



White Paper

# Upgrading of Luminaires

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# Introduction

The past and present use of resources has led to a high environmental impact, environmental damage and a massive reduction in natural resources. The EU intends to counteract this by extending the use of products that are already in circulation. Technical advancement has created the need to adapt very old lighting systems to state-of-the-art technology.

Existing luminaires can offer the possibility of being modernised under certain conditions. This aligns with the European Green Deal of sustainably transforming the economy by 2050.

This information paper outlines the various criteria that can be used to make a suitable individual decision on the modernisation of luminaires. Specialist planners can provide valuable support here.

It is assumed that all light sources, luminaires and components covered in this paper comply with legal requirements.

LED technology is state of the art. It operates in a different way to conventional light sources, which may also affect the lighting properties of the lighting systems. These properties include:

- Illuminance and its uniformity
- Luminous intensity distribution of the luminaire
- Luminous flux
- Glare limitation
- Light colour
- Colour rendering
- Spectral properties
- Luminance distribution in the room

Following the update of the lighting system, it is important to ensure compliance with the current application standards in the modified installation. This also applies to the use of retrofit lamps and LED modules.

This paper regularly refers to regulations and standards because

- standards document the state of the art,
- standards are generally used for the declaration of conformity (by manufacturers and testing institutes),
- standards are generally used by experts as a reference and
- failure to comply with standards may be considered a negligent act.

At the same time, it is important to note that the application of standards is not prescribed by legislators but is voluntary. Furthermore, the correct application of standards requires professional expertise.

The ZVEI Section Lighting recommends to apply the standards referenced in this paper during upgrading.

The understanding and content of this document is based on the requirements for the German market.

# 1 Motivation

## 1.1 The end of conventional light sources

In 2023, conventional lamps were phased out following EU legislation on Ecodesign (2019/2020/EU) and RoHS (2011/65/EU). For fluorescent lamps, the regulation on the restriction of mercury – more precisely the EU directive restricting the use of hazardous substances in electrical and electronic equipment (RoHS) – applies. Since February 25<sup>th</sup>, 2023 compact fluorescent lamps without integrated control gear may no longer be placed on the market. Since August 25<sup>th</sup>, 2023 this has also applied to T8 and T5 lamps for general lighting. Since September 1<sup>st</sup>, 2023 most halogen lamp types may no longer be placed on the market for efficiency reasons in line with the Ecodesign Regulation.

