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LpR

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Innovation United with Sustainability

I am particularly pleased to give you a short introduction to this new LED professional Review (LpR) release. We address some critical topics ranging from light sources to design aspects, communication subjects, and actual implementations in this issue. Inventions and technological progress are the basis for innovation. However, we also know that all developments – today more than ever – must be determined towards quality and, above all, sustainability. In this context, we were pleased to interview Mr. Hiroyoshi OGAWA, President and CEO of NICHIA. We also took the opportunity to send our congratulations on the occasion of NICHIA's 65th anniversary.

The topic of sustainability is complex and has many facets. One viewpoint is interchangeability, as prescribed by the new EU directives and discussed in the article about Replaceability. In cooperation with LightingEurope, we attained chief experts on UV-C disinfection, who provided us with the latest insights in this field. Wireless communication, and LiFi in particular, is a fascinating subject. Now, with standardization plans, there is further momentum towards market implementations. You will also find the link to the LiFi seminar from the International Solid-State Lighting Alliance published on LpS Digital in this release. In addition to all that, we present two specific new developments in the LED sector: New LEDs for outdoor applications and innovations in multi-chip LED packaging.

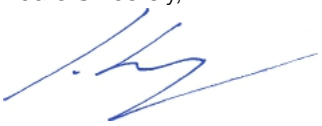
Smart Controls and Surgical Lighting articles complete the range of topics for technical developments and specific applications.

Finally, I would like to express my sincere thanks to all our contributors.

Enjoy your read and stay healthy!

PS: Call for Papers for the LpS Digital 2021 is open. Take the opportunity to submit your idea for a paper or present your latest innovations http://www.LpS-Digital.global.

Yours Sincerely,



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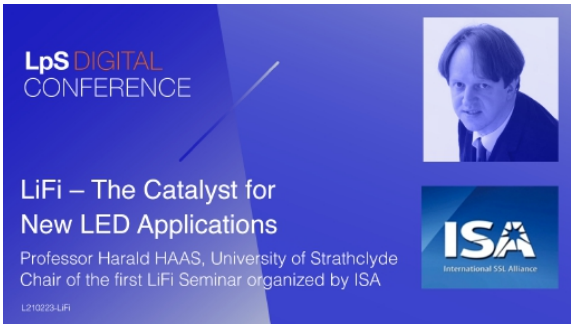
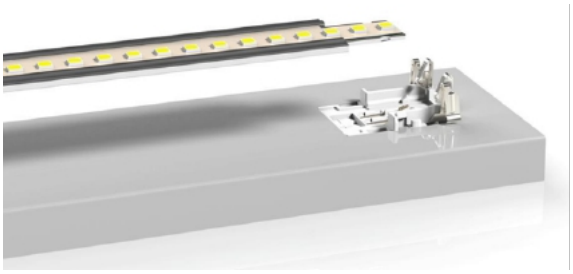


LiFi Seminar organized by the International SSL Alliance (ISA). State-of-the-art LiFi lectures including the keynote lecture by Professor Harald HAAS.

Hiroyoshi OGAWA



WIRELESS COMMUNICATION

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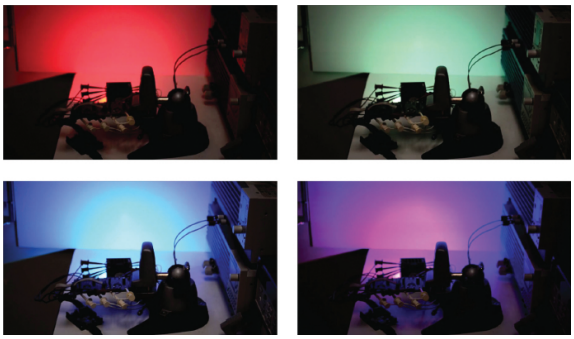
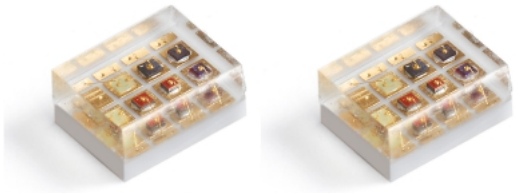


OUTDOOR LIGHTING

LED TECHNOLOGY



SURGICAL LIGHTING

ADVERTISING INDEX

Replaceability of Light Sources and Separate Control Gears

With the success of LEDs in general lighting, the time-honored separation of light sources (lamps) and luminaires has been discarded in the designs of LED luminaires. In mass-produced LED luminaires such as panels, downlights and high bays, the lamp and the luminaire have merged into one product. Large operators of commercial real estate, who have to ensure long-term facility operation, have always complained about this fact. A key justification for this design decision was the long life-time of LED light sources. Currently, however, a rethinking process is taking place, which is promoted by new regulations of the European Union.

