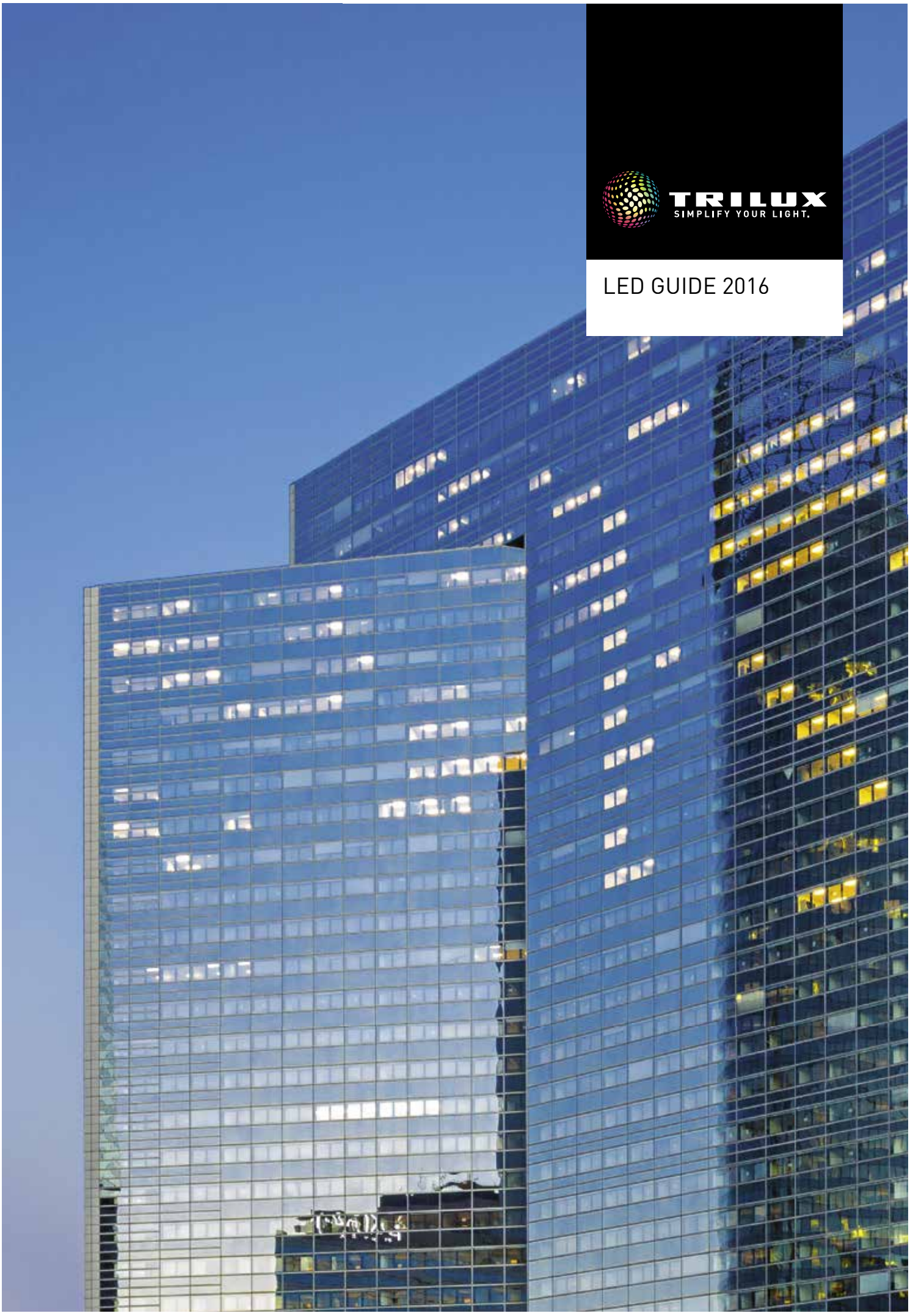


TRILUX
SIMPLIFY YOUR LIGHT.

LED GUIDE 2016

CONTENT

Introduction

Application areas

Products

Technology, themes and trends

CONTENT

Downlights

082
Inplana LED

082
Onplana LED

084
Less G2 LED

086
Ligra G2 LED

Spotlights

096
Fano LED

096
Fano Mini LED

098
Mido LED
Recessed

098
Mido LED
Surface-mounted

100
Quira LED

100
Quira Plus LED

102
Agira LED

Recessed luminaires

104
Arimo Slim CDP LED

106
Arimo Slim MRX LED

108
Solvan Flow C LED

Surface-mounted luminaires

104
Arimo Slim D CDP LED

106
Arimo Slim D MRX LED

108
Solvan Flow D LED

110
Lunexo D CDP-I LED

Suspended luminaires

092
Canilo LED

098
Mido LED

104
Arimo Slim H CDP LED

108
Solvan Flow H LED

110
Lunexo H CDP-I LED

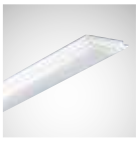
112
74 R LED

Wall- and ceiling-mounted luminaires

112
74 R LED

112
74 Q LED

114
6651··· LED



116
3331 G2 LED

Multivariable systems

118
LC67 LED

120
Sistema Compact LED

Continuous-line luminaires

122
E-Line LED

124
E-Line LED IP54

CONTENT

			TRILUX	Oktalite
Downlights	**Inplana LED**	Page 082 – 083	●	
	Onplana LED	Page 082 – 083	●	
	Less G2 LED	Page 084 – 085	●	
	Ligra G2 LED	Page 086 – 087	●	
Spotlights	**ScenaticPoint 905 LED**	Page 088 – 089	●	
	Lobu LED	Page 090 – 091		●
	Canilo LED	Page 092 – 093		●
	Canilo Plus LED	Page 092 – 093		●
	Antelope LED	Page 094 – 095		●
	Fano LED	Page 096 – 097		●
	Fano Mini LED	Page 096 – 097		●
	Mido LED Recessed	Page 098 – 099		●
	Mido LED Surface-mounted	Page 098 – 099		●
	Quira LED	Page 100 – 101		●
	Quira Plus LED	Page 100 – 101		●
	Agira LED	Page 102 – 103		●
Recessed luminaires	**Arimo Slim D CDP LED**	Page 104 – 105	●	
	Arimo Slim D MRX LED	Page 106 – 107	●	
	Solvan Flow C LED	Page 108 – 109	●	
Surface-mounted luminaires	**Arimo Slim CDP LED**	Page 104 – 105	●	
	Arimo Slim MRX LED	Page 106 – 107	●	
	Solvan Flow D LED	Page 108 – 109	●	
	Lunexo D CDP-I LED	Page 110 – 111	●	
Suspended luminaires	**Canilo LED**	Page 092 – 093		●
	Mido LED	Page 098 – 099		●
	Arimo Slim H CDP LED	Page 104 – 105	●	
	Solvan Flow H LED	Page 108 – 109	●	
	Lunexo H CDP-I LED	Page 110 – 111	●	
	74 R LED	Page 112 – 113	●	
Wall- and ceiling-mounted luminaires	**74 R LED**	Page 112 – 113	●	
	74 Q LED	Page 112 – 113	●	
	6651··· LED	Page 114 – 115	●	
	3331 G2 LED	Page 116 – 117	●	
Multivariable systems	**LC67 LED**	Page 118 – 119	●	
	Sistema Compact LED	Page 120 – 121		●
Continuous-line luminaires	**E-Line LED**	Page 122 – 123	●	
	E-Line LED IP54	Page 124 – 125	●	

Office	Education	Health&Care	Industry	Shop&Retail	Outdoor
Page 024 – 031	Page 032 – 041	Page 042 – 049	Page 050 – 059	Page 060 – 067	Page 068 – 081
●	●	●		●	
●	●	●		●	
●	●	●		●	
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			●	●	

			TRILUX	Oktalite
High-bay luminaires	**Mirona Fit LED**	Page 126 – 127	●	
	Mirona RL LED	Page 128 – 129	●	
Weather-proof luminaires	**Nextrema G3 LED**	Page 130 – 131	●	
	Araxeon LED	Page 132 – 133	●	
	Duroxo LED	Page 134 – 135	●	
	713··· LED	Page 136 – 137	●	
Light management	**LiveLink**	Page 162 – 167	●	
Post luminaires	**ViaCon LED**	Page 138 – 139	●	
	Lumega IQ LED	Page 140 – 141	●	
	Lumantix LED	Page 142 – 143	●	
Bollards and columns	**ConStela LED Bollard**	Page 144 – 145	●	
	8841 LS LED	Page 146 – 147	●	
	8851··· LED	Page 148 – 149	●	
Wall luminaires	**Skeo Pura LED**	Page 150 – 151	●	
Spotlights and floodlights	**ConStela LED Spotlight modules**	Page 152 – 153	●	
	Lumena Star LED	Page 154 – 155	●	

Office	Education	Health&Care	Industry	Shop&Retail	Outdoor
Page 024 – 031	Page 032 – 041	Page 042 – 049	Page 050 – 059	Page 060 – 067	Page 068 – 081
			•	•	
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			•		
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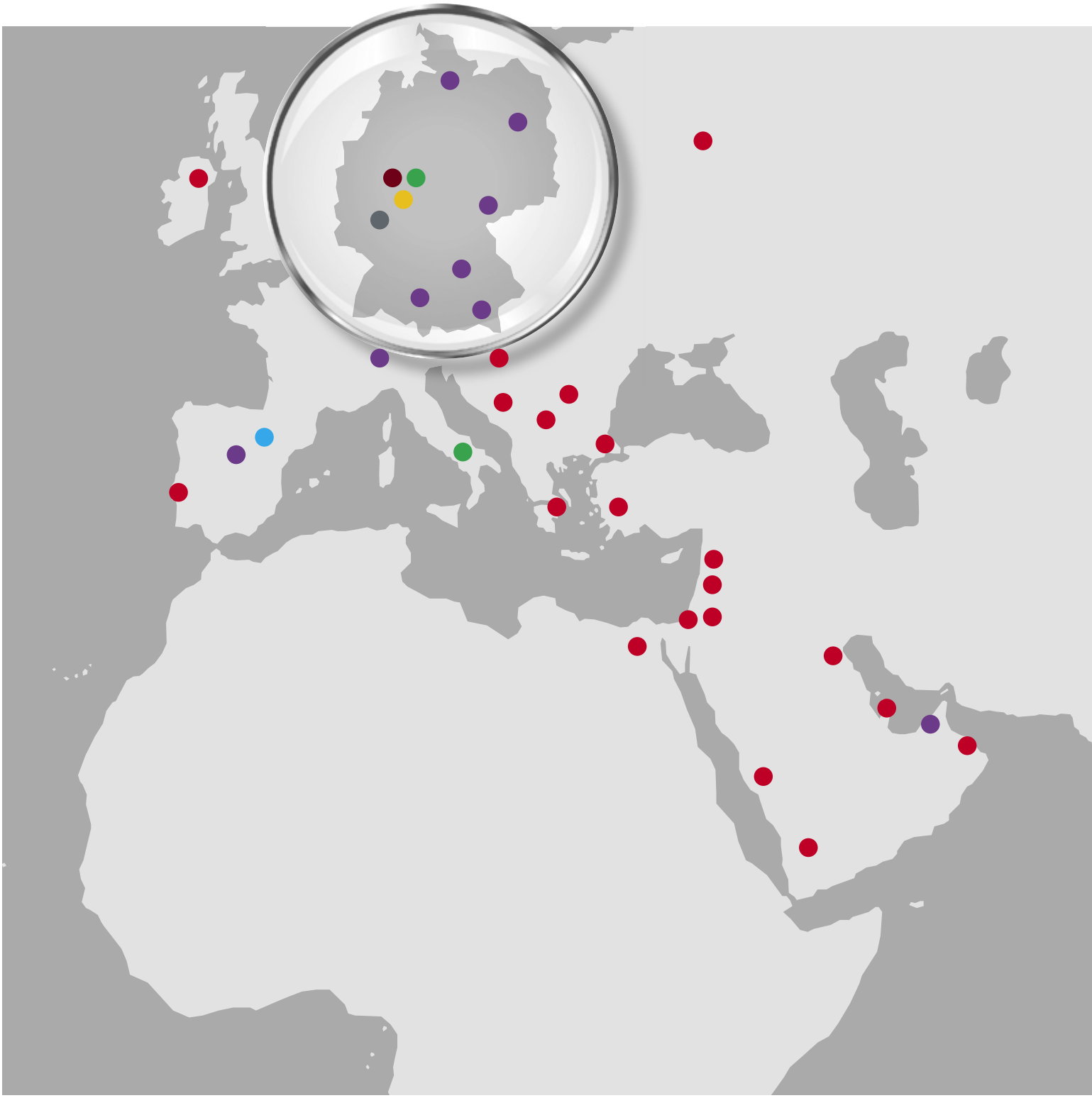

