

Giving light fittings a second life – **is it always the most sustainable solution?**

Position paper

Greater transparency through a holistic life-cycle perspective.

Lighting systems with high luminous efficacy are important building blocks for resource-efficient construction and operation of buildings. Many existing systems are still structurally in good condition, but use outdated technologies such as TL, PL or conventional discharge lamps. Switching to modern LED solutions offers the opportunity, to significantly reduce energy consumption and maintenance requirements while also markedly improving light quality and user comfort.

Is a retrofit always the most sustainable solution?

In the pursuit of sustainability, the retrofitting of existing luminaires is becoming increasingly important. In this refurbishment option the existing luminaire housing is retained and only the electrical equipment, optics and other lighting components are replaced. By preserving the luminaire housing and technically adapting it to modern LED technology, a retrofit is often perceived as a circular solution — and is therefore considered particularly sustainable. In fact, this option can be a very sensible strategy in certain situations. However, the preservation of existing materials alone tells us little about how sustainable a solution is overall.

A circular solution does not automatically result in the lowest environmental impact. To assess the sustainability of a product or system, its entire life cycle must be considered: from raw material extraction and manufacturing through transport, use, maintenance and replacement to the end of its life. Only this holistic assessment shows which solution has the lowest overall environmental impact.



Comparison of the environmental impacts of ADP and GWP

Current findings of the SUMATRA research project (SUstainable use of MATerials in future luminaire designs – from Recycling back to Application) help to assess the environmental impacts of the various refurbishment strategies for lighting solutions across the entire life cycle. The project was carried out by TRILUX together with partners such as the Fraunhofer Institute for Reliability and Microintegration IZM, Interzero and Inventronics.

As part of the life-cycle analyses carried out, various environmental impact categories were considered, including Global Warming Potential (GWP), Abiotic Depletion Potential of Elements (ADP-elements) as well as other categories such as toxicity, acidification and eutrophication. The analyses show that in particular GWP and ADP-elements significantly influence the overall environmental impact of lighting solutions.

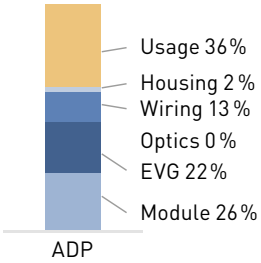
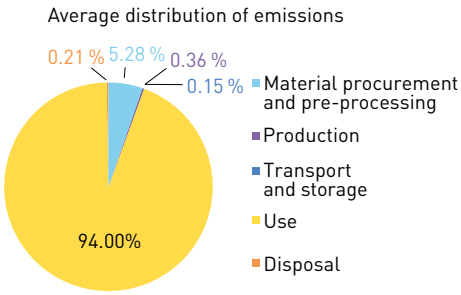


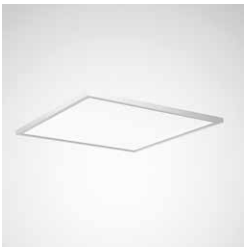
Figure 1: Averaged ADP ratios of an LED luminaire, Source: Final documentation of the SUMATRA research project (LpR103_Trilux_SUMATRA.pdf)

The category ADP-elements describes the impacts on scarce mineral resources. In this respect, technical components in particular – such as LED modules, drivers, ballasts, electronics, cabling and interconnection technologies—make a substantial contribution. They contain various metals and raw materials, including copper, aluminium and other materials that are relevant with regard to resourcescarcity.

The GWP category describes a product's contribution to climate change, expressed in CO_2 equivalents. During the life cycle of a lighting solution, this environmental impact is mainly determined by the use stage (Module B6). Energy consumption over the entire operating lifetime typically accounts for about 95 to 99 per cent of the total climate impact, depending on the type of luminaire and its application.

From this, a fundamental principle emerges: the greatest sustainability impact of a lighting solution is often not achieved by reducing the amount of material used for the housing. Instead, what matters is low energy consumption over the entire service life and the minimal use of materials in the electronic components.