Experience with the use of even high-quality LED luminaires shows failure rates of 0.2% per 1,000 hours of operation, which cumulates to about 10% after 50,000 hours. The appropriate replacement of these defective luminaires poses major challenges for operators. The luminaire industry has so far reacted to these requirements only very hesitantly. Currently, however, a rethinking process is taking place, which is promoted by new regulations of the EU. The main goals of the EU's Green Deal are CO_2 neutrality by 2050 and the avoidance of waste and pollutants [1].

Disposable luminaires are just not compatible with these goals. The first steps in this direction are embodied in the new EU Regulation 2019/2020, which replaces the previous regulations on the environmentally friendly design of lighting products. This article looks at the regulatory requirements, the benefits of replaceable light sources, the types of replacements and the need for standards, available technical solutions, and the implications for luminaire design and the luminaire industry.

Requirements of the European Union

The EU considers the extension of the Circular Economy to established economic actors as a crucial contribution to the implementation of a climate-neutral and resource-efficient economy in which growth is decoupled from resource use.

In this context, the ecodesign regulations of energy consumption-relevant products are being expanded to ensure that ecodesign is extended to as broad a product spectrum as possible and contributes to the circular economy. In addition to increasing energy and resource efficiency, the durability, reusability, replaceability and reparability of products are defined as key levers. Added to this is the avoidance of pollutants.

For lighting applications, the EU has taken a first step in this direction with Regulation 2019/2020 EU, laying down ecodesign requirements for light sources and separate control gears [2]. The regulation no longer refers to lamps and luminaires, but more generally to light sources and containing products. Containing products can, for example, be luminaires but all other products that contain (removable) light sources and/or separate control gears, such as refrigerators. The scope of the regulation is thus considerably broader than before.

Article 4 paragraph 1 of the regulation requires the replaceability of light sources and separate control gears devices in containing products with generally available tools without permanent damage to the product (and describes exceptions), paragraph 2 contains information on whether replacement can be carried out by end users or only by qualified persons or not and paragraph 3, their dismantling from containing products at end of life.

For the information of whether the replacement of the light source or the separate control gear in containing products can be performed by the end user or only by qualified persons or not at all; LightingEurope has developed new pictograms (**Figure 1**) [3].

The Regulation will apply from 01 September 2021 and Article 9 of the Regulation already stipulates that the Commission will carry out a review against the background of technical progress by 25 December 2024 at the latest, particularly with regard to f) the definition of additional product requirements for resource efficiency in accordance with the principles of the circular economy, in particular with regard to the possibility of removal and the replaceability of light sources and control gear.

Another important aspect of the regulation is the prohibition on market placement of most compact fluorescent lamps with integrated ballast from 01 September

2021 and most T8 fluorescent lamps from 01 September 2023 from the definition of ecodesign requirements in Article 3 in conjunction with Annex II Table 1 (here energy efficiency requirements). This means that, as was previously the case with incandescent lamps and halogen lamps, widely installed light sources may no longer be placed on the market, which creates pressure to act, especially for large operators of real estate.