Partners

Sales offices

TRILUX
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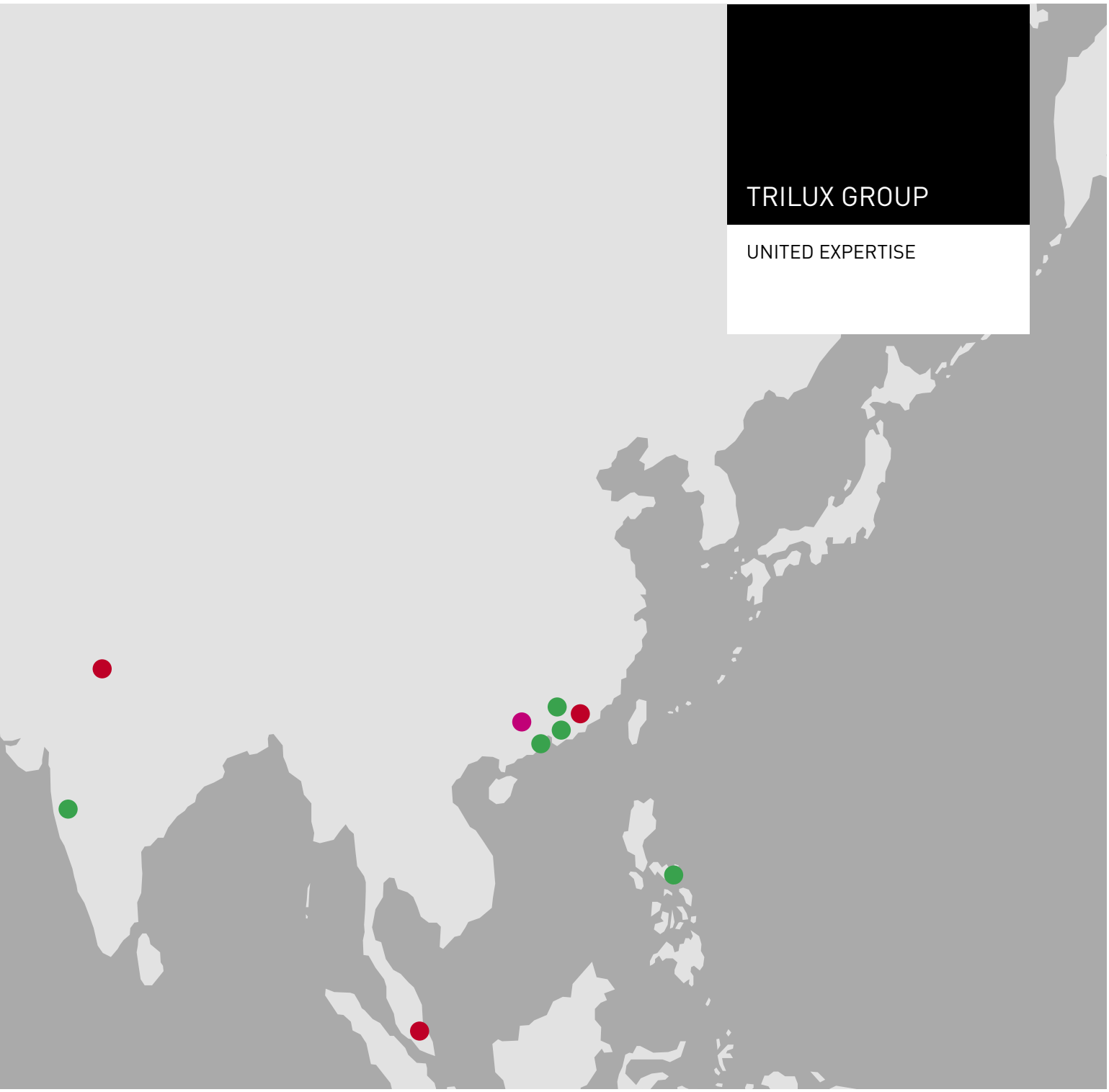


TRILUX GROUP

UNITED EXPERTISE

oktalite zalux light evolution b,a,g, ICT watt24

Established know-how, a passionate commitment and international experience: the TRILUX Group develops efficient, simple lighting solutions for all applications. Ranging from state-of-the-art light and control technology to custom luminaires with a high level of technical and design sophistication. Whether TRILUX and Oktalite as experts for the lighting division, ZALUX and BAG for the division OEM Systems Group or the affiliated companies ICT and watt24 – all work together every day to achieve their aim of making light even more efficient and providing solutions for customers featuring high levels of simplicity. For this purpose the corporate group brings together its research and development expertise under a single roof: the Innovation and Technology Centre (ITZ), a source for new ideas for saleable products. With these innovation-oriented structures, the TRILUX Group is a pioneering partner with a high level of expertise for customers located all over the world.

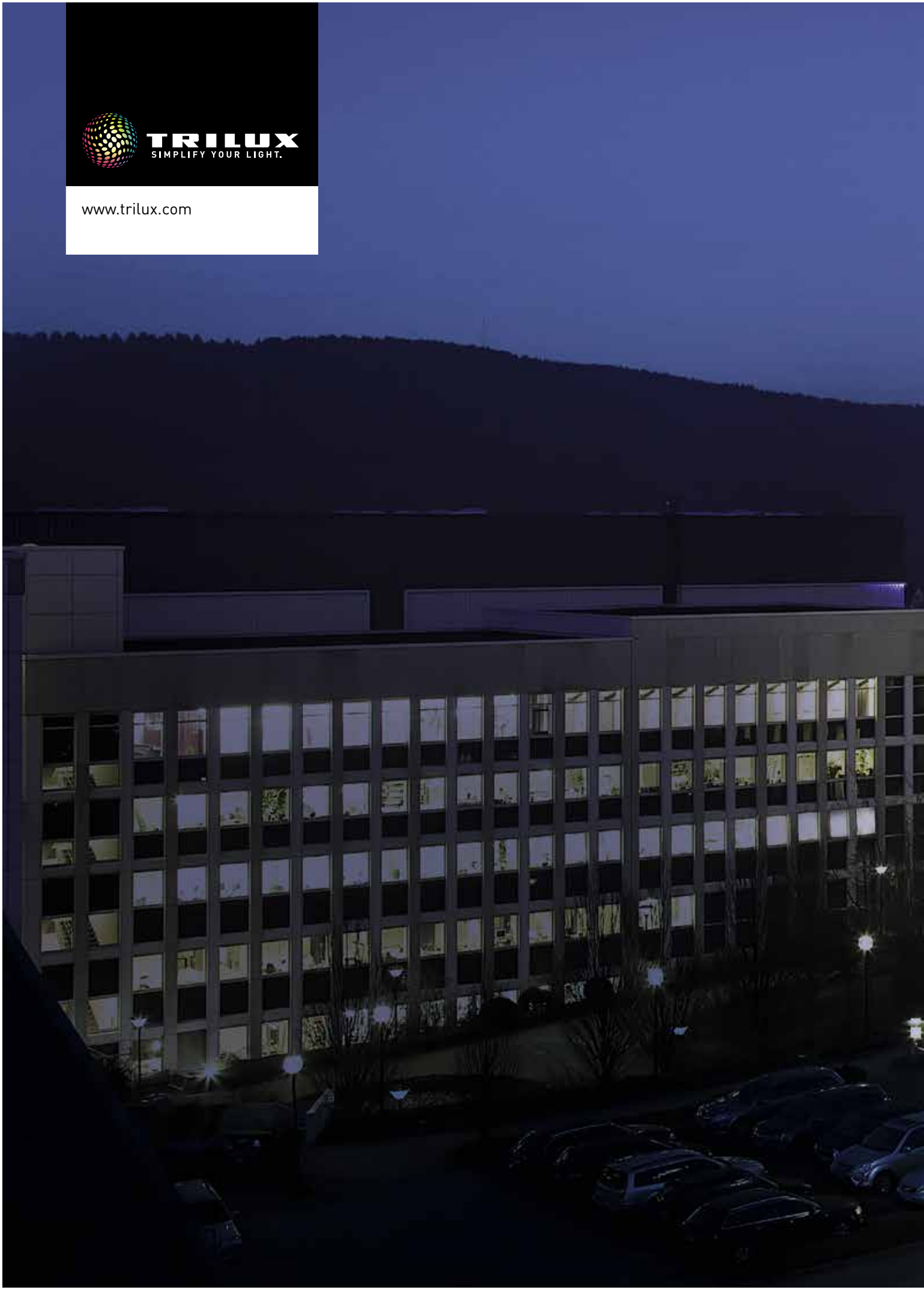
TRILUX GROUP

OUR COMMON BELIEFS
WITHIN THE GROUP

With the merger of various companies TRILUX offers a unique selling proposition on the lighting market. The expertise of lighting specialists creates lighting solutions that meet a wide range of customer requirements. The group also benefits from the active exchange that improves product development and allows realizing unforeseen projects. The combined expertise is the guarantee for light that complies with future requirements.

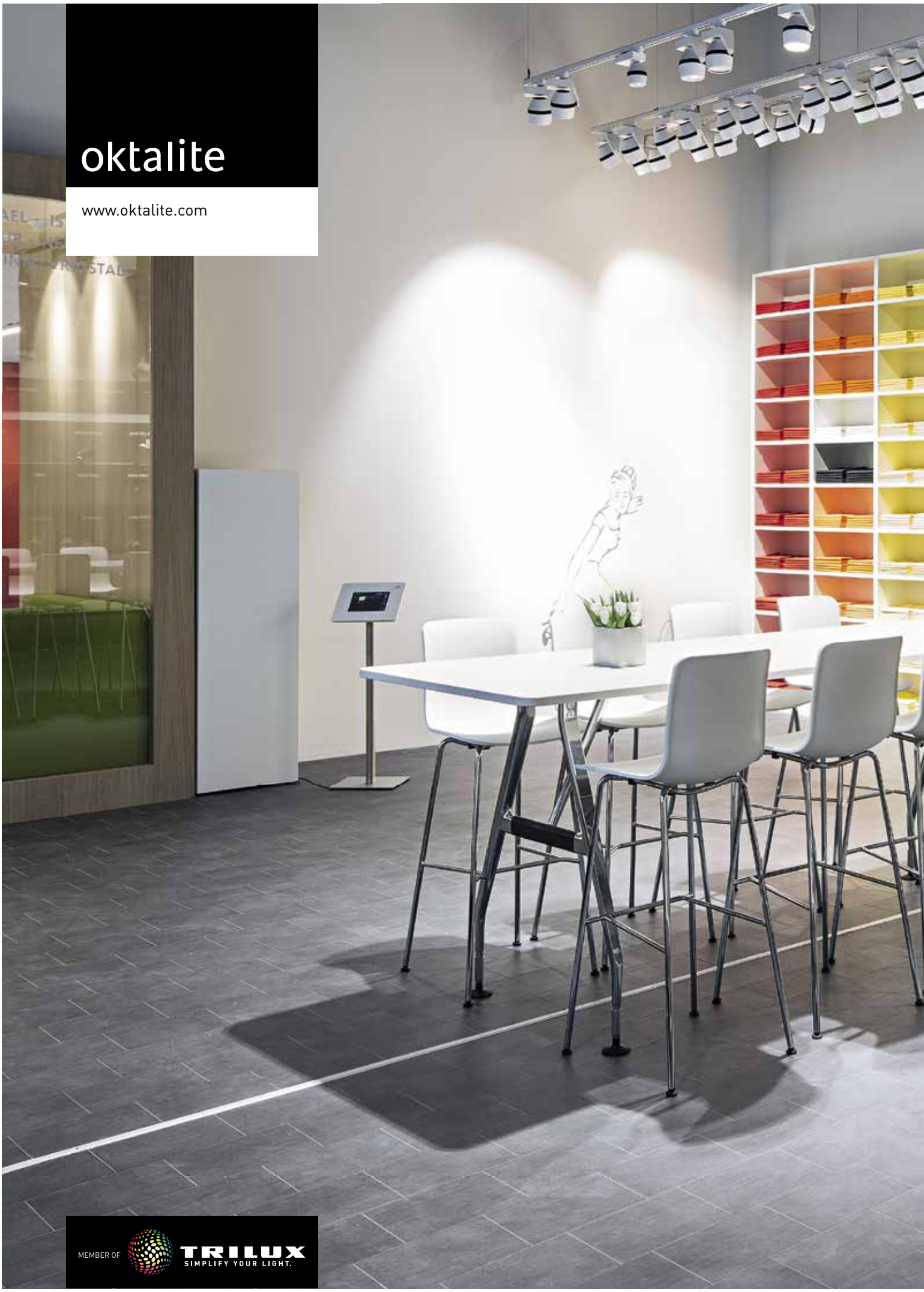
TRILUX
SIMPLIFY YOUR LIGHT.

www.trilux.com



TRILUX has characterised both the history and the future of light for more than 100 years, with the aim of creating artificial light that is just as efficient, diverse and sustainable as the sun itself. TRILUX today offers not only innovative luminaires for indoor and outdoor applications but also perfectly matching lighting solutions for all requirements.

TRILUX SIMPLIFY YOUR LIGHT represents the most simple and reliable path to customised, energy-efficient and sustainable lighting solutions. In the dynamic and ever more complex lighting market, customers are provided with optimal advice, ideal orientation and perfect light. To ensure this, TRILUX offers a wide portfolio of technologies as well as high-performance partners within the TRILUX Group and unites single components to create custom-designed complete solutions – always perfectly matched to customer requirements and specific applications.



oktalite

www.oktalite.com

MEMBER OF TRILUX
SIMPLIFY YOUR LIGHT.