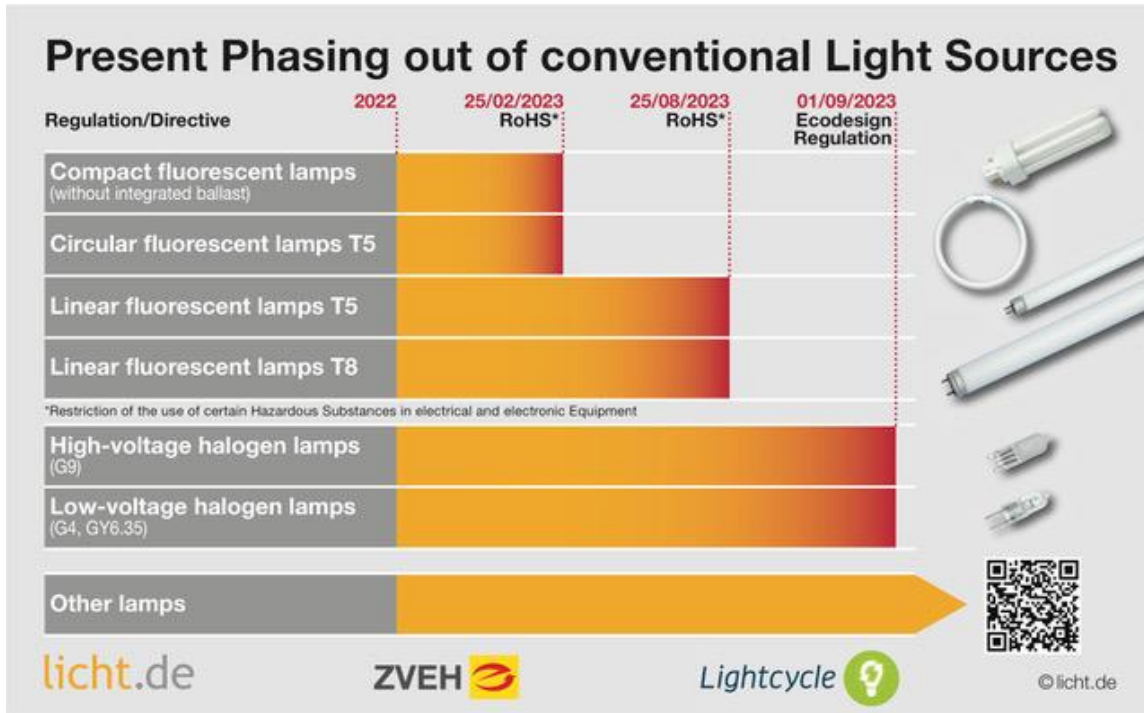


Figure 1: Current phase-out of conventional light sources (licht.de)

## 1.2 Contribution to environmental and climate protection

Upgrading luminaires to LED light sources instead of using conventional lamps leads to positive effects on environmental and climate protection in various ways:

- Waste prevention:  
LED light sources usually have a significantly longer service life than conventional lamps. By switching the lighting to LED technology, the number of lamps to be disposed of in the future is reduced. Fluorescent lamps contain environmentally harmful mercury.
  - Conservation of resources:  
The use of LED light sources extends the lighting system's functional and operating life. Parts of the old luminaires will be reused.
  - CO<sub>2</sub> reduction:  
The lower energy consumption of LED light sources contributes to the reduction of greenhouse gas emissions.

## 1.3 Business aspects

The costs for Electrical power have risen sharply in recent years. It can be assumed that they will remain at a high level in the future.

In 2019, lighting systems in industry, trade, retail and the service sector in Germany incurred around €12 billion in electricity costs and generated around 22 million tonnes of CO<sub>2</sub> ([www.licht.de](http://www.licht.de) - [Facts about lighting](#)).

Modernising lighting systems can therefore not only contribute to a significant reduction in future energy and maintenance costs, but also support sustainability goals.

Sustainability is an increasingly pressing matter for companies. Future reporting requirements call for information on energy consumption in buildings.

Compared to other renovation options in a building, lighting is an easy-to-implement and profitable investment and contributes to retain the value of the property. When upgrading the lighting, sustainability criteria such as long life, high efficiency, excellent light quality and connectivity options are key facts to be taken into account.

## 1.4 Increase in user comfort

For users of LED luminaires, there are clear advantages compared to conventional light sources. Since LED light sources reach their full brightness as soon as they are switched on, they are also suitable for operation in motion detectors and for short switching cycles. If equipped accordingly, they can also be dimmed without loss and without affecting their service life. Thanks to its low power loss, LED lighting heats up rooms less than conventional lighting.

During upgrading, it is possible to integrate additional comfort functions such as dimming, daylight-dependent control, colour temperature adjustment and lighting that supports people's circadian rhythms.

Kits are often equipped with DIP switches or other adjustment options that can be used to set the electrical current and therefore the light output of the luminaire. This allows non-dimmable LED systems to be better adapted to lighting requirements than conventional lamps.

## 1.5 Other factors

In many cases, upgrading a technically intact luminaire can be a sensible alternative to buying a new one, for example if there is a strong interest in keeping the luminaire:

- Design luminaires, listed and heritage luminaires
- Luminaires with special additional functions (e.g. recessed air handling luminaires)
- Recessed luminaires with high replacement costs (e.g. in stretch ceilings or stucco)
- Retaining the architecture (e.g. ceiling)
- Ceilings containing harmful substances that must not be opened (e.g. due to asbestos)

# 2 Options for upgrading solutions

In addition to using new luminaires, various technical solutions are available to upgrade existing luminaires. A distinction needs to be made between four different implementation options.

The requirement for all upgrading solutions is that the lighting system should correspond to the current state of the art once the luminaires have been modernized.

## 2.1 Retrofit lamps

Retrofit lamps are light sources that are used as a replacement for conventional lamps such as fluorescent lamps and that do not require any structural changes to the luminaire for their operation. In the case of luminaires with integrated electronic control gear (ECG), the compatibility of the control gear and light source must be checked (see lamp manufacturer specifications).