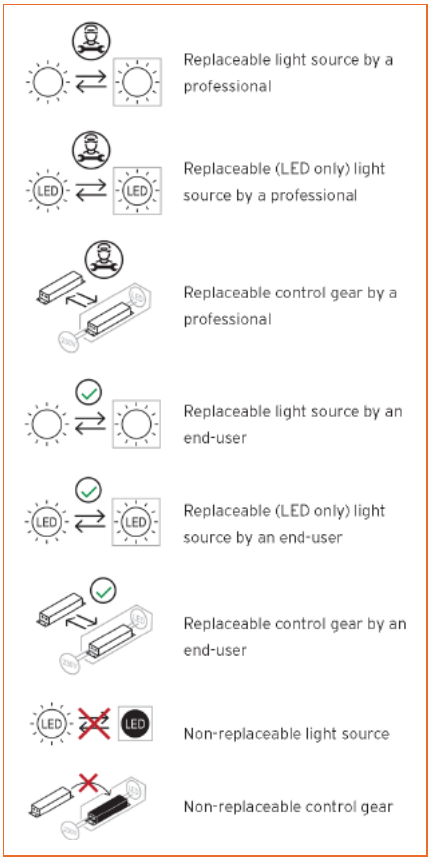


Figure 1: Replaceability of light sources and separate control gear

In addition to the regulations on product design (ecodesign), Directive 2011/65/EU on the restriction of the use of certain hazardous substances (the so-called RoHS II Directive) has a significant influence on the permissibility of placing products on the European market [4].

Due to their mercury content, fluorescent lamps are in the focus of the EU Commission, which is currently considering not extending or allowing to expire the exemptions for fluorescent lamps (Annex III) for the strict limit values of this directive (0.1% mercury (Hg) in homogeneous materials according to Annex I). In this case, most T5 fluorescent lamps and compact fluorescent lamps without integrated ballast will also be phased out.

Pros and Cons of LED Light Source Replaceability

Before the LED era, the replaceability of light sources was taken for granted as standardized and socketed lamps; lamps and luminaires were sold separately. Today, LED lamps with conventional bases (known as retrofits) continue to bridge the gap between the old and new worlds.

This tradition was disrupted with the introduction of LEDs as a light source for general lighting. Particularly for professional mass applications, luminaires were introduced to the market with the LED light source permanently installed in the luminaire, such as panels, downlights and high bays. The luminaire industry has emphasized to operators the long life of the LED light source, and many operators have readily taken advantage of the significant energy savings and short payback periods. In recent years, LED luminaires have become more and more affordable, so that today they are, in some cases, below the price level of the old luminaire technology.

Operators have had to experience problems with adequate replacements when luminaires fail in the field, and as luminaire prices have declined, luminaire mounting and dismounting costs have become increasingly significant. The luminaire industry can sell a new luminaire at the end of the LED light source's life; at best, the operator must bear the cost of this one entire new luminaire, as well as its disassembly and reassembly costs. Lacking an alternative, many operators had not considered the resulting opportunity cost.

The specific arithmetic for the operator depends on numerous parameters, such as the lighting duration and the remaining useful life of the property. The longer the remaining useful life and the longer the lighting period per year, the more economical luminaires with replaceable lamps become for the operator. The calculation becomes more advantageous if the luminous flux loss of the installed LED solution and the efficiency increase of a new LED light source at a later replacement time are included.

The above makes it clear that an operator of a property, thinking long term, should compare the Total Costs of Ownership (TCO) for both a solution with and without replaceable LED light source (and control gear) over a life cycle of the LED light source.

The actual assessment of the environmental impact of luminaires with replaceable light sources (and control gear) compared to non-replaceable ones is no less complex, as this has to consider the entire life cycle from the production phase to the use phase to the disposal phase (Life Cycle Assessment LCA). The results of such LCAs (e.g. from the Repro-light research project) show that the use phase has a significant impact on our environment, but that the replaceability of components and recyclability also play a role. Replaceable LED light sources must therefore not be at an efficiency disadvantage compared to non-replaceable light sources from an environmental point of view.

Since the service life of the light source in practice rarely corresponds to the service life of the luminaire, two cases must be distinguished in the case of replaceable LED light sources. If the service life of the luminaire exceeds that of the light source, the light source has to be replaced and the question arises whether the old light source can be repaired or recycled. In the opposite case, the question of re-use of the light source arises. Beyond economic efficiency and environmental aspects, there are numerous other aspects that speak in favor of replaceable light sources. From the operator's point of view, for example, the change in color temperature when there is a change of user (e.g. in the office) or change of season (e.g. in retail) can be of interest. For the luminaire manufacturer, product complexity can be reduced by the factors of color temperature and color rendering, depending on the type of replaceability of the light source, which can significantly increase the degree of prefabrication in the mass production of downlights, for example.

Since the reform of the liability for defects under sales law in Germany on 01 January 2018 (§ 439 and § 475 BGB), luminaire manufacturers are obliged to bear the removal and reinstallation costs in the event of a defective luminaire. If the defect is due to the LED light source, the luminaire manufacturer can keep the defect removal costs low with the help of replaceable light sources and satisfy the customer quickly and easily by supplying replacements.