Light is our passion – Lighting can create orientation, draw attention to products and arouse interest. Lighting fascinates because it is able in different ways to encourage us to buy. And exactly that is what has been motivating us and driving us for more than 30 years. Our special field: retail areas. We develop customised lighting concepts, standard and special products and services in line with the market. At the same time we always keep an eye on sustainability and also provide varied LED solutions for optimum and efficient illumination.
As a member of the TRILUX Group we are a full-range supplier: besides the scene setting in the sales area we are able to competently and economically illuminate all of the adjacent areas inside or outside of the building.

ITZ

www.trilux.com

TRILUX Innovation and Technology Centre – Innovations for the success of our customers

Energy Efficiency, Human Centric Lighting, Connectivity – the world of light offers significant opportunities for our companies. The TRILUX Innovation and Technology Centre (ITZ) continually conducts research on the further development of luminaires, their networking as well as the control and effect of artificial light. This results not only in technically advanced components, but also the marketability of products is considerably reduced. The ITZ acts as an independent company and is a central link between the particular business units of the TRILUX group, without affecting the autonomy of the brands. Focusing the core expertise of the technology sectors of electronics, photometrics and mechanics enables the use of stronger synergies for optimal and application-oriented system solutions. By setting up a strategic technology management within the ITZ, market trends and upcoming technologies are identified in good time and can be incorporated into future-oriented product concepts. The basis for successful implementation includes participation in international networks, partnerships, associations and standardisation organisations as well as active participation in research projects. In addition to technology and innovation topics, the ITZ offers central services for the entire TRILUX Group such as project management, laboratories and patent system.

TRILUX AKADEMIE

THEME DAYS
LED SEMINARS
WEBINARS

The TRILUX Akademie provides qualified training events for everyone professionally concerned with light. In addition to many topics dealing with fundamental lighting expertise and electrotechnical aspects, light in practice, lighting design for indoor and outdoor applications as well as efficiency and economy, also theme days, seminars and webinars provide participants with many other facets of lighting.

Seminars which are highly respected in the lighting industry communicate fundamental, practical expertise. Another path to better knowledge are the theme days by renowned experts. The academy also follows new paths with webinars that offer special themes flexibly and with no need to travel.

Participants gain qualifications with all training formats in accordance with their previous knowledge and training targets. To increase learning and training effectiveness, a focus is placed on discussions, interactivity and direct communication between lecturers and participants.


Die Zukunft
liegt nicht
im Dunkeln.

LED: THE COMPLETE PACKAGE HAS TO BE RIGHT

By now, LED technology has established itself in all applications. But which important details should still be considered and which new trends are influencing the lighting sector? Dietmar Zembrot, Member of the TRILUX Executive Board/Technology and Dirk Pietz, Head of Product Management, take a position.

The LED has been causing a highly rapid transition in the luminaire industry for years. How does TRILUX handle this?

Dietmar Zembrot: "We have adjusted to the characteristics of LED technology at an early time, and we also have established sustainable networks with global LED and technology suppliers. Only an ideal interplay between light source, optics, control system and housing provides customers with the optimum product. A particular challenge here is speed. As well as developing around 20 new series each year for the indoor and outdoor sectors, we also equip existing products with the best forms of technology. Our tried-and-tested Nextrema LED weather-proof luminaire is now available in the third generation and offers a performance improvement of 20 %."

How efficient are LED systems by now?

Dirk Pietz: "The luminous efficiency of white LEDs is already approaching 200 lm/W outside of laboratory conditions. When evaluating the complete luminaire though, the efficiency of the optics, the effectiveness of thermal management and the distribution of light intensity must also be considered. Our most efficient LED luminaires such as the E-Line LED and Mirona Fit LED have luminaire luminous efficiencies of over 150 lm/W, and have therefore far exceeded fluorescent lamp luminaires that have luminous efficiencies of a maximum of 75 lm/W."

What exactly is implied with the much-quoted 50,000 hour service life of LED?

Dietmar Zembrot: "That should be seen in a differentiated way, and according to the application, 50,000 hours of course result in different system operating times. In a shop application with an assumed 12 hours of burning time per day and 305 sales days, 50,000 hours service life means around 14 years of luminaire life. In the office area, with an average burning time of around 11 hours daily and about 250 work days, this means approximately 20 years of carefree lighting."

How can customers evaluate the service life specifications of the various manufacturers?

Dirk Pietz: "There are indeed critical differences in terms of luminaire quality and requirements placed on luminaires. The service life depends strongly on the reduction of luminous flux that determines the end of the lifespan. Since the end of 2015, we fundamentally document the rated service life for LED luminaires in a form that was recommended in an agreement between luminaire producers organised within the ZVEI. Here the value is specified to which the luminous flux of a luminaire (or statistically: a large group of identical luminaires) is reduced to at the specified time with reference to their rated luminous flux (in new condition), for example L80 = 70,000 hours. The number after the "L" (e.g. L80 or L70) specifies the degradation to be expected at the end of the rated service life, which should be taken into account when calculating the maintenance factor in photometric planning. Specifications for rated service life with regard to various degradation values can be converted."

It all sounds quite complicated...

Dirk Pietz: "No, not at all. TRILUX offers customers an online calculator to simply convert the rated service life, for example from "L80 = 70,000 h" to the rated service life "L85 = 50,000 h" while considering the specific ambient temperature.

Speaking of degradation, in several products TRILUX incorporates Constant Light Output Technology – what are the advantages of that?

Dietmar Zembrot: "With increasing operating periods, luminaire luminous flux decreases even with LED luminaires. This operationally-dependent degradation must be taken into account during planning so that illuminance does not fall below specified guidance values after a specific duration. It is for this reason that the lighting system is originally designed for higher illuminance levels. With Constant Light Output Technology we counteract the degradation-related loss in luminous flux, and keep the luminaire luminous flux constant over the complete service life by successively increasing the current value. This makes a higher system configuration due to degradation unnecessary and reduces operating costs."

LEDs revolutionised the lighting sector several years ago – when will the next revolution take place?

Dirk Pietz: "The next revolution is already happening – and it's all about Connectivity. Intelligent systems with high-quality sensor technology and highly efficient luminaires enable smart, convenient and energy-efficient lighting which can be matched precisely to on-site conditions or the user."

How does this show in the various applications, and what are the specific benefits?

Dirk Pietz: "This can be explained ideally with the example of an office. In tomorrow's office environments, both communication and individual work will have high meaning. Luminaires in a room adapt to the lighting needs of the individual user. Colour temperatures change at individual workstations but the general room impression stays the same and also possibly follows the natural course of daylight. Individually controlled Human Centric Lighting is the term to remember, and offers maximum lighting convenience for users. Users save their own personal light profiles via smartphones and the lighting installation detects these and matches them to the specific person."

How is TRILUX supporting customers during this transition in technology?

Dietmar Zembrot: "In this matter, we are also thinking in terms of Simplify Your Light, and we accompany our customers into the networked future of light. Our LiveLink light management system provides the complete benefits of connectivity but without its complexity. With LiveLink, our customers also benefit from the further advantages of networked solutions such as consumption data recording (monitoring), predictive maintenance and cloud connections, especially for the industrial sector."

What do your information strategies look like in terms of LED? Or put another way: Are TRILUX customers up-to-date?

Dietmar Zembrot: "True to the idea of Simplify Your Light, we support customers with extensive information, tools and know-how across all communication channels – meaning direct discussion, online, print and mobile. The aim is always to provide customers with access to the relevant content as simply and pleasantly as possible. Because of the rapid developments in the LED sector, the requirements for individualised lighting solutions are becoming increasingly demanding. In our international academy we communicate the latest technical knowledge about LEDs as part of theme days, seminars and webinars – this enables customers to ideally exploit the possibilities being created by the new products and applications.

How does the future development of LED technology look like?

Dietmar Zembrot: "Well, of course we are also placing our trust in the outstanding innovation and growth potential of this technology. We operate according to the motto of "class instead of volume", and continue to improve both efficiency and cost-benefit ratios before new LED solutions are launched into the market. We also do our background homework and work in initiatives such as Zhaga as well as association work such as Lighting Europe, with the aim of developing and establishing common industry standards for LED applications. We have also decided to take part in Philips Electronics' LED license luminaire programme to utilise basic technologies for the modification of light intensity and colour with LED luminaires – this means that our customers continue to benefit from products featuring state-of-the-art technology."

OFFICE

LIGHT AS A FACTOR FOR SUCCESS

Light in focus, performance in mind

Modern, contemporary office lighting is certainly no luxury but an important corporate tool to reduce costs and increase the performance capability and well-being of employees. In addition, luminaire design is a central creative element enabling the expression of corporate identity. The wide spectrum of TRILUX lighting solutions for the office sector not only fulfils all normative requirements – it also provides a new financial, functional and creative scope. Light management systems such as LiveLink can be optionally integrated to optimise cost savings and enable individualised light for each employee.

Benefits of TRILUX LED luminaires in offices
Energy efficiency: When energy-efficient LED lighting solutions are combined with light management, operating costs can be cut by up to 85 % when compared to conventional solutions.
Light management: High-performance sensors and the LiveLink light management system ensure minimum levels of energy consumption.
Human Centric Lighting: The selection of light quality, colour and intensity influences the ability to concentrate and perform as well as levels of well-being.
Individual light scenes: Light management systems enable optimum visual conditions to be set at the press of a button for any office situation.
Corporate identity: Light impact and luminaire design are an expressive component of the corporate identity. Many TRILUX solutions have won awards for their designs, for example the Red Dot Award and iF Design Award.

EXECUTIVE OFFICE

Not only the boss but also the light in an executive office should be exemplary in terms of intelligence, efficiency, flexibility and radiance. State-of-the-art lighting solutions can be flexibly set to various visual tasks, e.g. concentrated work on computer screens, employee meetings at conference tables or pleasant atmospheres for important customer visits. The Lunexo LED (page 110) features extremely pleasant quality of light, enables individual light settings and blends ideally into prestigious surroundings thanks to its discreet design. The Lateralo Plus LED (www.trilux.com/lateraloplus) also achieves optimum room illumination and an attractive light impact thanks to its unusual design.

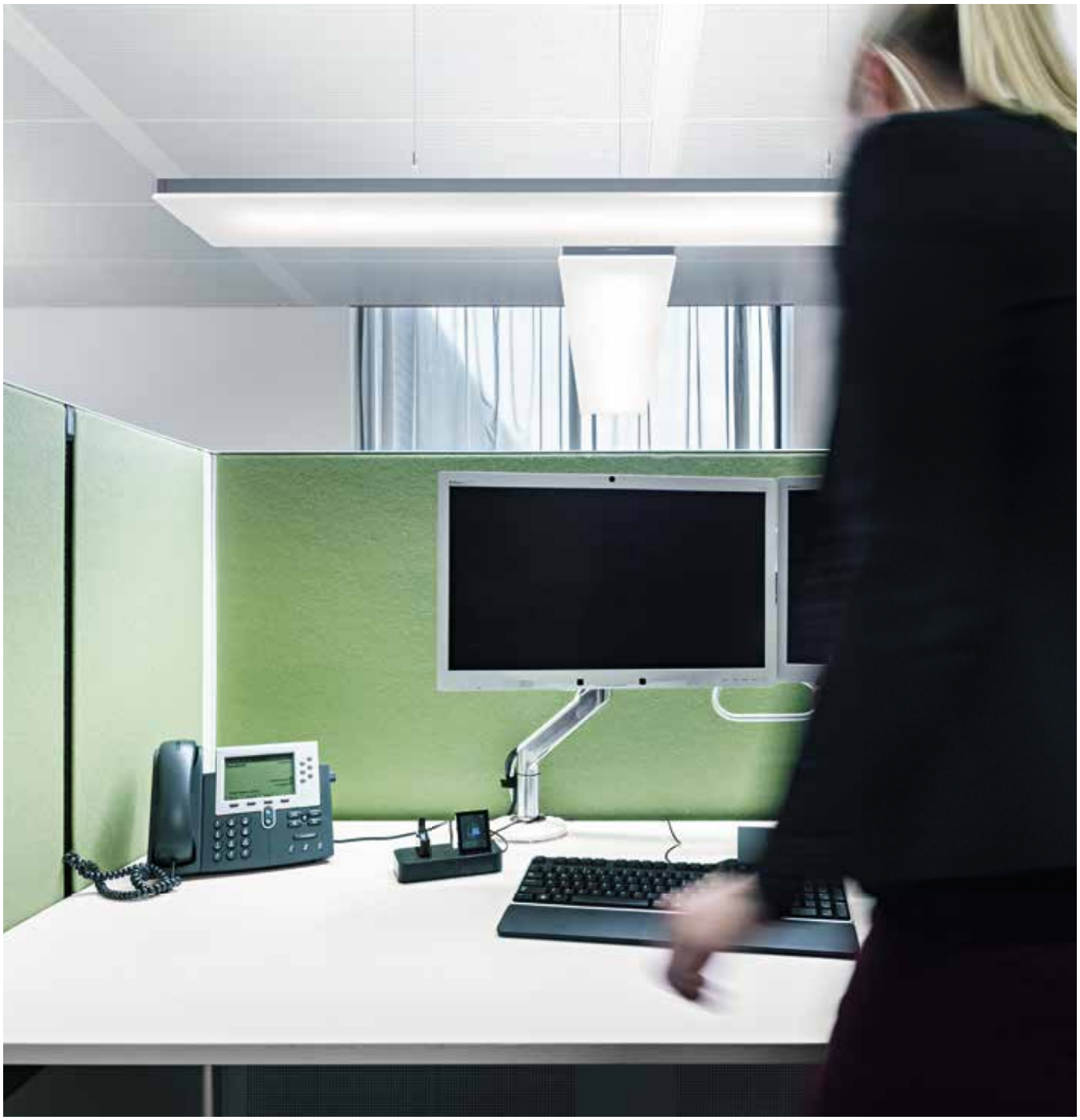
OPEN-PLAN OFFICE

Teamwork is a major focus in open-plan offices. At the same time, employees carry out their own individual tasks at their desks. Intelligent lighting solutions allow lighting conditions to be individually adapted to the needs and preferences of each single user – without losing sight of the overall situation. Controlling workstation lighting is possible for example with pre-saved light scenes, enabling each employee to set his own personal light for well-being via a smart device. The Arimo CDP-X LED (page 104) ideally fulfils the needs of open-plan offices with its wide range, individualised appeal and high quality of light. Also ideal is the continuous line-capable Solvan Flow LED (page 108), emitting especially pleasant light thanks to direct/indirect light distribution.