## 2.2 Conversion lamps

Conversion lamps go one step further than retrofit lamps. Conversion is the term used when structural changes to the luminaire are required. For example, conversion lamps for mains voltage can be operated directly on the mains without control gear after the luminaire has been modified. Alternatively, the original control gear can be removed and replaced by control gear suitable for the operation of LED conversion lamps and the internal wiring can be changed.

## 2.3 Universal upgrade kits

Universal upgrade kits go another step further than conversion. Here components of the original luminaire are replaced. These complete upgrade kits are provided by a manufacturer.

## 2.4 Luminaire-specific upgrade kits

Luminaire-specific upgrade kits refer to clearly specified existing luminaires. These are designed for the requirements and properties of existing luminaires; any additional functions in the original luminaire (e.g. recessed air handling luminaires) can be retained under certain circumstances.

# 3 Suitability of the existing lighting for upgrading

The luminaires to be converted must be checked regarding their suitability for modernization. The aim of the assessment is to determine the condition of the luminaires or lighting system to be modernized in terms of safety-related and lighting-related aspects.

## 3.1 Safety-related considerations

The basic composition of the luminaires must be in a good condition. The luminaires must be suitable for continued use throughout their expected lifetime in terms of their electrical and mechanical properties. It is recommended to check the following aspects:

### Connection and ambient conditions

- The electrical connection conditions (mains voltage, mains frequency) must match the properties of the luminaires to be modernized.
- The ambient conditions of the lighting system on site in terms of their maximum and minimum permissible ambient temperatures shall match. If, for example, the temperature in the luminaire falls below the dew point, damage caused by moisture may occur.
- The occurrence of dirt, dust, water (IP protection) must be clarified and must be covered by the specification of the luminaires (type plate information and documentation).
- The effects of chemically active substances (e.g. sulfuric compounds) present on site must be checked. This was often not important for conventional light sources, but it can lead to lifetime limitations in LED light sources.

### Electrical aspects

- The electrical contacts of all old plug-in connection components still used in the luminaires must not be discoloured (indication of overheating due to insufficient contact transition resistance). Electrical contacts in plug connections must not be corroded or dirty (visual inspection using a magnifier, if necessary).
- The cable insulation must not be discoloured or brittle. The cable insulation must cover the entire length; it must not show any defects (e.g. visible bare wires).
- The typical 5-pole through-wiring, which may be used in existing luminaires, must have a cable cross-section of at least 1.5 mm<sup>2</sup> (typically 2.5 mm<sup>2</sup>) in accordance with the installation regulations and must be designed as copper cables with a dielectric strength of at least 500 V.

- If there is a lighting control system, it must be determined which technology is used and it must be checked whether it is functional so that it can continue to be used.
- The protection class's requirements for protection against electric shock must be complied with. If the original luminaire was designed in protection class II, for example, the new LED components, materials and contact protection (tool-free opening of the luminaire) must be designed in such a way that protection against electric shock is still ensured.

#### Thermal aspects

- The use of LED light sources usually leads to a significant reduction in heat output. On the other hand, LED light sources and their control gear may be more sensitive to high ambient and operating temperatures.
- The condition of the luminaire, in particular the functionality of heat dissipation elements such as heat sinks and ventilation slits, must be checked to ensure that heat is efficiently dissipated, and overheating is avoided.
- Adequate thermal evaluation not only ensures the long-term reliability of the luminaires but can also improve energy efficiency and extend the lifetime of the luminaires.

#### Mechanical aspects

- Luminaires and their fixings must not be visibly damaged. In particular, they must not have any deformations, e.g. dents, and must not be corroded. There must be no openings (e.g. cracks in covers or drilled holes) or other damage (e.g. to seals) that would invalidate or restrict the IP rating specified on the luminaire.
- Plastics, in particular those holding live parts in position or serving as protection against electric shock, must have sufficient mechanical strength and must not be brittle.
- Check the function of seals on the luminaires.
- The strength of the existing luminaire indicated by the impact resistance (IK value) and, if applicable, ball-proof marking must be taken into account during the upgrading.