Different Types of Replaceability

Regulation 2019/2020 EU distinguishes in Article 4(2) between the replaceability of light sources and control gear with commonly available tools by the end user or by qualified personnel. This refers to replace-

ment in the field and not replacement at the manufacturer's factory. Light source replacement at the manufacturer's facility is a rare consideration due to disassembly and reassembly and round-trip transportation.

The replacement of light sources requires that safety is guaranteed (protection against electric shock), the light source is protected against improper handling and damage (e.g. ESD) and the thermal, mechanical as well as electrical connection between the luminaire and the light source is guaranteed (cf. ZVEI information on the replaceability of LED light sources 2017 [5]).

When light sources are replaced by the end user, these boundary conditions can only be guaranteed in practice by capped lamps. Otherwise, replacement of the LED light source at the point of use can only be carried out by qualified specialist personnel, provided that the manufacturer has provided for this via appropriate LED modules, which are connected via terminals or connectors, for example, and can be replaced without changing the operational, safety and application properties of the luminaire.

For the operator, the cost of replacing the light source is a crucial factor, as this can easily exceed the cost of the light source. Therefore, it is not only the question of who can carry out the replacement that is important, but also how long the replacement will take in the specific structural situation. Here, LED lamps are likely to often have an advantage over LED modules. In addition to the question of whether the light sources can be replaced by the end user or only by qualified personnel, it is of considerable importance from the operator's point of view whether standardized LED lamps and LED modules are used or not. With non-standardized LED lamps and LED modules, the operator usually enters into a long-term dependency on one manufacturer.

Under the two aspects of replaceability and standardization, the matrix for light sources is as shown in **Table 1**. Non-replaceable light sources are not listed.

Light Source	Replaceable by End User	Replaceable only by Qualified Persons
Standardized	Standardized LED Lamp	Standardized LED Module
Non-standardized	Non-standardized LED Lamp	Non-standardized LED Module

Table 1: Replaceability and standardization of light sources

Standardization of LED lamps ideally relates to two aspects, the socket & lampholder system and the light source itself. Sockets of lamps and the lampholders in luminaires are standardized by the International Electrotechnical Committee (IEC). The international manufacturer consortium ZHAGA deals with the interfaces for LED modules and lamps, control gear and sensors, which are important for integration in luminaires.

Standards

Advantages of Standards

In the old world of conventional lighting technology, luminaires without standardized lamps were unthinkable. Until the inefficient lamps were phased out, operators could rely on being able to buy them again many years later. Lamp manufacturers were able to produce their lamps in high volumes at low cost because of the high degree of standardization.

This situation has changed fundamentally with LED technology. Apart from LED retrofits (LED lamps with bases from conventional lighting technology), luminaire manufacturers have been able to push through luminaires with permanently installed LED light sources in commercial mass applications. With the return to the benefits of replaceable light sources in the interest of the environment and operators, the question of standardization again arises. The interoperability of LED lamps and LED modules between different manufacturers is the central argument for standardization.

Standardization can also achieve economies of scale, which are consequently reflected in a low-cost supply of replaceable light sources. The resulting automated mass production promotes the quality of the light sources. Technical risks inherent in the light source are reduced by both standardization and replaceability. The higher volumes of standardized light sources make investments in product and process innovation attractive for manufacturers.

Operators and luminaire manufacturers gain investment security and at the same time flexibility with standardized replaceable light sources. New business models such as Lighting as a Service (LaaS) or even reusability can gain a completely new dynamic through standardized replaceable light sources. All these advantages of standardizing replaceable light sources make a significant contribution to the sustainability of lighting solutions. Against this background, luminaire manufacturers will have to deal with this topic in the future. In the following, we will show which LED-specific standards are currently available for replaceable linear and point light sources.

Standards for Replaceable Linear LED Light Sources

Linear light sources represent one of the most important forms in professional lighting. The most common conventional linear light sources are T8 fluorescent lamps with G13 base and T5 fluorescent lamps with G5 base. The decided end of most of the T8 fluorescent lamps on 01 September 2023 (see also [6]) and the impending ban of T5 fluorescent lamps poses great challenges to the operators.