CONFERENCE ROOM

Conference rooms are the most multifunctional rooms of any office area. They host relaxed meetings and creative brainstorming, multimedia presentations and workshops with flip charts. The Inplana/Onplana LED (page 82) features a high quality of light with a purist design. Active versions provide the right light ambience according to the occasion. If a more unusual design is called for, the Lateralo Ring LED (www.trilux.com/lateraloring) offers optimum room illumination with an attractive light dynamics. 74 R LED wall and ceiling luminaires (page 112) available with decorative attachments in differing versions, colours and designs give offices a comfortable atmosphere.

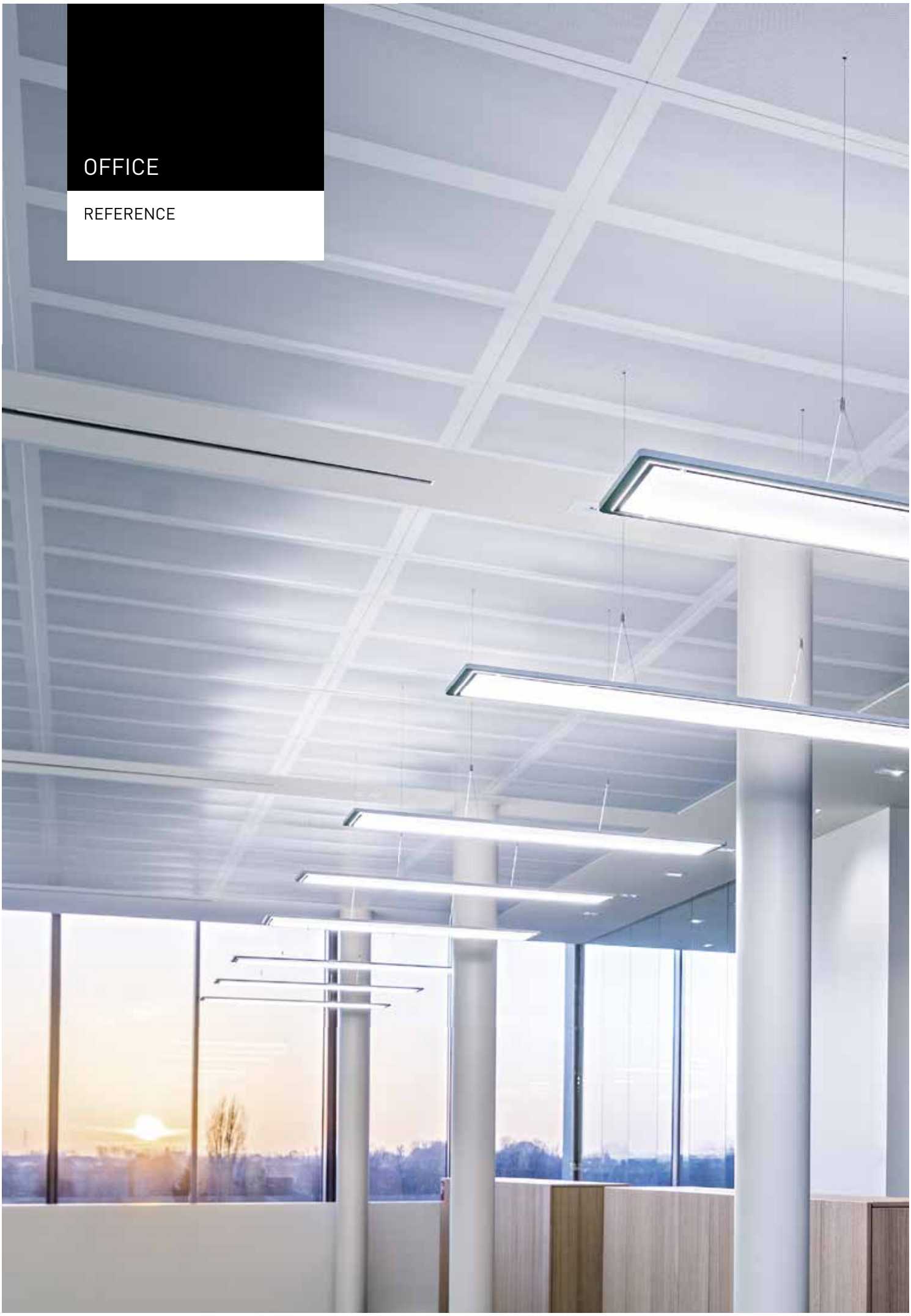
2-AXIS OFFICE



Small but impressive, at least in terms of lighting: in standard offices, positively motivating light atmospheres and optimum visual conditions are highly important for glare-free, concentrated work at desks and screens. Smaller offices benefit particularly from flexible lighting solutions that blend ideally into the architectural surroundings without dominating the space. It's here that the Lunexo LED (page 110) comes to the fore with extremely pleasant quality of light, a purist design and completely individual light settings. Or else the high-efficiency, timelessly elegant Belviso LED (www.trilux.com/belviso).

OFFICE

REFERENCE



First transparency, then light

The new construction of an office storey for the Crop's deep-freeze fruit and vegetable producer in the Belgian town of Ooigem is all about the character of the architecture. High-quality LED technology from TRILUX, more precisely TRILUX Lateralo Plus LED, was specified in accordance with the clear, modern design of the building. This luminaire is an architect's dream – purist, transparent and free of cables. Its minimised design gives it a floating appearance and ideally complements the architecture of the office penthouse with its generous fenestration, clear lines and muted colours. Simultaneously, the LED system generates high-lumen output, glare-free light for optimum lighting comfort at computer screen workstations.

In switched-off state the light optics has a transparent appearance for observers because the LEDs are integrated into the edges of the luminaire. The light itself is distributed across two levels thanks to innovative prismatic technology, and when switched on the luminaire emits both direct and indirect glare-free light at a ratio of 50:50. The light optics then appears white. Indirect light flatters objects with soft shadows and the direct light ensures very good visual conditions for work at desks and on computer screens.

The transparent, weightless look of the suspended LED luminaire is emphasised with a design without power cable – power feed to the luminaire is via the filigree wire suspension. "Die Lateralo Plus LED inspires with its consistent purism," stated Willem Dammers, Managing Director of TRILUX BENELUX. "Aesthetics and functionality come together – our claim of Simplify Your Light shows itself from its very best side."

Crop's already uses TRILUX products in its manufacturing areas. Highly-robust Nextrema LED luminaires have been installed in a large freezing facility with extreme ambient conditions. These positive experiences contributed to Crop's once again taking the decision for TRILUX with its new office complex – this time the 9,100 lm version of the Lateralo Plus LED. With a luminous efficiency of 101 lm per watt, the ultra-flat suspended LED luminaire features high energy efficiency and a nominal service life of 70,000 operating hours on average.

CROP'S N.V., OOSTROZEBEEKSTRAAT 148, 8710 OOIGEM, BELGIUM

In short
Construction project: New construction of an office storey
Luminaires: Lateralo Plus LED

EDUCATION

TOP OF THE CLASS
IN LIGHTING

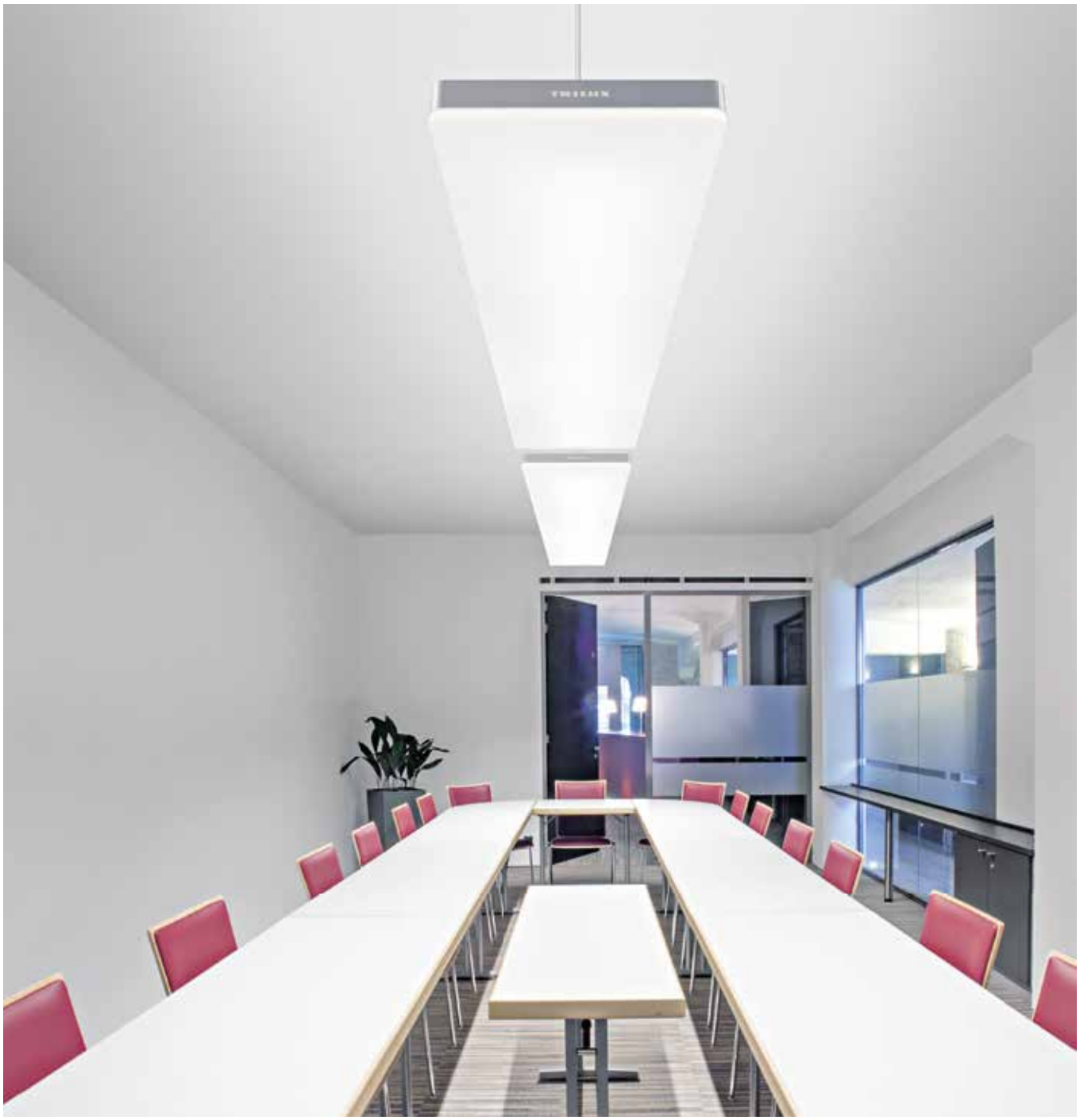
Intelligent light for schools,
universities and training facilities

Whether it's primary school, secondary school, vocational college or university: educational establishments decisively determine the stages of growing up. Creating best development conditions at these locations is therefore a direct investment in the future. Contemporary lighting focuses on the diverse needs of pupils, students and teachers. TRILUX offers ideal solutions for the complete spectrum of educational applications. Pupils and teachers benefit from ideal lighting. TRILUX LED luminaires support concentration in classrooms, improve visual comfort at computer workstations, ensure safety and orientation in corridors and create pleasant atmospheres in halls such as cafeterias and auditoriums. TRILUX LED luminaires are also winning from an operational point of view – they protect both budgets and the environment with low power consumption and low maintenance costs. With intelligent sensor technology and light management systems such as LiveLink, changing conditions such as daylight levels, learning situations and presence can be taken into account. This saves further energy and optimises the lighting.

