

Quantifying Lighting Benefits under the RoHS Directive: Calculating the Cost of Lost Time

27 January 2021

Background

The European Union regulates the use of toxic materials including mercury through its Restriction of Hazardous Substances (RoHS) Directive¹, which includes exemptions for certain mercury-containing products. Since 2015, the European Commission has been reviewing those exemptions, including provisions that allow the sale of mercury-based lighting. The Commission's Environment Directorate was due to update the exemptions in 2016 based on factors such as the availability of substitutes and their socio-economic impacts², but it has yet to issue a decision.

In July 2020 DG Environment published an updated analysis of the costs and benefits of this lighting exemption. The assessment³, conducted by the Oeko-Institut, included a detailed analysis of the financial and pollution impacts of phasing out three types of mercury-containing lamps – T5 linear fluorescent, T8 linear fluorescent and pin-based compact fluorescent. These lamps are typically replaced with retrofit LED (light-emitting diode) lamps, which contain no mercury, consume half as much energy for a given light level, and last 2-3 times longer.

The report found that if DG Environment eliminated these three fluorescent lamp types effective in 2021, then by 2035 there would be an EU-wide cumulative reduction of electricity consumption of 309.7 Terawatt-hours, €29.9 billion Euros in net financial savings (including costs associated with lamps, luminaires and labour), and 2.88 tonnes less mercury placed into circulation in Europe.

Summary

Since publishing that report, the Commission has not acted on the mercury-based lighting exemption, and therefore 2021 is no longer a realistic phase-out year. CLASP has revisited the Oeko-Institut analysis to update the potential savings under a later phase-out date, and to calculate the costs of this ongoing delay.

Our recalculation of the Oeko-Institut data for a one-year, two-year or three-year delay from the previous analysis shows significant costs to European citizens in terms of excess energy use, increased pollution, and higher cost to consumers.

With one year of regulatory delay, Europe loses €5.6 billion in cost savings due to excess energy use and adds 570 kg to its mercury pollution burden. As the delay lengthens, the cost goes up.

If these fluorescent lamps are eliminated effective in 2022, delayed by one year from the previous analysis, we find the following impacts:

¹ [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](#)

² [Assessing Annex III Fluorescent Lamp Exemptions in the Light of Scientific and Technical Progress](#), CLASP, February 2020.

³ [Study on the socio-economic impact of substitution of certain mercury-based lamps - Update 2020](#), Oeko-Institut, 10 July 2020

- Excess energy use: 62.2 TWh of increased electricity use over the year, or about equal to the annual electricity consumption of Switzerland⁴
- Financial cost: €5.6 billion savings lost; €465 million savings lost per month; €15.5 million savings lost per day
- Increased pollution: 570 kg of additional mercury pollution from lamps⁵

If these fluorescent lamps are eliminated effective in 2023, delayed by two years from the previous analysis, we find the following impacts:

- Excess energy use: 120 TWh of lost electricity savings, or about equal to the annual electricity consumption of the Netherlands⁶
- Financial cost: €11.7 billion savings lost over two years; €487 million savings lost per month; €16.2 million savings lost per day
- Increased pollution: 1060 kg of additional mercury pollution from lamps⁵ over two years

If these fluorescent lamps are banned in 2024, delayed by three years from the previous analysis, we find the following impacts:

- Excess energy use: 164 TWh of lost electricity savings, or about equal to the annual electricity consumption of Poland⁷
- Financial cost: €16.9 billion savings lost over three years; €469 million savings lost per month; €15.6 million savings lost per day
- Increased pollution: 1430 kg of additional mercury pollution from lamps⁵ over three years

For a high-level explanation of European lighting energy use and costs, see Appendix A.

Analysis

On 10 July 2020, DG Environment published a report prepared by the Oeko-Institut titled “Update of the data provided by the analysis model developed in the course of the ‘Study to assess socio-economic impact of substitution of certain mercury-based lamps currently benefiting of RoHS 2 exemptions in Annex III.’⁸ In this report, Oeko-Institut updated the data calculations carried out for that previous report, which were based on 2013-2017 data, to more accurately reflect the rapidly evolving LED lamp market. The analysis updated the calculated net benefits to Europe from ending the RoHS exemptions for certain fluorescent lamps – namely, T5 and T8 linear fluorescent lamps and pin-based compact fluorescent lamps – from a decision to end the RoHS exemptions for these lamp types in 2021.

