philips’ CorePro (entry-level, 30,000 hours lifetime, 18 watts) LED replacement and Philips’ MasterLED (professional-grade, 50,000 hours lifetime, 12.5 watts) LED retrofit models. In a typical one-shift office operation, the lights will be on for an average of 10 hours per day – allowing for one eight-hour shift and a few hours before and after for cleaning and flexi-time.

The table shows that the entry-level LED (T8 LED-1) offers a payback period of 4.5 months compared to the fluorescent (and will last 1.5 times longer than the fluorescent lamp) and the professional grade lamp (T8 LED-2) offers a payback period of 10.1 months (and will last 13 years, which is 2.5 times longer than the linear fluorescent lamp). These calculations reflect energy costs and bulb costs only, and do not incorporate labour costs to change the lamp which are avoided due to the reduced frequency of bulb changes (which would make the payback period even shorter). Considering the life-cycle costs of this installation over a 13 year period and discounted to today’s net present value, end-users will save €105 with the T8 LED-1 (CorePro) or €136 with the T8 LED-2 (MasterLED) for each T8 fluorescent lamp replaced.

**TABLE 4: ECONOMIC ANALYSIS OF T8 FLUORESCENT VS. LED LAMPS IN EUROPE**[[10]](#footnote-10)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Economic indicator description** | **T8 LFL** | **T8 LED-1** | **T8 LED-2** | **Units** |
| Price for one lamp: | €3.68 | €6.77 | €12.74 | *Euros/lamp* |
| Rated lamp wattage: | 36 | 18 | 12.5 | *Watts* |
| Rated lamp lifetime: | 20,000 | 30,000 | 50,000 | *Hours* |
| Annual electricity consumption (10 hr/day): | 131 | 66 | 46 | *kWh/yr* |
| Annual cost of electricity: | €16.48 | €8.24 | €5.72 | *Euros/year* |
| **Payback period in years:** |  | **0.38** | **0.84** | ***years*** |
| Payback period in months: |  | 4.5 | 10.1 | *months* |
| Life-Cycle Cost, 13 years, net present value: | €223.40 | €118.82 | €87.12 | *Euros (NPV, 2021)* |
| Life-Cycle Cost savings (net present value): |  | €104.58 | €136.28 | *Euros (NPV, 2021)* |

**RoHS Directive Exemption Criteria**

Under the RoHS Directive, Article 5(1)(a) sets out the criteria that must be met in order to justify maintaining product exemptions:

*Article 5. Adaptation of the Annexes to scientific and technical progress*

*1. For the purposes of adapting Annexes III and IV to scientific and technical progress, and in order to achieve the objectives set out in Article 1, the Commission shall adopt by means of individual delegated acts in accordance with Article 20 and subject to the conditions laid down in Articles 21 and 22, the following measures:*

*(a) inclusion of materials and components of EEE for specific applications in the lists in Annexes III and IV, provided that such inclusion does not weaken the environmental and health protection afforded by Regulation (EC) No 1907/2006 and where any of the following conditions is fulfilled:*

*— their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable,*

*— the reliability of substitutes is not ensured,*

*— the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.*

*Decisions on the inclusion of materials and components of EEE in the lists in Annexes III and IV and on the duration of any exemptions shall take into account the availability of substitutes and the socioeconomic impact of substitution. Decisions on the duration of any exemptions shall take into account any potential adverse impacts on innovation. Life-cycle thinking on the overall impacts of the exemption shall apply, where relevant;*

*(b) deletion of materials and components of EEE from the lists in Annexes III and IV where the conditions set out in point (a) are no longer fulfilled.*

The Swedish Energy Agency and CLASP published a study in February 2020 titled “Assessing Annex III Fluorescent Lamp Exemptions in the Light of Scientific and Technical Progress”[[11]](#footnote-11) which evaluated in detail each of the criteria against the three types of fluorescent lamps. The study concluded that for these three high sales volume mercury-containing fluorescent lamps – CFLni, T5 and T8 linear fluorescent – none of the six criteria for granting an exemption were met.

1. 5. Methodology

The results presented in this report use the same [spreadsheet](https://rohs.exemptions.oeko.info/fileadmin/user_upload/reports/VHK_Oeko_Combined_Model_RoHS_CFL_LFL_20200707_clean.xlsx) published by the Commission for the Socio-Economic Impact Assessment and calculates the impact of these delays in terms of lost mercury savings, energy savings, CO2 savings and financial savings at the EU level and for each of the 27 member states. For national impact calculations, individualized electricity prices from EuroStat ([household](https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_204_c&lang=en) and [non-household](https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_205_c&lang=en)) and [carbon intensity rates](https://www.eib.org/attachments/strategies/eib_project_carbon_footprint_methodologies_en.pdf) (average CO2/kWh) from the European Investment Bank were used, to reflect the national burdens associated with EU-wide delay.

1. Bellanger, M., Pichery, C., Aerts, D. et al. Economic benefits of methylmercury exposure control in Europe: Monetary value of neurotoxicity prevention. Environ Health 12, 3 (2013). <https://doi.org/10.1186/1476-069X-12-3> [↑](#footnote-ref-1)
2. United for Efficiency, Global Lighting Market Model, 2015. [↑](#footnote-ref-2)
3. RoHS Directive available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02011L0065-20210401> [↑](#footnote-ref-3)
4. Oeko-Institute focused on these three lamp types at the Commission’s direction, because updated market data provided by CLASP and the Swedish Energy Agency in 20XX showed that the market data used in the previous analysis of these lamp types was outdated, resulting in overly high estimates for the costs of replacing fluorescent lamps. This was especially true in cases where the old market data showed that like-for-like replacements were not commercially available, but more recent market data showed product availability. [↑](#footnote-ref-4)
5. Statistics report: Key World Energy Statistics 2020, the International Energy Agency, Paris, France. Published August 2020. [↑](#footnote-ref-5)
6. <https://www.lighting.philips.com/main/support/support/tools/ledtube-selectortool> [↑](#footnote-ref-6)
7. <https://www.ledvance.com/professional/products/product-stories/led-tubes-online-special/index.jsp> [↑](#footnote-ref-7)
8. <https://assets2.sylvania.com/media/bin/asset-1377974/asset-1377974> [↑](#footnote-ref-8)
9. <https://tungsram.com/en/products/led-retrofit/led-tubes> [↑](#footnote-ref-9)
10. For this calculation, it is assumed the lamps operate on average 10 hours per day (3650 hours/year), electricity costs are €0.1254/kWh (EuroStat, 2021a), that there is an annual increase in electricity price of 4.0% and a discount rate of 4.0% (VHK, 2019). [↑](#footnote-ref-10)
11. To view the Sweden-CLASP report assessing each of the three fluorescent lamp types against the RoHS criteria for exemptions, please click on this link: <https://www.clasp.ngo/research/all/assessing-annex-iii-fluorescent-lamp-exemptions-in-the-light-of-scientific-and-technical-progress/> [↑](#footnote-ref-11)