Benefits of TRILUX LED luminaires in educational facilities
Economic solutions: Together with a light management system, energy cost savings of up to 85 % are possible compared to conventional lighting installations.
Planning reliability: High quality and consistency with colour rendering as well as simple, rapid installation allow for easier planning and commissioning.
Intelligent light: Sensors and light management systems enable many luminaires to be more precisely matched to on-site lighting requirements.
Light is effective: With the Active lighting solutions from TRILUX, light colour can be varied from stimulating cool white light to more calming warm white light.

Specialist classes such as in chemistry or physics rooms and manual training rooms have particularly diverse lighting requirements. The learning situation often changes – if an experiment takes place at the teacher's desk, light must ensure that details can still be clearly seen in the back rows. If pupils carry out their own tests or make notes, pleasant lighting conditions must be available at each work desk. Light must also be dimmable if media or certain testing instructions specify darkness. Flexible lighting solutions are needed that also supply high quality of light. These are ideal preconditions for the completely continuous-line-capable Coriflex LED (www.trilux.com/coriflex). The Arimo MRX LED (page 106) also provides ideal conditions for use in specialist classes thanks to outstanding efficiency and various mounting methods.

Classrooms are the centre of learning mainly for primary and secondary school-level pupils. They spend a major part of the school day in these for writing, discussing, reading, doing exams and holding presentations. Sometimes full concentration is needed, sometimes peace and quiet and at other times activity – by both pupils and teachers. State-of-the-art lighting solutions support pupils and teachers not only with pleasant light but also with their specific light impact. For example the purist, continuous-line-capable Solvan Flow LED (page 108), the asymmetric version of which is ideal for whiteboard lighting. The Belviso LED (www.trilux.com/belviso) ensures highly uniform general lighting in the classroom.



Schools and colleges are not only places of learning but also the workplace of training staff, teachers and administrative employees. Lighting solutions have to match the highly diverse activities and tasks in their "territory", ranging from concentrated computer screen work, correcting and reading to conferences, individual meetings and even relaxed breakfast breaks. The Lunexo LED (page 110) with completely individual light settings meets such varied lighting requirements. The ArimoS CDP LED (page 104) available in a range of versions features high quality of light thanks to uniform illumination.

Even though most pupils notice school corridors only ‘in passing’, long hallways determine the character of many educational establishments. They are a place for waiting, walking and even running. Reason enough to install the right lighting solution for both safety and a pleasant ambience. The LC67 LED light channel system (page 118) achieves light lines without dark spots and can also follow corridors and hallways around corners. Robustness, zero maintenance and efficiency are also important for operators because of the often considerable lengths of many corridors. Ideal preconditions for the redesigned classic 74 Q and 74 R LED (page 112), ensuring energy savings thanks to sensor versions as well as pleasantly planar, uniform light.

Lighting requirements for sports halls are usually fundamentally different from the rest of a building. Challenges include flying balls, less frequent cleaning intervals, high ceilings, large surfaces, partly reflective floors and the highly fluctuating ingress of daylight. Despite these factors optimum visual conditions must exist all over, simply due to safety reasons. This also applies to dim or dark evening hours when many halls are used by sports clubs. Standard-compliant lighting with pleasant glare reduction is provided by the Actison LED (www.trilux.com/actison). The combination of height and large surface quickly leads to matters of costs for hall lighting. TRILUX LED solutions ensure both ideal conditions for sport and low operating costs, mainly due to high energy efficiency. The Mirona Fit LED (page 126) with several lumen packages and optics also enables a two-to-one replacement of conventional luminaires, and is ideal for refurbishment projects.

EDUCATION

REFERENCE

An all-round success

Bringing the demands of heritage protection into unison with the requirements of modern technology is often challenging. As a consequence, it is even more gratifying when a lighting concept gains the spontaneous blessing of the authorities – as happened at the Märwil kindergarten (district of Thurgau, Switzerland), equipped with LED systems from TRILUX.

With refurbishment of the listed building, a focus was placed on acknowledging a sensibility for the historic surroundings, especially when specifying suitable luminaires. At the same time though, efficiency and lighting comfort were to be significantly improved. "There was an urgent need to take action in a room with a dark, open wooden ceiling because this area in particular was poorly lit," remembered the preschool teacher Nadine Mosimann. The Lateralo Ring suspended LED luminaire was able to fulfil all points in the requirement profile. "The delicate design of the luminaire looks really stylish and doesn't overwhelm the room," continued Nadine Mosimann. An all-round success.

Visually more discreet but just as ideal, the ultra-flat ArimoS D CDP LED blends into a panelled ceiling with square grid structures at another location in the building. With its planar light the luminaire creates pleasant, glare-free visual conditions. The third luminaire in the team was the Polaron IQ LED, the surface-mounted version being installed as wall luminaires. Its indirect light emission and appealing design create pleasant accents in the changing rooms and traffic areas.

"Now everything's really great," said a pleased Nadine Mosimann. "Every room now has attractive, bright light." As a result, the times when insufficient lighting levels and cool white light depressed the moods of both children and teachers are finally over. And since the LED systems are dimmable, pleasant atmospheres can also be created in accordance with specific occasions.

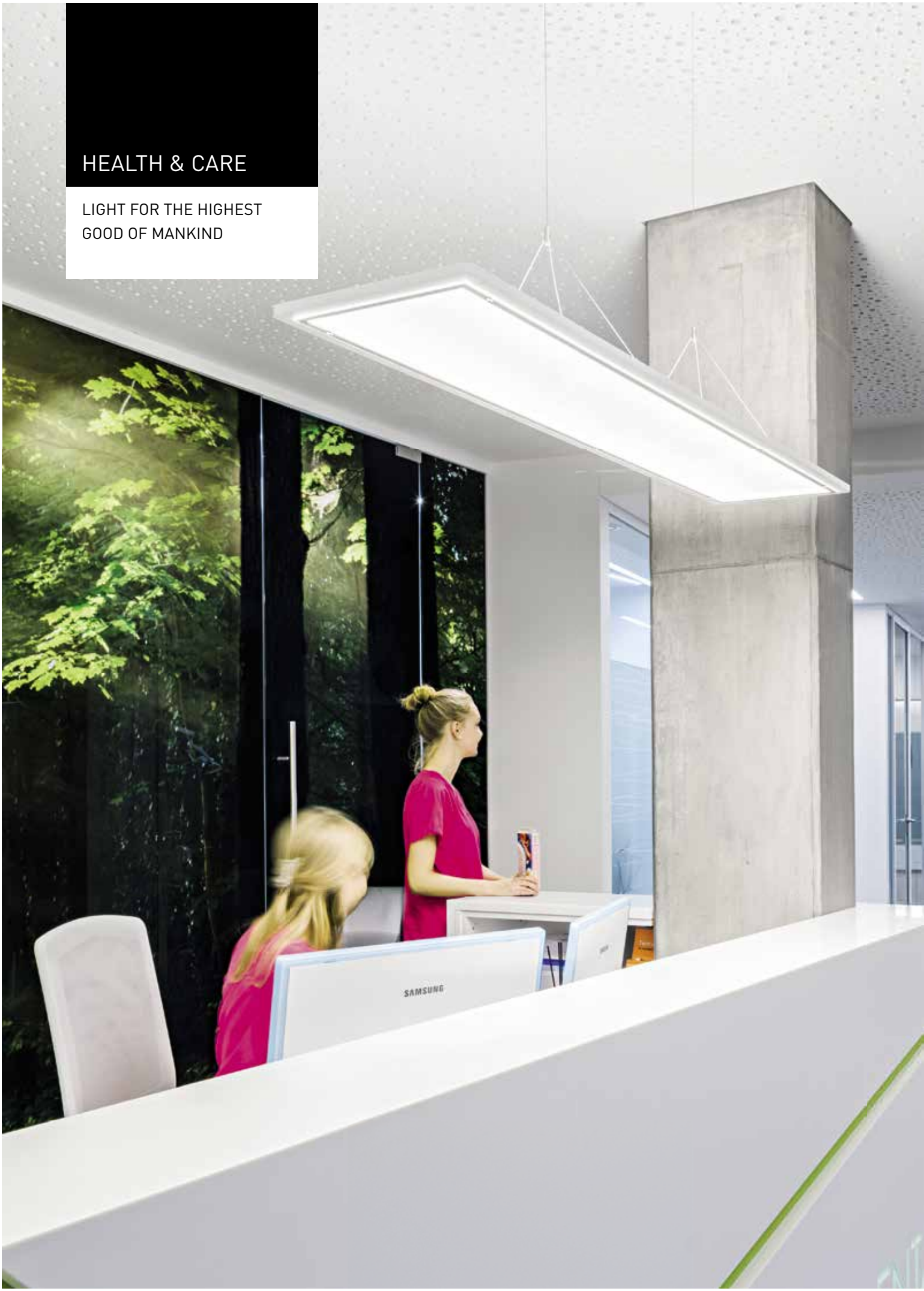
Upgrading to LED has reduced the connected load by 25 % while significantly increasing luminous intensity and visual comfort. The last factor is particularly important for some of the children at the facility in Märwil – they suffer from impaired vision. A customised lighting concept makes the lives of the affected young ones significantly simpler. This is another example of how TRILUX implements its brand message of Simplify Your Light in practice: customers can always be sure of optimum lighting solutions and simple processing from the lighting specialists.

A HERITAGE-PROTECTED KINDERGARTEN WITH TWO DAYCARE GROUPS

In short
Building owner: PSP Regio Märwil primary school community, Switzerland
Lighting design: TRILUX
Luminaires: Lateralo R, Polaron IQ WD1 + WD2, ArimoS D CDP

HEALTH & CARE

LIGHT FOR THE HIGHEST
GOOD OF MANKIND



A focus on health: TRILUX LED lighting solutions

A calm, pleasant atmosphere in patient rooms, safety in corridors and glare-free computer workstations – there's hardly any application placing so many different and challenging demands on lighting as hospitals and doctors' practices. Requirements often exist in addition to high quality standards, e.g. concerning hygiene or special patient protection. When it comes to something as important as human health, people and technology must interact as professionally and problem-free as possible. Lighting contributes here as well – light can be stimulating or calming, support concentration or positively influence sleeping rhythms. Human Centric Lighting thereby supports the recovery and healing process as well as levels of well-being. LED solutions and light management from TRILUX create ideal framework conditions for medical personnel and patients, enabling them to concentrate on what is essential – health.

Benefits of TRILUX LED luminaires in the health sector
Individual effect: RGB LED and white-white LED solutions enable lighting concepts to be implemented with light effects individualised for each area.
Reliability for operators: TRILUX LED solutions are highly durable with low maintenance.
Contribution to patient health: Human Centric Lighting is able to support the recovery process.

Optimum visual conditions achieving high levels of safety and orientation are especially required by patients with limited mobility or vision. For many older people it is also a challenge to find their way around in hospitals. An intelligent lighting solution completely complies with such needs and provides a lot more: it emits high-quality and simultaneously glare-free light to protect the eyes of patients when being transported horizontally, and despite brightness creates a pleasant atmosphere instead of appearing cool and sterile. Light lines without disturbing dark spots for pleasant light effects are created with the LC67 LED (page 118). The Active variant of the redesigned classic 74 Q and 74 R LED (page 112) enables biologically effective lighting concepts to be realised.

RECEPTION AREAS, WAITING ZONES AND RELAXATION ZONES

In reception areas, waiting zones and recreational areas, light must primarily give patients and their relatives a feeling of being welcome with a pleasant ambience. The Polaron IQ LED (www.trilux.com/polaroniq) is the ideal choice with its purist design and wide range of versions, in turn providing maximum planning flexibility. At the same time, optimum working conditions must be created for people active in these areas. For example while entering patient data into a computer or coordinating appointments. The Inplana/Onplana LED (page 82) provides pleasant light atmospheres in such applications, as well as standard-compliant lighting in accordance with UGR19. In recreational areas for patients with special needs, e.g. those suffering from dementia, Human Centric Lighting can also contribute significantly to well-being by supporting the waking-sleeping rhythm, for example with Active versions of the Inplana/Onplana LED (page 82).

Patient rooms are the main place of stay for most patients – visitors are received and hectic hospital life stays outside. It is also the place where patients are supposed to recover. This process is supported by a restful atmosphere, created for example by the pleasantly planar, uniform illumination of the 74 Q and 74 R LED (page 112). Its Active version also features biologically effective light to support the recovery process. In addition to room dimensions and furniture, the lighting also significantly contributes to how a patient room appears. Added to this is a second requirement of light, because staff working in such surroundings need good visual conditions for nursing and examinations. The high-efficiency, timelessly elegant Belviso LED (www.trilux.com/belviso) features optimum quality of light for both requirements.