The analysis calculated impacts on the following:

⁴ IEA data show 63.3 TWh electricity use by Switzerland in 2018

⁵ The Oeko-Institut analysis does not consider mercury emissions associated with the higher coal-fired electricity consumption of fluorescent lighting. For a discussion of those additional mercury emissions, see [Assessing Annex III Fluorescent Lamp Exemptions in the Light of Scientific and Technical Progress](#), CLASP, Feb 2020. For one year of delay, there is an additional 995 kg of additional power plant-related mercury emissions; for two years of delay there is an additional 1920 kg; for three years of delay there is an additional 2624 kg.

⁶ IEA data show 117.1 TWh electricity use by the Netherlands in 2018

⁷ IEA data show 166.8 TWh electricity use by Poland in 2018

⁸ [Study on the socio-economic impact of substitution of certain mercury-based lamps - Update 2020](#), Oeko-Institut, 10 July 2020

- Purchase cost of lamps and luminaires as well as labour costs for luminaire rewiring and replacement, where relevant
- Energy savings from replacing mercury-containing fluorescent lamps with LED
- Mercury avoided in the market from replacing fluorescent lamps with LED

The Commission also released an Excel spreadsheet⁹ that allows stakeholders to conduct their own calculations using the same inputs as the July 2020 report. CLASP’s analysis uses this spreadsheet to calculate the impact of delay from Oeko-Institute’s assumption of a 2021 end to sales of these three mercury-based lighting products. Based on the Commission’s regulatory process the minimum delay we calculated was 1 year, for a 2022 effective date to phase out the lighting exemption. We also modelled delays ranging from 1 to 7 years.

The following table presents the results of applying a one to ten year delay on the benefits to Europe as a whole – in terms of energy savings, net financial savings (taking into account replacement lamps, luminaires and labour) and avoided mercury pollution. It is evident from these results that major benefits are lost from a failure to act quickly to phase out mercury-containing fluorescent lamps. For example, a one-year delay from 2021 to 2022 costs the EU over 5 billion Euros in net benefit. In later years, the impact of delay is less significant, reflecting a clear but more gradual shift from fluorescent to LED technology in lighting.

Detailed results from the model are included in Annex C of this memo.

Table 1. Recalculated Impacts of Delay by Exemption End Year

Cumulative values from year shown to 2035	Total Reduction in Energy Use	Cumulative Savings	Net	Cumulative Avoided Mercury
<i>Units</i>	<i>TWh</i>	<i>Billion Euros</i>		<i>Tonnes</i>
2021	309.73	€ 29.87		2.88
2022	247.56	€ 24.29		2.31
2023	190.13	€ 18.18		1.82
2024	145.75	€ 12.99		1.45
2025	114.82	€ 9.15		1.19
2026	89.22	€ 5.80		0.97
2027	66.72	€ 3.42		0.79
2028	49.59	€ 1.75		0.64

Using the table of findings above, the following presents the costs (i.e., the differences in savings) to Europe from a one-year delay (ending exemption in 2022), a two-year delay (ending exemption in 2023), and a three-year delay (ending exemption in 2024). The cost of inaction over the exemptions for fluorescent lamps are very significant. By delaying the phase-out from 2021 to 2022, €5.6 billion of savings are wiped out. Delaying to 2023 eliminates €11.7 billion of net savings for European citizens.

⁹ Oeko-Institut has made its Excel spreadsheet model, titled “VHK-Oeko-Institut Combined Model for RoHS” and dated 7 July 2020, [available for download here](#).

Table 2. Cumulative Savings Losses From Delayed Phase-Out

	Excess Energy Use	Net Economic Loss	Excess Mercury Pollution
<i>Units</i>	<i>TWh</i>	<i>Billion Euros</i>	<i>Tonnes</i>
One year delay (to 2022)	62.17	€ 5.58	0.57
Two year delay (to 2023)	119.60	€ 11.68	1.06
Three year delay (to 2024)	163.98	€ 16.88	1.43

The chart below illustrates how the economic benefits from regulating mercury-based lighting decrease over time, thanks to the natural rate of market transition to LED. Each month of delay in which fluorescents remain for sale in the European market incurs significant cost, abandons energy savings, and results in additional mercury pollution.