This makes the market's need for appropriate solutions for standardized linear LED light sources all the more urgent. Currently, the standards available for linear LED lamps and LED modules are as shown in **Table 2**. Retrofit solutions based on the G13 base, for example, will not be discussed here.

Linear Light Source	Replaceable by End User	Replaceable only by Qualified Persons
Standardized	Linear LED Lamp Socket / Lampholder: GR6d Lamps: ZHAGA Book 14	Linear LED Module Terminal & Module: ZHAGA Book 21
Non-standardized	e.g. R-Tube	

Table 2: Standards for replaceable linear LED light sources

GR6d is an LED-specific socket & lampholder system for linear lamps according to IEC EN 61001-1 / AMD56:2017, which is designed for up to 2 A 250 V. It is a single-sided electrically contacted system where the mating holder is used for mechanical support and thermal length compensation. A push-in & push-out system simplifies the tool-free insertion and removal of the lamps, while for removal a retaining function still protects against unintentional falling out of the lamps. Electrical parameters (currents or voltages) are defined via a key system in the socket and base.

Based on the GR6d socket & lampholder system, ZHAGA Book 14 defines, among other things, the mechanical interfaces for installing the lamps in luminaires. In particular, the defined lengths L60 (564 mm), L120 (1164 mm) and L150 (1464 mm), which are

based on classic lengths of T5 fluorescent lamps, should be mentioned here. The ZHAGA Book 14 opens up the possibility of integrating light control into the lamps. By replacing suitable lamps, not only the color temperature but also the light distribution of luminaires can be changed as required (cf. **Figure 3**).

The lamps in **Figure 3** are self-cooling and the L60 length can easily accommodate 20 W of power per lamp, the L120 40 W and the L150 50 W. The glare-free versions of the lamps (UGR < 19 for 4H8H) achieve a system efficiency (incl. losses of the separate control gear) of up to 155 lm/W (4000 K, Ra 84, Rf 83, Rg 92, R9 16, 25 °C). This efficiency level is on par with today's luminaires with fixed LED light sources. Such an L150 lamp can achieve more than 7500 lm luminous flux and is thus suitable for much more than replacing a luminaire with an 80 W T5 fluorescent tube (5700 lm at 25 °C), where the luminaire efficiency still has to be deducted.

Figure 2: GR6d socket & lampholder system

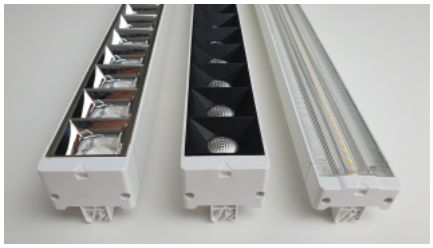


Figure 3: LOP26 & LOP15 lamps with GR6d socket and different light distributions

Figure 4: Linear LED module with connection element according to ZHAGA Book 21

GR6d based lamps from different manufacturers are now designed to have no glue, solder or cable connections. Therefore, the lamps can be disassembled with conventional tools and the circuit boards can be easily replaced; the lamp itself becomes repairable and very easy to recycle.

ZHAGA Book 21 was designed as a standard for linear LED modules that can only be replaced by qualified persons at the point of use (**Figure 4**). The connection element (board connector) enables tool-free removal of the board, which can be operated with max. 60 V 2 A (SELV). With ZHAGA Book 26 a non-SELV version is planned. The wiring is done on the back side of the connection element. As a rule, the circuit boards must be self-cooling. ZHAGA defines two board lengths of 2 ft (601 mm) and 4 ft (1219 mm) and a board width of 20 mm. For the 4 ft board, a gross luminous flux of max. 8800 lm is defined (at 1400 mA). The light-directing elements must be installed in the luminaire.

Standards for Point-shaped LED Light Sources

Point-shaped light sources are used in many downlights, track lights and spotlights. In functional buildings, single-ended compact fluorescent lamps (CLF) were widely used for such luminaires until the early 2010s. Strictly speaking, compact fluorescent lamps are not point-shaped but rod-shaped light sources because of their large dimensions.

From 01 September 2021, compact fluorescent lamps with integrated ballast (CFL-i, base E14, E27 etc.) will have to leave the market throughout the EU. Due to the harmful substance, mercury, contained in compact fluorescent lamps, compact fluorescent lamps without integrated ballast (CLF-ni, base G23, G24-d1, G25-q2, G7 etc.) are also threatened with such a ban (RoHS). This would generate an enormous replacement demand.