#### Emergency lighting

- If centrally powered combined emergency luminaires or self-contained emergency luminaires are to be upgraded, it must be ensured that not just the general lighting but also the emergency lighting function is professionally upgraded. The ZVEI recommends contacting the manufacturer of the emergency lighting components. In particular, reference is made to the German ZVEI paper "Information on converting general lighting luminaires to emergency luminaires" [Information on converting general lighting luminaires to emergency luminaires \(zvei.org\)](https://www.zvei.org/Information-on-converting-general-lighting-luminaires-to-emergency-luminaires)
- It must be ensured that the emergency lighting function is fully maintained after the upgrade has been carried out. In particular, it must be ensured during upgrading that the load on the energy sources (e.g. batteries) is not unacceptably increased, that the switching times are not extended and that any automatic test systems of the emergency lighting continue to carry out their function.

#### Luminaires with limited surface temperatures

- If the existing luminaire has a D or FF mark, which indicates the suitability of the luminaire for use in locations with a fire hazard due to dust and fibrous materials, it must be ensured that the surface temperatures of the luminaires are not unacceptably increased by the upgrading.

#### Explosion-proof luminaires

- In very few cases do retrofit lamps fulfil the safety requirements for explosion protection. They may only be used with the authorisation of the luminaire manufacturer.

Modification of explosion-proof luminaires can lead to hazards; in all cases, they lose their approval.

## 3.2 Lighting-related considerations

If modernisation by upgrading existing luminaires is considered, the existing system must first be checked for compliance with the lighting parameters of the current application standards and legal regulations. The requirements of the currently valid regulations may differ from those on which the previous design of the existing system was based. The use of rooms or the arrangement of workplaces may also have changed.

The following lighting-relevant points should be checked:

- Check the condition of the light-directing components (e.g. specular louvers) for dirt, deformation or damage. Lighting louvers are an important part of the existing luminaire for complying with the intended luminous intensity distribution (amount and direction of light) and glare limitation.
- Check the condition of the lighting covers (e.g. prism-based and/or opal covers) for possible dirt, damage or yellowing. Lighting covers affect the luminous intensity distribution and glare limitation.
- Review the use of space based on the regulations to be observed today: The ZVEI Section Lighting recommends consulting a specialized planner. Any existing planning documents for the existing system can serve as a basis.
- The inspection of the state and condition of the space-defining surfaces should also be seen as part of the lighting survey. For example, a new suitable coat of paint on the ceiling and walls can have a positive effect on the result of a lighting upgrade.

### 3.2.1 Regulations

Quality of light and occupational safety should be important guiding principles in every lighting modernisation. Therefore, the following lighting regulations should be observed:

Workplaces in non-residential buildings / schools (all documents available in german language):

- DIN EN 12464-1:2021-11 “Light and lighting – Lighting of work places – Part 1: Indoor workplaces” (quality of light – productivity and quality of work); help can be found in the Licht.de guide [“licht.forum 60 – DIN EN 12464-1:2021-11 Lighting of indoor workplaces”](#)
- ASR A3.4 (as of May 2023) “Lighting and line of sight: Current requirements for workspaces and measures for companies” (occupational health and safety) for Germany only.
- For additional information, please refer to the ZVEI information paper [“Light modulation – Temporal light artefacts and interaction with technical devices / September 2021”](#)

Indoor car parks:

- For company indoor car parks that are part of workplaces, DIN EN 12464-1 must be applied.
- For public indoor car parks, DIN 67528:2018-04 “Lighting of public indoor car parks and public parking spaces” must be applied.

### 3.2.2 Light quality and user comfort

When modernising a lighting system, the focus should also be on improving the quality of light. Good light improves productivity and illuminance is directly related to quality of work; a balance between quality of light and energy efficiency is recommended.

The minimum requirements for good and energy-efficient light are documented in DIN EN 12464-1:2021-11 (cf. chapter 3.2.1).

The use of daylight-dependent lighting control in combination with presence control supports this idea and, in addition to a further reduction in energy costs, leads to an improvement in user comfort. Depending on the amount of daylight entering a building, the artificial light level is automatically adjusted. The lighting is switched off when leaving the room.

## 4 Economic aspects

The decisions to upgrade should be based on a detailed consideration of economic factors. Cost analysis adds up all the costs across the life cycle – from product selection to operation to disposal. They are:

- costs for acquisition, installation, commissioning and financing,
- costs for disassembly and disposal,
- energy costs and
- maintenance and repair costs.

It is extremely important to define a period under consideration for a life cycle analysis. This should be chosen to correspond to the economic horizon of the end customer or the application.