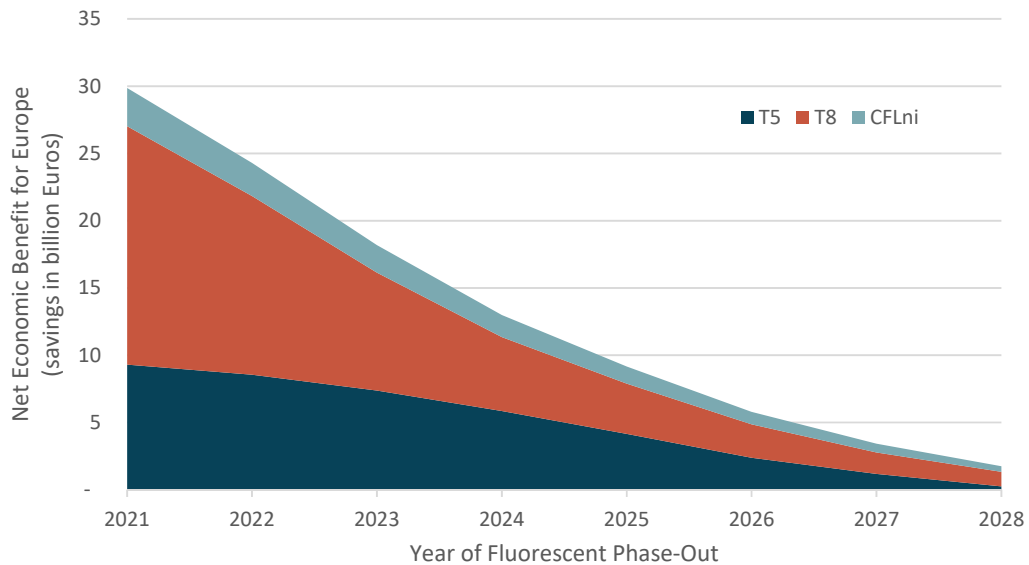


Figure 1. Net Economic Benefit of Eliminating Fluorescent Lamps

Annex A. Explaining the Magnitude of Savings

The Oeko-Institut model and CLASP's recalculation to account for delays reveal a high net benefit to European consumers of eliminating fluorescent lamps, with net cost savings of €15-16 million per day over the first year. To help contextualize those numbers, we walk through the electricity and cost figures for lighting energy use, and the impact of changing out fluorescent lamps for higher-efficiency LEDs.

- The model calculation incorporates the cost of electricity, lamps, luminaires and labour, but the largest of these costs is the energy savings from replacing fluorescent lamps with LEDs, which use roughly half as much energy.
- In 2018, Europe consumed 2,806 Terawatt-hours (TWh) of electricity in all end-uses. If we divide that consumption by 365 days, we find that Europe consumed 7.7 TWh of electricity per day.
- The United for Efficiency (U4E) programme at UNEP estimates that lighting is approximately 15% of total electricity use, so if we multiply the daily total electricity consumption for Europe by 15%, we calculate that Europe uses 1.153 TWh per day for lighting.
- A Terawatt-hour is equivalent to a billion kilowatt-hours. If we estimate that the average price of electricity in Europe is €0.15/kWh (N.B. average residential €/kWh is higher, non-residential is lower), then the cost of one TWh is €150,000,000, €150 million.
- Multiplying that cost of a Terawatt-hour by 1.153 TWh per day for lighting, we find that the daily cost of all the electricity in Europe for lighting is €173 million Euros.
- If we estimate that the electricity consumption for fluorescent lighting is one-third of lighting electricity, then Europe is spending €57.7 million/day for running fluorescent lamps. LED retrofit lamps cut that energy bill in half, so if all the fluorescent lamps were changed overnight, the daily electricity savings would be half of €57.7 million, or €28.8 million.

This figure is higher than the calculated €15-16 million per day in potential savings, because not all the sockets are replaced in the first year and the VHK/Oeko Institut model is much more precise in how it tracks electricity, lamps, luminaires and labour. However this top-down calculation does illustrate how it is possible to arrive at lost daily savings of €15-16 million Euros from delaying the phase-out of fluorescent lighting under the RoHS Directive.

Annex B. Minor Correction to the Oeko-Institut / VHK Spreadsheet

In adjusting the model to run the delayed start year scenarios, CLASP identified a formula that created a “divide by 0 error” in the spreadsheet calculation. This error only appeared when the start year (in cell D5) was changed from 2021 (the reference year for the July 2020 report) to 2022, 2023, 2024 and so on.