For mounting COB LEDs in downlights, track lights and spotlights, ZHAGA Book 10 has become a widely used standard in the lighting industry. ZHAGA Book 10 describes two diameters of round mounting brackets for COB, D50 and D35. The smaller diameter of 35 mm is gaining in importance against the background of the miniaturization of LED luminaires. Unfortunately, COBs installed in this way are difficult to replace in the field, even by qualified specialists. This is due to the fact that the connection elements are not designed for replacement in the installation situation and to the challenge of restoring the thermal interface between COB and heat sink in this situation in a process-safe manner.

Currently, the standards listed in **Table 3** exist for replaceable point-type LED light sources without integrated control gear.

This table is not fully comprehensive but covers the main relevant standards.

Point Light Source	Replaceable by End User	Replaceable by End User
Standardized	Socket & Lampholder: GH36d Diameter 50 mm	ZHAGA Book 5 Diameter 69 mm
Not-yet standard-ized	Socket & Lampholder: GH27d Diameter 35 mm	

Table 3: Standards for replaceable point LED light sources

ZHAGA Book 5 is a socket & lampholder system for point-shaped LED lamps with a total diameter of 69 mm, which is not standardized by IEC. The maximum system power is rated at approximately 40 W.

The GH36d socket & lampholder system picks up the 50 mm diameter defined in ZHAGA Book 10 and is standardized according to IEC 61001-1/A58-2018 (**Figure 5**). Socket and lampholder are electrically rated up to 2 A 150 V. The thermal management limits the maximum system power to approx. 35 W depending on the connected heat sink. The maximum power can be coded via corresponding keys. A twist & lock system allows the lamp to be easily inserted into or removed from the lampholder.

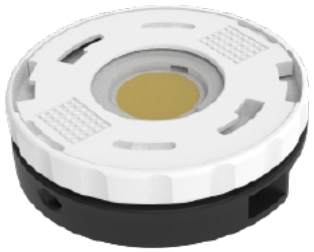


Figure 5: GH36d lampholder with corresponding LED lamp

A new open system for the lamp (**Figure 6**) allows easy insertion of commercially available COBs with footprints of 19 x 19, 20 x 24 and 17.85 x 17.85 mm, with the COBs held in place in a similar way to modern connecting elements. In this way, the manufacture of the lamp is simplified at every step of the value chain. The lamp system already has two interfaces for reflectors or optics with connection diameters of 50 mm and 40 mm.

Against the background of the miniaturization of luminaires, the new GH27d system

with 35 mm diameter has now been developed analogously to ZHAGA Book 10 (cf. **Figure 7**), which has not yet been standardized. It has the same design as the GH36d lampholder and lamp system and is available for commercially available COB with footprints of 13.5 x 13.5, 12 x 15 and 15.85 x 15.85 mm. The maximum system power is specified at 17 W due to thermal restrictions. Optics or reflectors can be connected via an interface with 35 mm connection diameter.

Figure 6: GH36d lamp system for COB with upper part, lower part and lampholder

Figure 7: GH27d with D35 vs. GH36d with D50

Implications for Luminaire Designs

The standardized linear and point LED light sources presented here enable a simple modular luminaire design, with the help of which, end users or qualified persons can replace the light sources on site, and also, ideally, without dismounting the luminaire.

For a coherent overall concept, modularization of luminaires must extend to other components. As already required by the 2019/2020 EU regulation, the second important replaceable component must be the separate control gear. And finally, optional sensors are also part of such a system as a third component, at least when they are installed in luminaires (containing products).

On the one hand, standardization of control gear is less advanced than standardization of light sources. On the other hand, separate control gear is usually replaceable by qualified personnel. Some standardization of the dimensions and mounting points of control gear has taken place in ZHAGA Book 13. For the control of such devices, DALI-2 has brought an important advance in terms of cross-manufacturer interoperability of systems (IEC 62386). For the first time, DALI-2 also allows sensors to access the bus and communicate with the master, operating devices and other sensors (multi-master). Although DALI-2 Parts 251, 252 and 253 standardize the memory banks for inventory, energy monitoring and maintenance of luminaires, they do not yet take into account the aspect of replaceability of light sources and control gear.