## 4.1 Life cycle costs

Since lighting refurbishments are long-term decisions, the period under consideration and annual useful life must be determined at the beginning when calculating the life cycle costs. Depending on the application, the period under consideration can be 10 to 15 years, or significantly longer in the case of outdoor lighting systems.

With product lifetime as a key criterion, it is important to ensure that the lifetime is not shorter than the period under consideration, as there may otherwise be additional costs, e.g. because of repair or replacement. It should be noted that products with a higher initial investment can save more costs in the long term. The payback period as a decision parameter therefore generally only provides the simplest choice, but seldom the most attractive solution in the long term.

This is especially true for LED upgrade kits/luminaires with a light management system, which are usually more expensive to purchase, install and commission, but which create low life cycle costs thanks to lower energy and maintenance costs.

While the costs for energy, maintenance and servicing can account for up to 80 percent of the total life cycle costs, the costs for acquisition, installation and commissioning then only make up around 20 percent of the costs.

## 4.2 Energy-related optimization

When luminaires are upgraded, other functions that reduce energy consumption can also be implemented, for example dimming of luminaires which is the prerequisite for using daylight and presence sensors.

In addition to lighting planning, professional planning also includes sensor planning. It takes into account the possibilities for energy-related optimisation and increased user comfort as part of the upgrade.

Especially in larger buildings, which often have building control technology and centralized lighting control in place, integration of the upgraded luminaires should be considered. If they haven't, a decentralized lighting control system should be implemented. This is the only way to achieve comprehensive energy-related optimisation and enhanced functionality.

In buildings without building control/lighting control, intelligent lighting control can be realized using mesh/wireless network-capable components without the need for extensive electrical installation work.

## 4.3 Funding

Subsidies are awarded by the government for lighting refurbishments. Through its Federal Grant Programme for Efficient Buildings (individual measures), the Federal Office for Economic Affairs and Export control (BAFA) subsidizes the installation of indoor lighting systems with a high system luminous efficacy and high lumen maintenance. Only the complete replacement of luminaires (no individual components of luminaires) and other necessary ancillary work including commissioning and components is eligible for funding. Painting work is excluded.

Lamps that are replaceable, or are intended for later installation or for installation in existing luminaires, e.g. retrofit lamps, are not eligible for funding.

Further information can be found on the BAFA website:

[https://www.bafa.de/SharedDocs/Downloads/DE/Energie/beg\\_infoblatt\\_foerderfaehige\\_kosten.pdf](https://www.bafa.de/SharedDocs/Downloads/DE/Energie/beg_infoblatt_foerderfaehige_kosten.pdf)

Municipalities and public-sector clients as well as sports clubs can receive funding from the Federal Ministry for Economic Affairs and Climate Action (BMWK) for the refurbishment of outdoor and indoor lighting. Greenhouse gas savings of at least 50 percent must be demonstrated for the system components to be installed. Further details can be found at [Funding Programs | National Climate Initiative of the Federal Ministry for Economic Affairs and Climate Action](#).

## 5 Legal aspects

### 5.1 Upgrading of luminaires – important change

Upgrading usually results in changes that may affect the safety and operation of the luminaire (except for retrofit lamps). It is therefore necessary to check and evaluate all changes that affect the conformity of the product (here: the luminaire) with the relevant legal acts. If any important changes have been made in line with the EU Blue Guide (2022), the product is to be regarded as a new product and requires a conformity assessment procedure to be carried out. The EU Blue Guide (2022) describes in detail the concept of important change (cf. [link for Blue Guide 2022](#)). See the following excerpt:

*“A product, which has been subject to important changes or overhaul after it has been put into service must be considered as a new product if: i) its original performance, purpose or type is modified, without this being foreseen in the initial risk assessment; ii) the nature of the hazard has changed or the level of risk has increased in relation to the relevant Union harmonisation legislation; and iii) the product is made available (or put into service if the applicable legislation also covers putting into service within its scope). This has to be assessed on a case-by-case basis and, in particular, in view of the objective of the legislation and the type of products covered by the legislation in question.*

*Where a modified product is considered as a new product, it must comply with the provisions of the applicable legislation when it is made available or put into service. This has to be verified by applying the appropriate conformity assessment procedure laid down by the legislation in question. In particular, if the risk assessment leads to the conclusion that the modified product has to be considered as a new product, then the compliance of the modified product with the applicable essential requirements has to be reassessed and the person carrying out the substantial modification has to fulfil the same requirements as an original manufacturer, for example preparation of the technical documentation, drawing up a EU declaration of conformity and affixing the CE marking on the product.”*

(cf. EU Blue Guide (2022), p. 17ff.)