The error appeared in Row 172, cells Z to AN, of the LFL T5 and LFL T8 sheets and in Row 191, cells Z to AN, of the CFLni sheets within the workbook. CLASP corrected the division error by modifying the formula to include an Excel function statement that checks if a value is going to cause an error because it divides by zero, and if so, to simply put zero in that cell.

Here is an example of the modification made to the formula, in sheet “LFL T5-CLASP”, cell Z172:

Original equation	=Z115/Z171
Corrected equation	=IFERROR(Z115/Z171,0)

The “IFERROR” function checks to see if the fraction will yield a problematic result, in this case dividing by zero because the value of Z171 becomes zero when the start year is changed from 2021 to 2022. If it does, then cell Z172 simply becomes zero itself.

We checked all the other functions and equations on the worksheets and did not find any other problems or issues with the spreadsheet. We are sharing this correction in the interests of transparency, and our corrected version of the spreadsheet is available on our website.

Annex C. Detailed Output from the Oeko-Institut / VHK Spreadsheet

The following tables are the results calculated using the Excel spreadsheet provided by the Commission to model delay in the effective date of the phase-out of fluorescent lamps under the RoHS Directive.

Table A.1. Results for Delaying the Phase-Out of T5 Linear Fluorescent Lamps

T5 Fluorescent Lamps																	
Oeko-Institut / VHK Spreadsheet Results, Delaying a Fluorescent Phase-Out until the Year Shown in the Table																	
2021	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	- 1,477	- 2,984	- 4,501	- 5,980	- 7,389	- 8,754	-10,033	-11,223	-12,321	-13,321	-12,192	-11,121	-10,128	- 9,222	- 8,403	-129046	<i>GWh</i>
Total additional cost, M euros	2,273	1,720	1,196	682	182	- 211	- 610	- 984	- 1,329	- 1,659	- 2,534	- 2,308	- 2,096	- 1,901	- 1,724	-9304	<i>Million Euros</i>
Total avoided mercury in kg	122	115	105	95	85	79	72	66	60	54	50	46	42	38	34	1064	<i>kilograms</i>
2022	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	- 1,508	- 3,024	- 4,503	- 5,912	- 7,278	- 8,556	- 9,746	-10,845	-11,844	-12,773	-11,651	-10,610	- 9,660	- 8,802	-116713	<i>GWh</i>
Total additional cost, M euros	-	- 1,982	- 1,461	- 950	- 453	- 62	- 334	- 706	- 1,048	- 1,375	- 1,615	- 2,410	- 2,189	- 1,986	- 1,800	-8556	<i>Million Euros</i>
Total avoided mercury in kg	-	- 115	- 105	- 95	- 85	- 79	- 72	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	941	<i>kilograms</i>
2023	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	- 1,517	- 2,996	- 4,405	- 5,770	- 7,049	- 8,239	- 9,337	-10,337	-11,266	-12,120	-11,037	-10,048	- 9,154	-103274	<i>GWh</i>
Total additional cost, M euros	-	-	- 1,732	- 1,223	- 729	- 341	- 52	- 421	- 761	- 1,085	- 1,325	- 1,555	- 2,271	- 2,060	- 1,868	-7374	<i>Million Euros</i>
Total avoided mercury in kg	-	-	- 105	- 95	- 85	- 79	- 72	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	827	<i>kilograms</i>
2024	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	- 1,479	- 2,888	- 4,254	- 5,532	- 6,722	- 7,820	- 8,820	- 9,749	-10,603	-11,377	-10,358	- 9,436	-89038	<i>GWh</i>
Total additional cost, M euros	-	-	-	- 1,499	- 1,007	- 621	- 231	- 135	- 471	- 793	- 1,033	- 1,263	- 1,481	- 2,120	- 1,922	-5860	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	- 95	- 85	- 79	- 72	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	721	<i>kilograms</i>
2025	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	- 1,409	- 2,775	- 4,053	- 5,243	- 6,341	- 7,341	- 8,270	- 9,124	- 9,898	-10,591	- 9,648	-74694	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	- 1,278	- 895	- 508	- 144	- 190	- 508	- 748	- 978	- 1,196	- 1,401	- 1,963	-4160	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	- 85	- 79	- 72	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	626	<i>kilograms</i>
2026	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	- 1,366	- 2,644	- 3,834	- 4,932	- 5,932	- 6,861	- 7,715	- 8,490	- 9,182	- 9,794	-60751	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	- 1,156	- 771	- 410	- 79	- 237	- 477	- 707	- 925	- 1,130	- 1,319	-2379	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	- 79	- 72	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	541	<i>kilograms</i>
2027	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	-	- 1,278	- 2,469	- 3,567	- 4,566	- 5,496	- 6,349	- 7,124	- 7,816	- 8,428	-47093	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	-	- 1,026	- 668	- 339	- 26	- 214	- 444	- 662	- 867	- 1,056	-1183	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	-	- 72	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	462	<i>kilograms</i>
2028	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	-	-	- 1,190	- 2,288	- 3,288	- 4,217	- 5,071	- 5,845	- 6,538	- 7,149	-35587	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	-	-	- 909	- 583	- 273	- 32	- 198	- 416	- 621	- 810	-247	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	-	-	- 66	- 60	- 54	- 50	- 46	- 42	- 38	- 34	390	<i>kilograms</i>