Programming of control gear has been standardized outside the DALI standard via the LED set standard (ZAHGA Book 22/23) and the NFC standard (ZHAGA Book 24/25). Fundamental aspects of the replaceability of control gear from an EMC point of view are currently being worked out within the framework of the ZHAGA TF-EMC. In view of the high hourly rates of qualified persons, the possibility of simple and, at best, tool-free replacement of operating devices is desirable. For this purpose, (coded) plug systems within a luminaire would be useful.

Such connector systems and interfaces are already defined for dedicated or retrofittable sensors. ZHAGA Book 20 describes these for indoor luminaires and ZHAGA Book 18 for outdoor luminaires. Both communication and power supply between control gear and sensor are standardized via the D4i standard within the DALI organization. The topics of control and sensor technology are gaining in importance, not least against the background of the EU's Energy Performance of Buildings Directive (EPBD) 2018/844 [7], which stipulates a Smart Readiness Indicator (SRI) for buildings that also extends to the area of lighting. With the next amendment of the GEG, the German legislator will also have to implement this directive.

The integration of the above aspects into the luminaire design contributes to maintainability, repairability, updateability and upgradeability, thus making luminaires fit for the future and, with a suitable design, also sustainable overall. The luminaire design thus determines the possibilities for circular economy in the area of general lighting, which will have an impact for decades.

However, luminaire manufacturers should not see modular luminaire design exclusively as a contribution to the Circular Economy but should also recognize the opportunities that lie in a reduction in the number of variants, a reduction in inventories, rapid delivery capability via late stage configuration or even mix & match by the customer and, last but not least, an increase in customer satisfaction.

Summary and Outlook

The Green Deal is the future project of the European Union to decouple economic growth from resource consumption and to become climate neutral by 2050. "Do not think the Green Deal is a luxury we cannot afford, it is a lifeline out of the virus [...] Do not fall into the trap that COVID is an excuse to undo things." stated the Vice President of the European Commission Frans Timmermans before the ENVI Committee of the European Parliament on 21 April 2020.

The Circular Economy is the central building block of this project, for which the EU will hold all economic actors accountable. With the 2019/2020 regulation, the EU has taken the first steps for the implementation of this plan in the lighting market and has for the first time in Article 4 required the replaceability of light sources and separate control gear from 01 September 2021.

Manufacturers can still circumvent this replaceability by justifying in their technical documentation why the replacement of the light sources and separate control gear would not make sense. However, according to Article 9 f), additional product requirements are already due in 2024, especially with regard to the possibilities of

removing and replacing light sources and control gear.

The luminaire industry would be well advised to correct the misguided development of LED disposable luminaires over the last decade and to actively shape the development of sustainable luminaires in the new decade. The earlier companies adapt to this, the more likely they are to benefit from this trend reversal.

The article shows that suitable standards and products for replaceable light sources and separate control gear are already available. Others will follow. The first luminaire manufacturers are already offering corresponding modular luminaires. Numerous large operators have been demanding this step for a long time and are planning to align their investment decisions accordingly.

However, the departure from the linear economy also urgently requires closer cooperation between all those involved in the value chain, such as planners, upstream suppliers, manufacturers, wholesalers, installers, contractors, facility managers, operators, recyclers and disposers. There are tremendous opportunities to develop new business models in the wake of this transformation. Technologies as such are rarely disruptive, but mostly the new business models that emerge from them. ■

References

[1] European Commission (2020): The European Green Deal. Communication of 11 March 2020.

[2] European Commission (2019): Regulation (EU) 2019/2020 of 1 October 2020 laying down ecodesign requirements for light sources and separate control gears. Official Journal of the European Union, 15 Decembere 2019.

[3] LightingEurope (2020): Guidelines for the application of Commission Regulation (EU) 2019/2020. Version 2 of 06 October 2020.

[4] European Parliament and European Council (2011): Directive 2011/65/EU of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. Official Journal of the European Union, 01 July 2011.

[5] ZVEI White Paper (2017): The Replaceability of LED Light Sources. May 2017.

[6] Mordziol, Christoph (2019): Abschied von der T8 Lampe (Departure from the T8 lamp). In: Elektro Praktiker 06/2019, 07/2019 and 10/2019.

[7] European Parliament and European Council (2018): Directive (EU) 2018/844 of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. Official Journal of the European Union, 19 June 2018.

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