Diagnosis is often a matter of details – what colour is a skin change, are wound surroundings reddened, how do wound margins appear... Absolute precision is needed with all examination and treatment activities, ranging from taking blood to closing lacerations. This in turn places high demands on the lighting conditions in treatment rooms. The Arimo CDP LED (page 104) features high quality of light and completely uniform illumination for such applications. The Sanesca LED (www.trilux.com/sanesca) is ideal for positioning above treatment tables, preventing glare for patients, doctors and care personnel.

HEALTH & CARE

REFERENCE

Next relamping: 2035

An organic design, much glass and bright light – the architecture of the Mariëndaal Centre of Excellence (MCE) in the Dutch town of Arnheim features a high degree of openness and space, and this impression needed to be further emphasised with the lighting. "The customer wanted very bright lighting with luminous flux of 3,000 lm for the employee restaurant that has ceiling heights of up to seven metres," remembered Willem Dammers, Managing Director at TRILUX BENELUX. In terms of the market, these conditions at the time of order placement could only be met by TRILUX.

TenneT employees now enjoy the pleasantly glare-free light of Inperla Ligra Plus LED at their tables. In the corridors these downlights also guarantee optimum illumination, as the series features a variety of different luminous flux levels and beam angles. "Whether corridor, stairway or the extremely high ceiling in the restaurant – we were able to meet highly diverse lighting needs with a single product range. That's an integral part of Simplify Your Light," explained Willem Dammers. "And at the same time we managed to achieve a uniform look throughout the building."

The MCE bears the seal of 'Bewuste Bouwers', roughly translated as 'responsibly acting construction authorities'. The seal distinguishes buildings focusing on the environment and sustainability from the building phase across its complete lifespan. The high-performance LED lighting from TRILUX underlines this claim, being exceedingly energy-efficient, durable and therefore also resource-friendly. That also pays off at another level. The light sources need only to be very infrequently replaced – a genuine benefit with such high ceilings in a carefully designed employee restaurant. "The next relamping is expected for 2035 based on a service life of 50,000 hours," said Willem Dammers. In everyday use this corresponds to an 8-hour operation of luminaires, five days a week.

MARIËNDAAL CENTRE OF EXCELLENCE

In short
Construction project: New construction of headquarters
Luminaires: Inperla Ligra Plus LED downlight

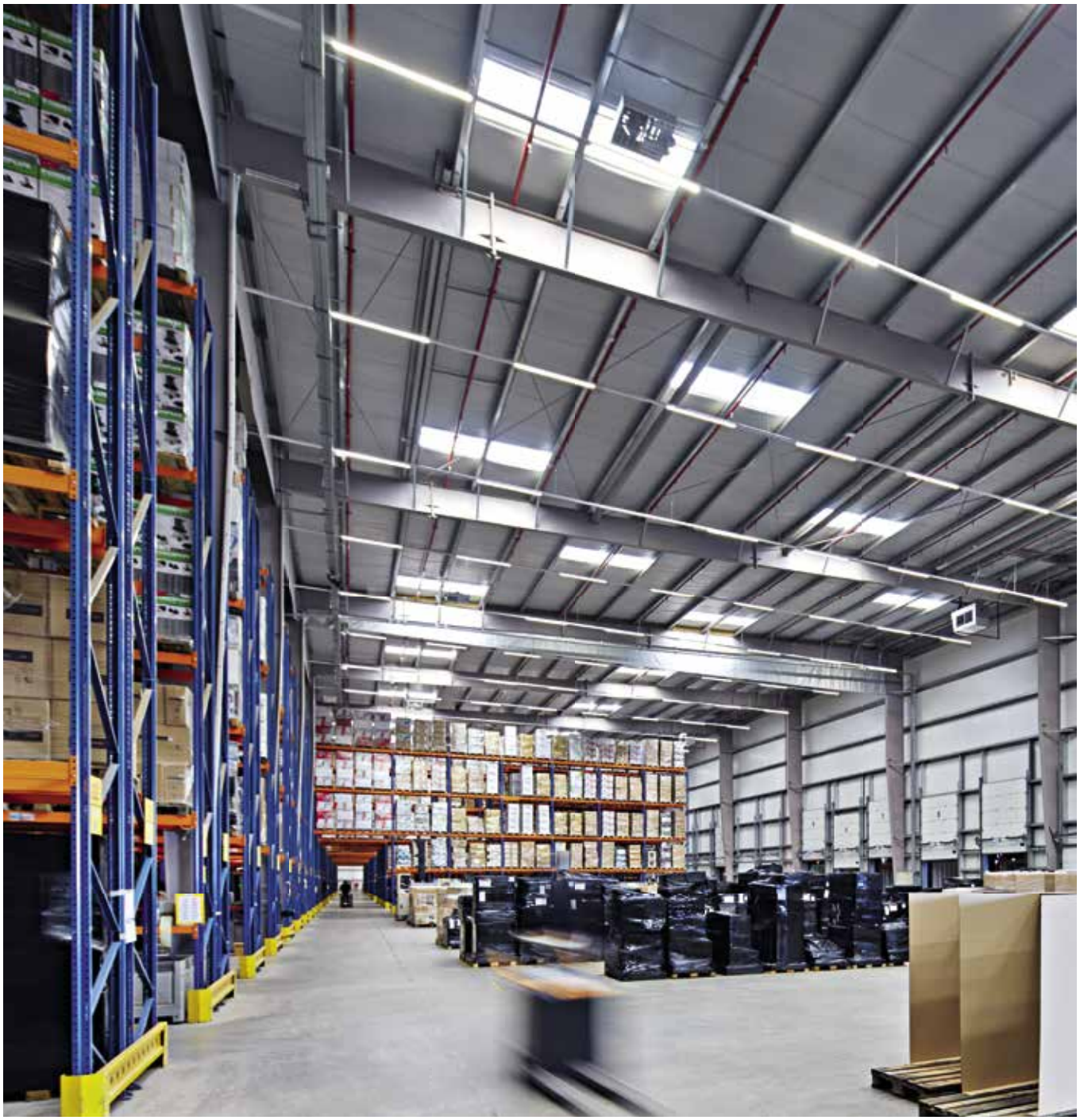
INDUSTRY

EXTREME CONDITIONS
DEMAND SPECIALISTS

Business locations in best light

The industrial sector places the highest demands on lighting solutions. A central criterion for selection across all branches is the level of economy, and it is here that TRILUX luminaires feature outstanding energy efficiency and above-average service life. Energy costs can be cut by up to 85 % when upgrading a conventional lighting solution to LED in combination with light management. According to the specific application, luminaires must often also withstand extreme conditions, e.g. high levels of dust, heat, cold, humidity and vibrations – as well as emitting precisely the right light everywhere. Added to this is the demand for high reliability over many years, as nobody wishes to stop production just because the highbay lighting at a height of 15 metres fails. Becoming increasingly popular: sensor-controlled lighting solutions in turn controlled by a light management system, for example the TRILUX LiveLink system – this increases flexibility and quality of light and enables further reductions in operating costs.

Benefits of TRILUX LED luminaires in industry
Low operating costs: maximum economy from energy-efficient LED technology
Almost no maintenance: optimised thermal management for long service life
Diverse product portfolio: individualised lighting solutions for all industrial applications
High-performance lighting technology: perfect illumination due to high lumen packages of up to 52,000 lm
High quality of materials: robust, high quality components
Intelligent control: optional LiveLink light management system for energy-efficient lighting according to needs

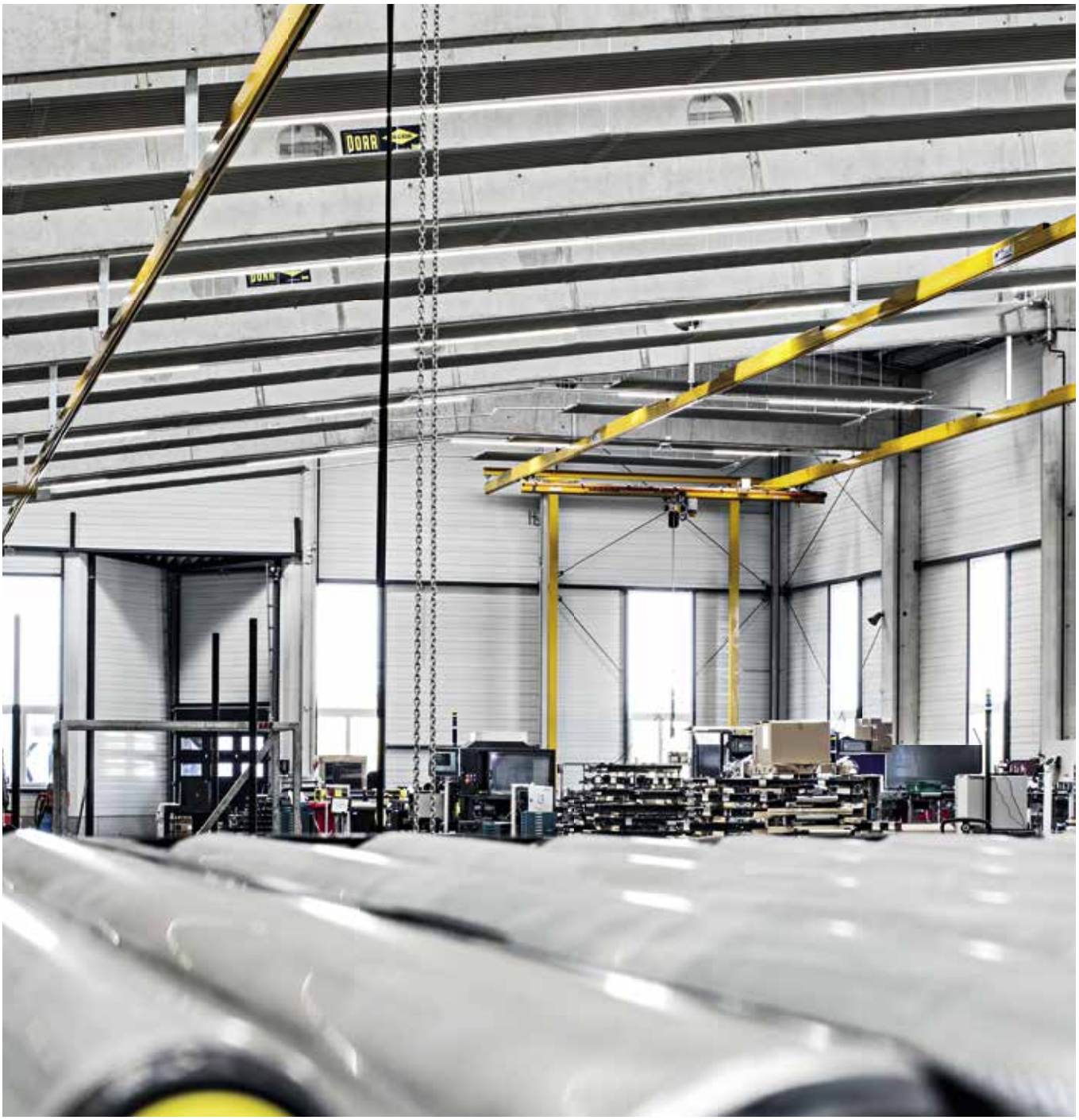


Warehouses are usually large, windowless buildings with high roof constructions and narrow aisles, equipped with highbay racking right up to the hall ceiling. In such applications, TRILUX lighting solutions ensure perfect visual conditions and safe working conditions. Ideal for warehouses are narrow distribution reflectors with high glare limitation, as found in the extensive range of high-efficiency E-Line LED luminaires (page 122). The Mirona Fit LED (page 126) is also ideal for illuminating warehouses – its high light output 52,000 lm version even enables two-to-one refurbishments of conventional systems.

In addition to the usual industrial requirements for high energy efficiency and service life, lighting solutions in cold stores must also be designed for continuously reliable operation in low temperatures and humidity. The 150 lm/W highly-efficient Nextrema G3 LED (page 130) or the IP54 version from the extensive E-Line LED range (page 124) are ideal solutions for this application.