Table A.2. Results for Delaying the Phase-Out of T8 Linear Fluorescent Lamps

T8 Fluorescent Lamps		Oeko-Institut / VHK Spreadsheet Results, Delaying a Fluorescent Phase-Out until the Year Shown in the Table															
2021	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	- 4,645	- 8,695	-11,355	-12,674	-13,539	-14,171	-14,571	-14,931	-15,246	-15,511	-10,611	- 6,610	- 4,187	- 3,088	- 2,414	-152246	<i>GWh</i>
Total additional cost, M euros	3,267	1,448	- 329	- 1,547	- 2,044	- 2,321	- 2,547	- 2,670	- 2,782	- 2,887	- 2,076	- 1,300	- 829	- 613	- 480	-17712	<i>Million Euros</i>
Total avoided mercury in kg	310	250	152	71	44	31	20	18	15	13	11	9	7	6	4	962	<i>kilograms</i>
2022	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	- 4,049	- 6,709	- 8,028	- 8,894	- 9,525	- 9,926	-10,286	-10,600	-10,866	-11,089	- 6,871	- 4,316	- 3,157	- 2,446	-106761	<i>GWh</i>
Total additional cost, M euros	-	2,276	508	- 702	- 1,190	- 1,459	- 1,677	- 1,791	- 1,894	- 1,990	- 2,050	- 1,348	- 850	- 623	- 483	-13274	<i>Million Euros</i>
Total avoided mercury in kg	-	250	152	71	44	31	20	18	15	13	11	9	7	6	4	652	<i>kilograms</i>
2023	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	- 2,660	- 3,979	- 4,845	- 5,476	- 5,876	- 6,236	- 6,551	- 6,816	- 7,039	- 7,221	- 4,506	- 3,275	- 2,519	-67000	<i>GWh</i>
Total additional cost, M euros	-	-	- 1,237	34	- 447	- 708	- 918	- 1,025	- 1,120	- 1,208	- 1,268	- 1,320	- 885	- 644	- 495	-8765	<i>Million Euros</i>
Total avoided mercury in kg	-	-	- 152	71	44	31	20	18	15	13	11	9	7	6	4	402	<i>kilograms</i>
2024	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	- 1,319	- 2,185	- 2,816	- 3,216	- 3,576	- 3,891	- 4,156	- 4,379	- 4,561	- 4,704	- 3,406	- 2,608	-	-40818	<i>GWh</i>
Total additional cost, M euros	-	-	-	518	42	- 215	- 420	- 521	- 612	- 695	- 755	- 806	- 849	- 668	- 511	-5491	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	71	44	31	20	18	15	13	11	9	7	6	4	250	<i>kilograms</i>
2025	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	- 865	- 1,497	- 1,897	- 2,257	- 2,572	- 2,837	- 3,060	- 3,242	- 3,385	- 3,493	- 2,669	-27775	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	284	30	- 173	- 272	- 360	- 440	- 500	- 552	- 594	- 629	- 522	-3727	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	44	31	20	18	15	13	11	9	7	6	4	179	<i>kilograms</i>
2026	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	- 631	- 1,032	- 1,392	- 1,706	- 1,972	- 2,195	- 2,376	- 2,519	- 2,628	- 2,708	-19159	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	191	- 10	- 108	- 194	- 273	- 333	- 384	- 427	- 462	- 489	-2491	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	31	20	18	15	13	11	9	7	6	4	135	<i>kilograms</i>
2027	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	-	- 400	- 760	- 1,075	- 1,340	- 1,563	- 1,745	- 1,888	- 1,996	- 2,076	-12844	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	-	108	12	- 74	- 151	- 211	- 263	- 305	- 340	- 367	-1592	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	-	20	18	15	13	11	9	7	6	4	104	<i>kilograms</i>
2028	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	-	-	- 360	- 675	- 940	- 1,163	- 1,345	- 1,488	- 1,596	- 1,676	-9243	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	-	-	87	3	- 74	- 134	- 185	- 228	- 263	- 290	-1083	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	-	-	18	15	13	11	9	7	6	4	84	<i>kilograms</i>