This means: **If no important changes are made in line with the Blue Guide, it is not a new product and the person upgrading the product will not become the manufacturer.**

Important changes that may affect the risks associated with the product may be:

#### 1. Change in original performance:

Upgrading solutions generally result in reduced power consumption, which usually generates less heat in the luminaire and typically reduces the associated risk.

If the electrical power is increased, a case-by-case assessment is required.

#### 2. Change in purpose:

The luminaire's purpose must not be changed. For example, interior luminaires, office luminaires or street lighting luminaires must continue to be used as such after the upgrading. The risk arising from the purpose remains unchanged in this case.

#### 3. Change in type:

The luminaire's type must not be changed. For example, fixed luminaires with IP65 protection must still have the same properties. The risk arising from the type remains unchanged in this case.

If the protection class of the luminaire is changed, an important change must be assumed, as there is an extensive change in the requirement for protection against electric shock.

#### 4. Other changes:

The replacement of existing components and the use of new ones usually leads to changes in EMC and blue light properties. The manufacturer of the upgrading solution should confirm the EMC conformity and the standard conformity of the blue light properties of the corresponding upgrading solution. To ensure EMC

conformity, specific information, e.g. on distances between cables, must be followed. If radio-based control systems are used, the requirements of the Radio Equipment Directive (RED 2014/53/EU) must be observed. Upgrading solutions with a RG0/RG1 blue light classification can be used without further testing. Components in the RG2 classification require further action specified in the installation instructions.

A risk analysis and assessment are required to gauge any increased risk. If the risk analysis and assessment indicate increased risks that were not covered by the original conformity assessment, a conformity assessment of the overhauled luminaire is required.

See chapter 5.2 for responsibilities for the necessary risk analyses.

Current standards and regulations can be found in the EU Official Journal and national publications.

## 5.2 Risk assessment

Procedures for risk analysis and assessment are described in sectoral guidelines or standards. One possibility, based on the Directive on Machinery, is to carry out a multi-stage procedure in accordance with the interpretation proposal of the “Bundesministerium für Arbeit und Soziales” (German Federal Ministry of Labour and Social Affairs)\*, which has been adapted for luminaires.

The ZVEI recommends using the following flowchart to help determine if the upgrade involves an “important change”:

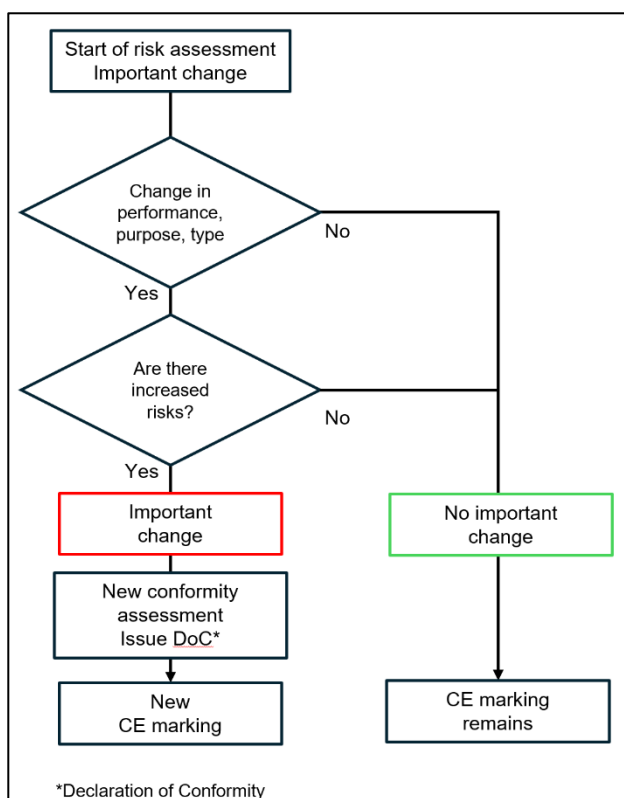


Figure 2: Assessment of important changes

Products that have been modernised without making any important changes therefore do not require a new conformity assessment.