Flat Panel specifications*

Luminous flux	4,200 lm
Service life	min. 50,000 h
Ambient temperature	25° C
Protection rating	IP40
Connected load	40 watts
Total weight	4,67 kg
713,935 kg CO_2e	

Figure 2: Distribution of the Global Warming Potential (GWP) of relevant emissions with respect to the life cycle of an office luminaire

Source: Product Carbon Footprint (Cradle-to-Grave) according to the Product Life Cycle Accounting and Reporting Standard, CO_2OL (02/2020, average scenario DE/FR)

Luminaire housings are made from recyclable metals.

In a retrofit the existing luminaire housing is usually retained, while the technical components that are primarily responsible for light output and energy efficiency are replaced. These include, among others, light sources, optics, drivers, ballasts, cabling and internal electronics. The continued use of the existing housing therefore corresponds to the circular economy principle 'Reuse'. Regardless, it is necessary to assess which environmental impacts are actually avoided as a result.

Luminaire housings are often made of steel or aluminium. These materials are comparatively easy to recycle and can be reused as raw materials at the end of their service life. Moreover, the results of the SUMATRA research project show that, compared with technical components and electronic components, they generally make a smaller contribution to ADP-elements and to GWP.

This leads to an important insight: preserving an existing luminaire housing contributes to the circular economy, but does not automatically prevent the largest environmental impacts of a lighting installation. The crucial levers are often in the use phase – for example through high system efficiency, optimal light distribution and the use of an intelligent lighting control system.

A light is more than the sum of the materials used.

To assess the actual sustainability of a retrofit, it is important not to regard a luminaire merely as a collection of materials – but as a technical system in which all components interact with one another. Modern LED technology offers possibilities that go beyond the mere replacement of a light source. By developing a luminaire holistically, for example optics, thermal design, efficiency and intelligent functions can be optimally coordinated.

If, on the other hand, the new technology is integrated into an existing design, this can in certain cases restrict technical optimisation. The existing housing geometry, thermal properties or optical capabilities can reduce the achievable efficiency and performance.

Even a difference of only a few percentage points in system efficiency can, over a service life of 15 to 20 years and across a large number of luminaires, have a significant impact on total energy consumption and thus on the overall CO_2 balance.

Higher efficiency reduces energy consumption in operation only if it reduces the power draw while maintaining the same luminous flux, and not by increasing the luminous flux at the same power draw. A professionally designed lighting scheme must therefore always take account of the project-specific requirements for illuminance – and, in doing so, choose luminaires with exactly the right luminous flux and light distribution.

It is not enough to consider material savings alone. What matters are the environmental impacts across the entire life cycle.



Retrofitting or replacement – comparing different strategies

TRILUX does not regard a retrofit per se as the best of all possible solutions – but rather as one of several strategies within a comprehensive sustainability approach. The most sustainable solution is not automatically the one that retains the most existing components, but the one that causes the least environmental impact over the entire life cycle.

In certain situations, a retrofit can be an excellent solution. This applies, for example, to special luminaire designs, architecturally significant installations, specialised ceiling systems or modular linear lighting systems, where existing components can be efficiently adapted to modern technology.

In other cases, a newly developed LED luminaire is the more sustainable solution over its entire life cycle — for example, if it offers greater energy efficiency, improved light distribution and allows smart functions to be integrated.

The decision between retrofitting and a new installation should therefore always be based on a holistic assessment of all relevant factors. These include, for example, material use, resource scarcity, energy consumption, CO_2-impacts, technical performance, safety, comfort, costs and future viability.

The TRILUX approach: a holistic life-cycle view of lighting systems

Sustainability is not determined solely by the preservation of a product or product component, but by the sum of environmental impacts that occur over its entire lifetime. A holistically planned lighting solution therefore achieves the best balance between minimal use of materials, high energy efficiency and long-term technical performance.

Further information on the topic of refurbishment, including helpful tips and tools for the successful modernisation of lighting systems, is available at **www.trilux.com/refurbishment**.

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