Table A.3. Results for Delaying the Phase-Out of CFLni, Pin-Based Compact Fluorescent Lamps

CFLni lamps	Oeko-Institut / VHK Spreadsheet Results, Delaying a Fluorescent Phase-Out until the Year Shown in the Table																
2021	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	- 693	- 1,354	- 1,966	- 2,506	- 2,974	- 3,363	- 2,972	- 2,581	- 2,209	- 1,874	- 1,587	- 1,349	- 1,152	- 991	- 866	-28434	<i>GWh</i>
Total additional cost, M euros	500	299	112	68	234	373	563	500	437	376	320	273	234	203	180	-2849	<i>Million Euros</i>
Total avoided mercury in kg	134	126	114	101	86	71	57	45	34	25	20	15	12	9	7	856	<i>kilograms</i>
2022	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	- 661	- 1,273	- 1,814	- 2,281	- 2,670	- 2,988	- 2,585	- 2,201	- 1,856	- 1,560	- 1,316	- 1,113	- 946	- 818	-24081	<i>GWh</i>
Total additional cost, M euros	-	424	238	59	105	243	365	499	433	370	312	264	224	193	168	-2456	<i>Million Euros</i>
Total avoided mercury in kg	-	126	114	101	86	71	57	45	34	25	20	15	12	9	7	721	<i>kilograms</i>
2023	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	- 612	- 1,153	- 1,620	- 2,009	- 2,327	- 2,581	- 2,187	- 1,832	- 1,528	- 1,277	- 1,068	- 897	- 765	-19856	<i>GWh</i>
Total additional cost, M euros	-	-	359	181	18	119	240	341	428	364	304	255	214	181	156	-2043	<i>Million Euros</i>
Total avoided mercury in kg	-	-	114	101	86	71	57	45	34	25	20	15	12	9	7	595	<i>kilograms</i>
2024	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	- 541	- 1,008	- 1,397	- 1,715	- 1,969	- 2,164	- 1,801	- 1,490	- 1,233	- 1,019	- 845	- 709	-15890	<i>GWh</i>
Total additional cost, M euros	-	-	-	294	132	3	123	224	305	355	294	244	202	169	143	-1636	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	101	86	71	57	45	34	25	20	15	12	9	7	481	<i>kilograms</i>
2025	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	- 467	- 856	- 1,174	- 1,429	- 1,623	- 1,764	- 1,447	- 1,185	- 968	- 790	- 652	-12356	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	233	99	20	119	200	264	284	232	190	156	130	-1263	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	86	71	57	45	34	25	20	15	12	9	7	380	<i>kilograms</i>
2026	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	- 389	- 707	- 961	- 1,156	- 1,296	- 1,403	- 1,138	- 918	- 738	- 599	-9306	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	187	69	29	109	172	212	221	178	144	117	-926	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	71	57	45	34	25	20	15	12	9	7	294	<i>kilograms</i>
2027	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	-	- 318	- 572	- 767	- 907	- 1,015	- 1,094	- 872	- 691	- 550	-6786	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	-	144	46	33	95	135	167	168	133	106	-647	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	-	57	45	34	25	20	15	12	9	7	224	<i>kilograms</i>
2028	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total	Units
Total energy savings, GWh	-	-	-	-	-	-	-	- 254	- 449	- 590	- 697	- 776	- 834	- 651	- 510	-4760	<i>GWh</i>
Total additional cost, M euros	-	-	-	-	-	-	-	107	29	33	73	104	128	124	97	-421	<i>Million Euros</i>
Total avoided mercury in kg	-	-	-	-	-	-	-	45	34	25	20	15	12	9	7	166	<i>kilograms</i>