FOOD INDUSTRY

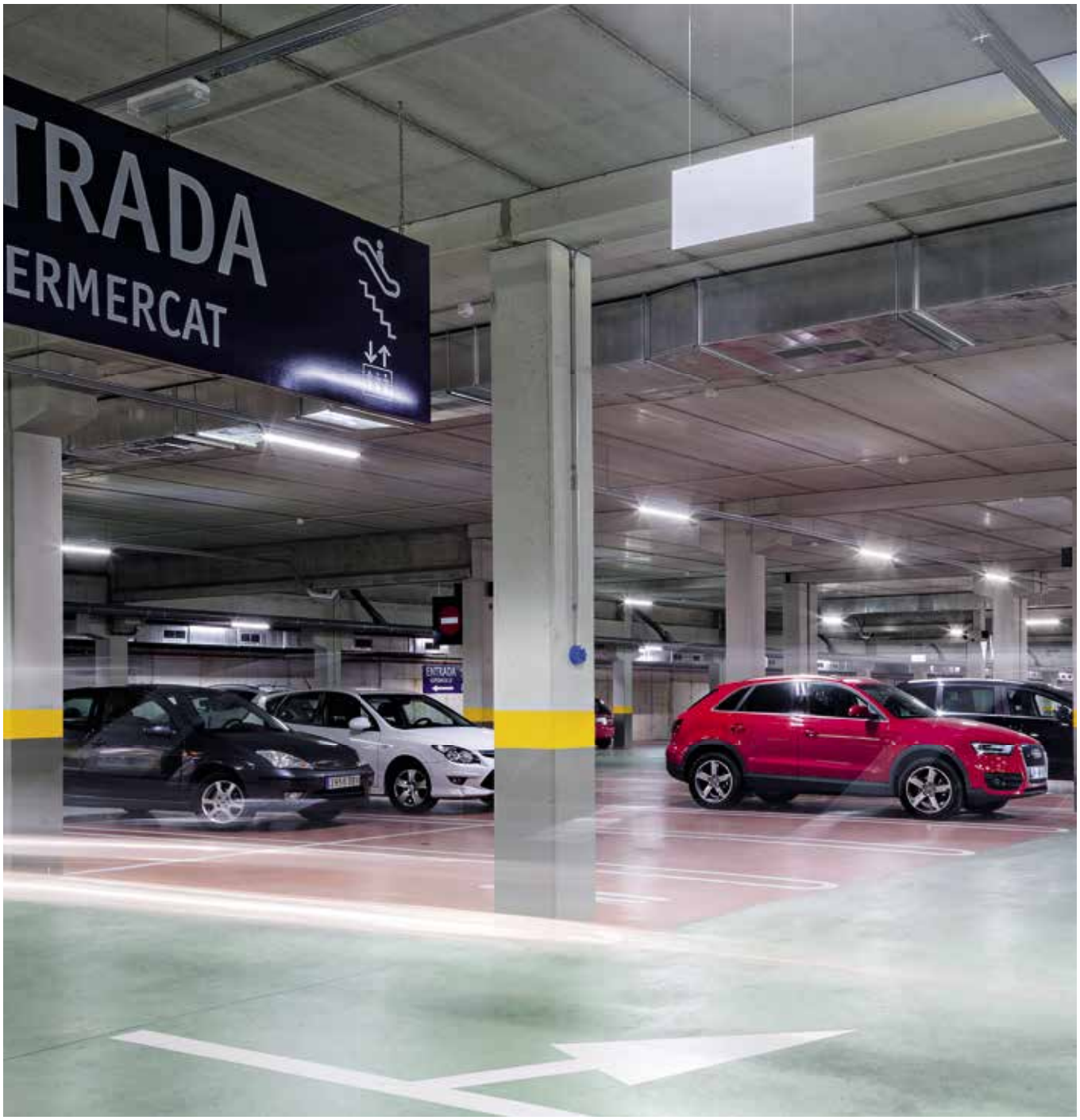
Where food is industrially produced, processed or stored, especially high hygiene and safety standards apply, also regarding lighting. The optics and housing for example must be made of shatter-resistant material and be easy to clean. Legislation also demands natural colour rendering with Ra > 80. TRILUX lighting solutions for the food industry comply with HACCP guidelines and can thus be installed in IFS Food and BRC certified companies. For example the E-Line LED IP54 (page 124) or Araxeon LED (page 132), available in various lumen packages and light distribution characteristics.



TRILUX LED lighting solutions have been designed for the rough working conditions found in industrial production locations. The optimised thermal management of the luminaires ensures continuously reliable and energy-efficient operation both at high and low ambient temperatures. At the same time, the photometrically and optically customised luminaires ensure ideal visual and working conditions, thus essentially contributing to productivity levels and occupational safety. With various lumen packages and light distribution characteristics, the E-Line LED (page 122) or Mirona Fit LED (page 126) provide complete flexibility for such applications. The 52,000 lm version of the Mirona Fit LED for example even allows conventional systems to be replaced two-to-one.

CANOPIED OUTDOOR AREAS

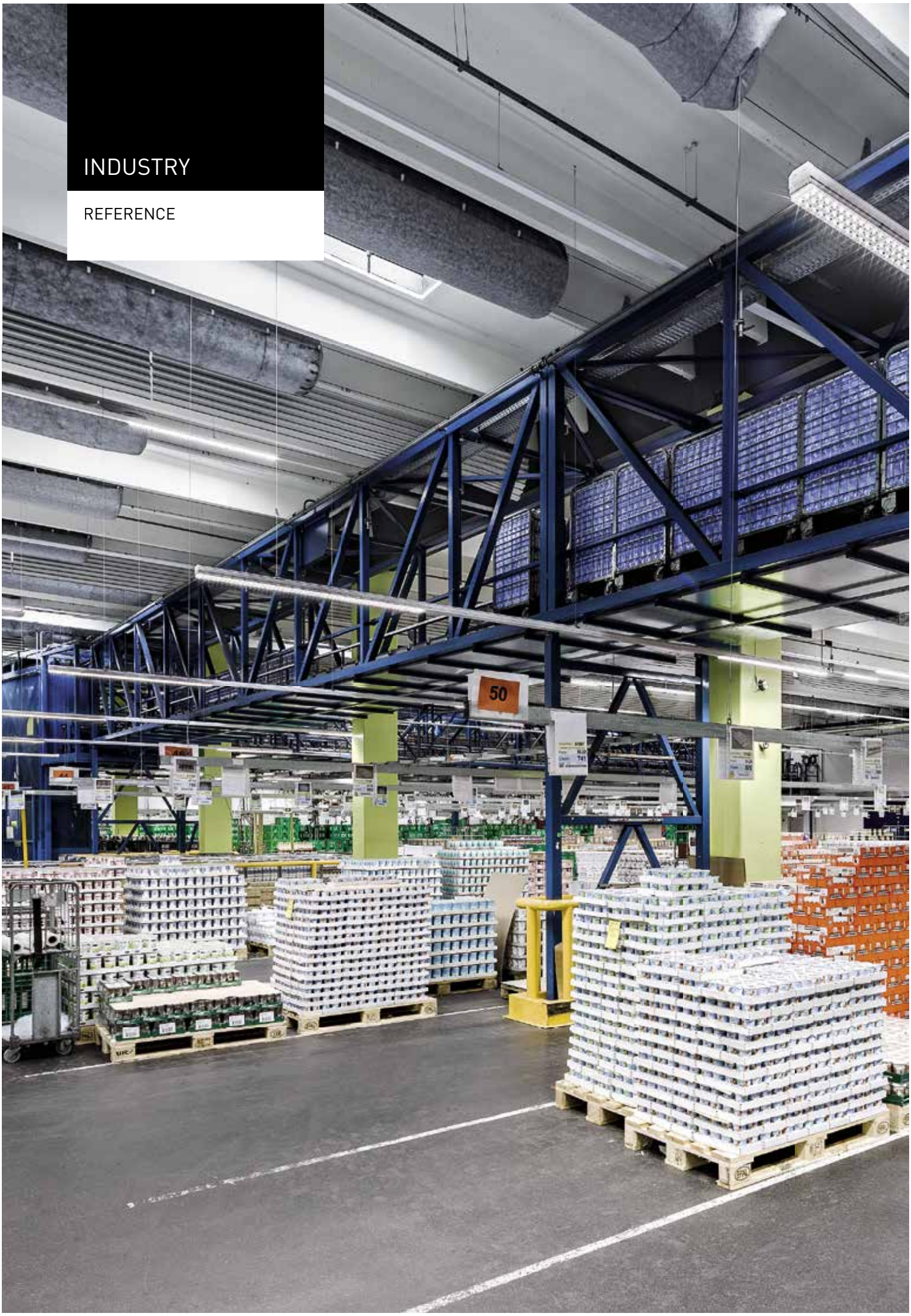
Canopied outdoor areas (protected from direct weathering and sunlight) place high demands on the luminaires. In addition to high humidity and day/night temperature fluctuations also exhaust fumes, dirt and vibrations contribute to the rough operating surroundings. Canopied outdoor areas therefore demand particularly robust, reliable and high-performance lighting solutions. The Nextrema G3 LED (page 130) defies humidity, soiling and fluctuations in temperature from -30 °C to +35 °C, thus providing reliable operation even in extreme conditions. Also suitable for areas with high protection rating requirements is the dust and jet water-protected IP54 version of the E-Line LED (page 124).



Perfectly illuminating a car park is a complex task. Low ceiling heights, tight transit areas, steep ramps and descents as well as many pillars aggravate planning and implementation. In addition, the lighting situation must be equally adapted to the needs of manoeuvring car drivers as well as pedestrians that often pass between cars or navigate the traffic routes without protection. As a result, indoor car parks fundamentally require bright and glare-free lighting that also needs to be energy-efficient, durable and with low maintenance due to reasons of cost efficiency. TRILUX LED solutions such as the robust Araxeon LED (page 132) or the compact, high-output Nextrema G3 LED (page 130) also feature intelligent functions such as running light that 'accompanies' pedestrians and vehicle drivers on their way through the building, thus also giving a feeling of safety.

INDUSTRY

REFERENCE



The Arla dairy group installs a lighting solution from TRILUX

In the Arla dairy centre in Christiansfeld, Denmark TRILUX upgraded the company's lighting installation to LED technology. In addition to energy efficiency, sustainability was also on the project agenda since the dairy group places high importance on responsible handling throughout the complete production chain. "The aim was to achieve less energy consumption along with significantly reduced greenhouse gas emissions," explained Martin Skødt, Maintenance Manager at Arla. In terms of saving energy, the Mirona LED, E-Line LED and the Nextrema LED scored across-the-board. A total of 5,500 square metres were equipped with the robust systems from TRILUX.

The systems have to withstand a great deal – a maximum temperature of 4.5 °C exists in the storage areas. The Mirona LED, E-Line LED and Nextrema LED must also withstand continuous humidity to achieve the requisite 7,500 operating hours per annum without failures.

E-Line LED continuous-line systems were installed in the three warehouses. Their particular advantages also include simple mounting, high durability and of course short payback times, and the system features energy efficiency of up to 152 lm per watt.

As part of the refurbishment project, levels of illuminance in the halls were updated in accordance with the latest standards. "This meant that lighting levels were doubled to 200 lux," explained TRILUX Key Account Manager Oliver Schwarz. Energy consumption on the other hand was reduced by around one third. A new light management system, coupled to several presence sensors, also contributes to this result.

The dairy works at Christiansfeld now has a state-of-the-art lighting installation completely unaffected by humidity and low temperatures. Lighting comfort was significantly increased and project supervision by TRILUX prove to be simple and highly collaborative. As such, TRILUX has once again shown its ability to implement its brand message of 'Simplify Your Light' in everyday operations.

ARLA FOODS CHRISTIANSFELD DAIRY CENTER

In short
Building owner: Arla Foods Christiansfeld Dairy Center
Project data: Cold store of 5,500 m^2
Luminaires: Mirona LED, E-Line LED and Nextrema LED

SHOP & RETAIL

BEST PRODUCTS
DESERVE BEST LIGHT

How light encourages purchases

Light arouses emotions, desires and curiosity and also attracts. In the retail sector, light is specifically used to set the scene for goods and influence purchasing behaviour. According to the motto of "well-presented is half-sold", lighting is the decisive creative element in supporting sales. Light also creates atmosphere, provides orientation and gives structure to spaces. Oktalite lighting solutions and light management therefore importantly contribute to supporting sales.

Benefits of LED luminaires in Shop & Retail
Natural colours: high colour rendering ensures optimum recognition of colours and materials.
Customised light spectrum: the right light spectrum is efficient because hardly any wavelengths are absorbed.
Minimum heat load: thanks to a lack of IR radiation, heat stress on goods is reduced.
No fading: no ultraviolet component delays the fading of goods.
High efficiency: the combination of high-performance LEDs, efficient reflectors, intelligent thermal management and optional light management reduces energy consumption.