If the modernisation results in an important change, a new conformity assessment must be documented in writing (as with a new product) and included in the (new) DoC (Declaration of Conformity). The product must then be relabeled with the CE marking and all manufacturer obligations apply referring to the actual law.

Due to the great effort required with the conformity assessment procedure for a luminaire, the upgrade solution (conversion lamps or upgrade kits) should be designed in such a way that it does not lead to any increased risk and therefore no important change to the luminaire.

To ensure this, the manufacturer of the upgrade solution and the responsible person upgrading the existing luminaire must meet the following requirements:

1. Manufacturer of the upgrade solution:
  - a) Carry out a risk analysis and assessment of the upgrade solution
  - b) Determine the upgrade solution's EU conformity (actual requirements)
2. Responsible person upgrading the luminaire:
  - a) Test suitability of the existing luminaire: technical/lighting-related (cf. chapter 3)
  - b) Carry out a risk analysis and assessment of the upgraded luminaire in combination with the built-in upgrade solution (not required for retrofits and luminaire-specific upgrade kits)

## 6 Decision

Once the existing system has been tested (see chapter 3) with regard to its electrical, safety-related and lighting-related properties, and taking into account the past and future use of the area, two scenarios can occur:

1. The existing system can be upgraded while retaining the existing luminaire positions, thus complying with current regulations. The manufacturer ensures that the technical requirements with regard to safety and electrical aspects as well as lighting technology, which are laid down by the original luminaire and the current technical regulations, are complied with.
2. An upgrade should not be carried out if it is out of the question from a safety or lighting-related or economic point of view (cf. chapters 3 and 4). In this case, new luminaires should be used.

## 7 Installation and operation

**Important points for installation, operation and maintenance:**

- Professional installation: Modifications to luminaires must be carried out by qualified personnel. Compliance with manufacturer's instructions: The installation instructions provided must be observed during installation or upgrading.
- Electrical safety: During luminaire installation, the applicable electrical safety and installation regulations, e.g. DIN VDE 0100, should be complied with to protect people and animals from risks.
- Installation of light sources: Double-capped retrofit lamps should comply with the international safety standard IEC 62776 (DIN EN 62776 in Germany) "Double-capped LED lamps designed to retrofit linear fluorescent lamps – safety requirements".
- Testing and commissioning: After installation, the luminaires must be checked for correct functioning and safety and put into operation. This should be carried out by visual and electrical testing as well as functional testing, see DIN VDE 0701.
- Documentation: It is recommended to document all relevant information regarding the installation of luminaires.
- Electrical maintenance: Recommended every 4 years for stationary equipment (repeat tests according to DIN EN 50699 – VDE 0702:2021-06)
- Lighting-related maintenance: Following the maintenance plan according to DIN EN 12464-1 for maintaining the lighting values.
- It should be noted that certification mark approvals of the original luminaire are suspended after upgrading.
- For more information go to the ZVEI publication page: Publications (zvei.org).

### **Note:**

This information was prepared with great care, taking into account the legal situation known at the time of its preparation. However, no liability can be assumed for the correctness and completeness of the statements. In particular, different regulations may apply for certain products in individual cases or the legal situation may have changed in the meantime. Each economic operator is responsible for applying the provisions applicable to their case.

## ZVEI: Electro and Digital Industry Association

The ZVEI represents the common interests of the electrical and digital industry and the associated service companies in Germany and at international level. The association has more than 1,100 member companies, and the ZVEI Group employs 170 people.

The industry employs 900,000 people in Germany (as of April 2024). In 2023, sales totaled 238 billion euros.

The electrical and digital industry is one of the most innovative economic sectors in Germany. New products account for a fifth of industry sales. One in three innovations in the manufacturing industry as a whole originates here. Almost a quarter of all R&D expenditure in the manufacturing industry in Germany comes from the electrical and digital industry. Every year, the industry spends around 20 billion euros on R&D and more than seven billion euros on investments.

### Contact

Toni Will • Manager Technical Communication • Fachverband Licht •  
Tel.: +49 69 6302 350 • Mobil: +49 151 26441 516 • E-Mail: [Toni.Will@zvei.org](mailto:Toni.Will@zvei.org)

ZVEI e. V. • Electro and Digital Industry Association • Lyoner Straße 9 • 60528 Frankfurt am Main • Germany  
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