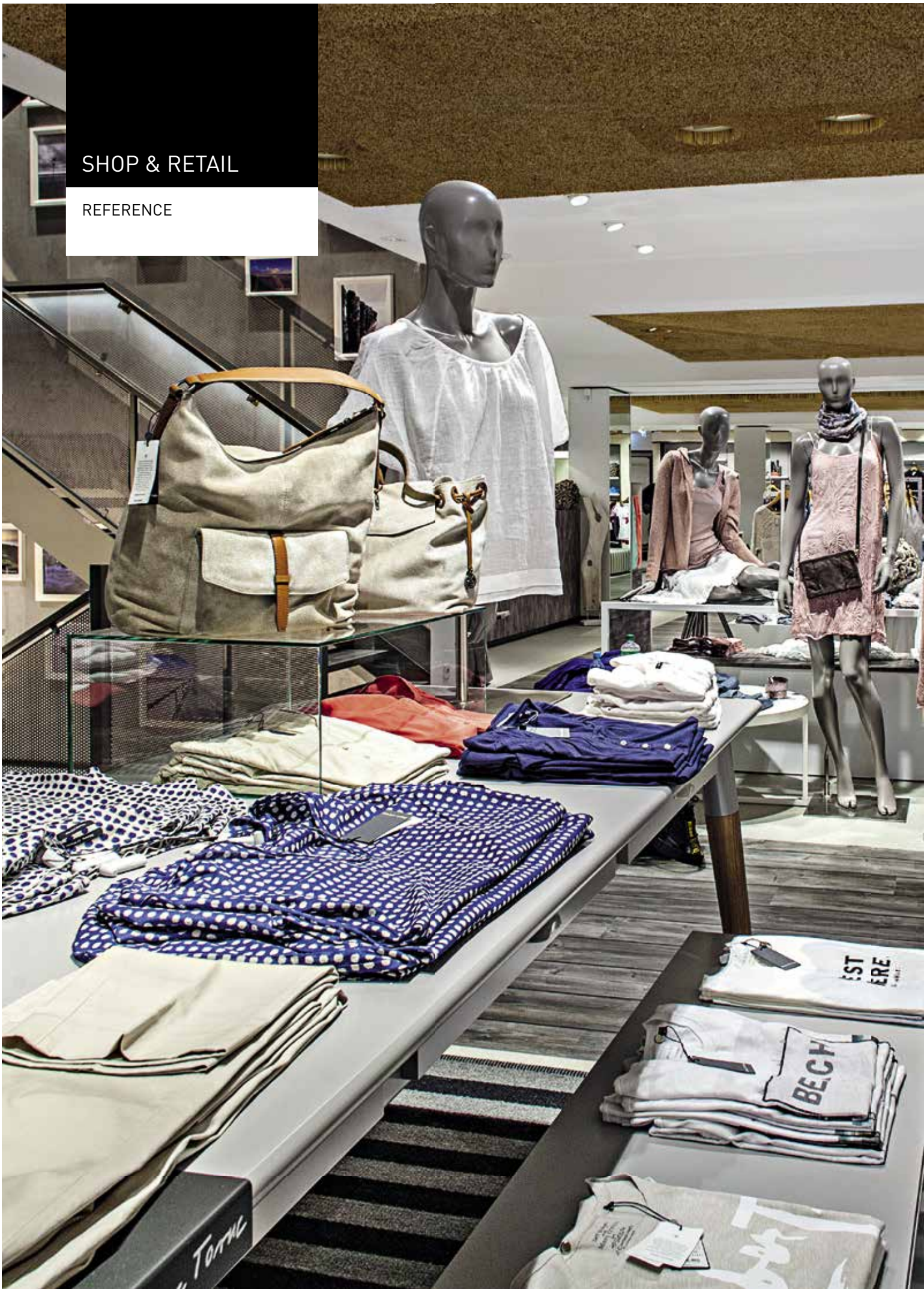
Light intensity, light colour and contrast – light does not equal light. In the fashion sector in particular, appearances play a decisive role in sales success. Lighting must create high-attention displays that still need to look as natural as possible, because authentic looks are important especially with apparel and shoes. The Lobu LED track spotlight (page 90) ideally supports such requirements and takes a back seat itself in terms of looks with its discreet design. The lighting task is central – Lobu LED ensures ideal colour and material recognition due to six different white light colours with outstanding colour rendering values up to 95 Ra. High-quality segmented reflectors provide best possible light distribution and pleasant visual comfort.

When displaying food in retail environments, it is mainly a case of emphasising the freshness and quality of products. The right light becomes a sales-promoting factor when it underlines the quality of the food, and gives the goods an authentic and appetising appearance. It is simultaneously important that the light source has reduced heat emission to maintain the freshness of goods. Lighting of the aisles is also important, due to the high product pressure found here. Light also determines the atmosphere. The Mido LED luminaire (page 98) provides new possibilities for displaying goods in shelves. The indirect light guided by the reflectors made of Miro Silver® creates a lively landscape of light on the goods, in turn providing a relaxed shopping experience. The Mido LED is also a power package, with a high lumen-output LED module featuring an outstanding energy balance.

Lighting in the retail sector is highly exacting, because each sales area places very specific demands on ideal light. While sales and cash point areas are ideally illuminated with relaxed and uniform general lighting, shelving areas require supplementary display lighting – glances should after all fall on the goods and not on the aisles. High room heights as existing in the automotive sector for example often place further demands. The Canilo Plus LED track spot (page 92) is a genuine power package with lumen packages up to 6,000 lm that resolves this task with bravado. The high output Canilo Plus LED is one third more efficient than conventional HIT-70W solutions.

SHOP & RETAIL

REFERENCE



Oktalite solutions emphasise the island flair at Hellner Moden

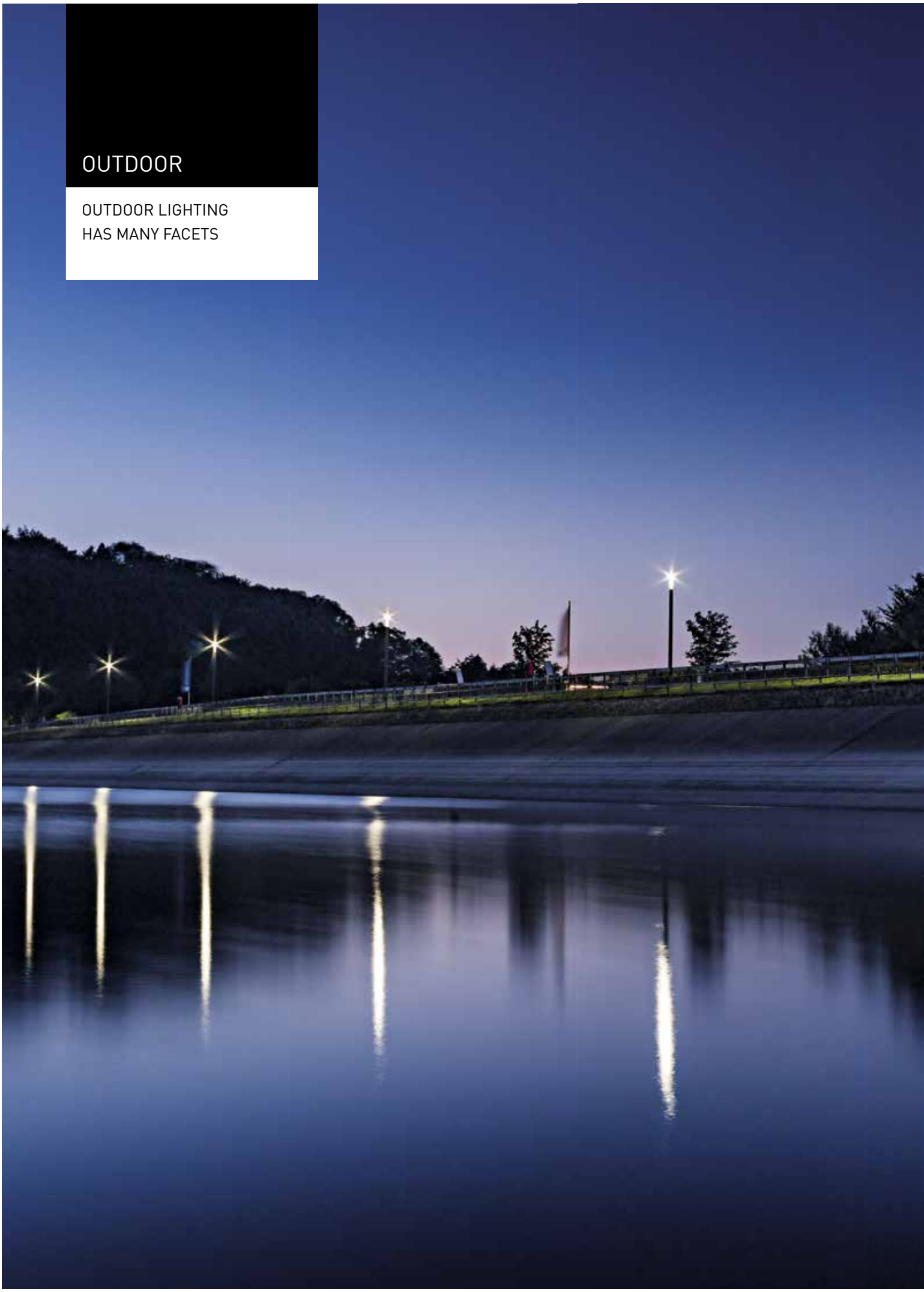
High-quality brand apparel from renowned producers – the speciality of Hellner Moden in Westerland on the German island of Sylt. As part of comprehensive upgrading, the owner Karl Max Hellner opted for state-of-the-art LED lighting from Oktalite. He was aiming for a warm atmosphere that reflects life on Sylt, because the interior design strongly highlights the island flair. Reeds are integrated into the ceiling design, the traffic route through the fashion store is a wooden boardwalk and the floor has a sandy look. Visitors discover wickerwork on the walls and wavelike racks. To ideally display this unique interior, Quira and Taro Mini LED spots were selected for the sales space consisting of a total of 1,000 square metres. The Best Colour LED module ensures high levels of colour fastness thanks to a colour rendering index of Ra > 90. The highlight is a DALI-controlled light management system enabling preprogrammed light scenes to be played, thereby transforming the shop window into a magnet for customers. Photo: Jens Schmidt

HELLNER MODEN, WESTERLAND SYLT, GERMANY

In short
Building owner: Karl Max Hellner
Lighting design: Oktalite
Luminaires: Quira, Taro Mini, Quad Too

OUTDOOR

OUTDOOR LIGHTING
HAS MANY FACETS



Prestigious, functional or sophisticated

Ensuring good visibility and safety in dim or nocturnal conditions is virtually obligatory for all outdoor lighting. Contemporary outdoor lighting must also provide much more – while many district councils place top priority on cost efficiency, the operators of prestigious architecture mostly favour customisable lighting solutions. For many companies the outdoor lighting of their headquarters serves as an extended business card, whereas vehicle drivers require optimum visual conditions.

All TRILUX outdoor luminaires combine pioneering and high-quality design, from classic to modern, with high-efficiency LED technology. In practice, the luminaires also feature simplified mounting and maintenance. Outdoor solutions from TRILUX are also ready for the networked future, and are suitable for new Smart City applications such as the technology-supported search for parking spaces.

Benefits of TRILUX LED luminaires for outdoor applications
A good balance both economically and ecologically: long service life ensures low environmental burdens, while energy efficiency and optimised dimensioning of luminaire luminous flux reduce operating costs.
Precision: optics have low light loss to ensure ideal light impact.
Robustness: it is often tough outside – TRILUX outdoor solutions are vibration- and break-resistant.
Flexibility for designers: with a design for any application, anything is possible with outdoor LED solutions from TRILUX. Product ranges allow for seamless outdoor designs.

Illuminating main roads demands special, uniform lighting due to high speeds and multi-lane carriageways. Lighting should primarily ensure that the complete traffic zone is reliably and brightly illuminated but without glare. Orientation signage and information panels must also be highly legible. The Lumega IQ LED (page 140) available in various construction sizes guarantees outstanding light distribution thanks to its MLT^{IQ} system developed by TRILUX. The innovative lighting technology ensure continuously outstanding illumination and maximum safety without disruptions.

Residential streets are often very busy areas. Vehicle drivers not only encounter other traffic participants such as pedestrians and cyclists, but also playing children. Street lighting merely focused on the carriageway is not sufficient. The illumination of parking bays, cycle paths and pedestrian paths is also needed. At best, lighting solutions not only provide safety but also reflect the residential character by promoting a pleasant atmosphere. Maximum planning flexibility as well as future safety are offered by the modular, expandable ViaCon LED (page 138) – its "Smart Lighting Ready" version also features several Smart City functions. The same expandable characteristics are provided by the efficient Lumantix LED (page 142) which upgrades urban areas with its appealing design.

Public parking spaces and service stations are part of the general traffic domain. Vehicle drivers encounter pedestrians and cyclists often use these areas as short cuts. Lorries and cars park, drive and steer. Pedestrians often appear suddenly behind vehicles or hurriedly cross the road. Fences and obstacles may also limit visibility. Reliable and durable lighting helps to minimise the danger of accidents and collisions. TRILUX luminaires feature ideally matched photometric characteristics and comply with the latest technological standards. The Lumega IQ LED (page 140) available in various construction sizes guarantees outstanding light distribution and therefore optimum illumination and maximum safety thanks to its MLT^{IQ} system developed by TRILUX. With various wattages and lumen packages, the Lumena Star LED (page 154) also adapts to public facilities of all sizes.

Pedestrian zones are often the heart of a town or city where people meet, do business and go out to celebrate in the evenings. An attractive city centre is therefore not only a significant lever for the local economy and tourism but also a zone of well-being for citizens. Urban lighting is transforming accordingly from functional to aesthetic, because retailers, hotels and restaurants also require attractive surroundings for their guests. Whether illuminated plazas, highlighting significant buildings with light or appealing luminaire designs – contemporary lighting concepts for urban areas must take into account such aesthetic aspects as well as the list of requirements dictated by communal decision-makers. Here cost efficiency, robustness, low maintenance costs and a contribution to safety and the prevention of criminality are focused on. All such needs are fulfilled with the variably designable ConStela LED (page 144) and the efficient and expandable Lumantix LED (page 142).

When it comes to zebra crossings, central islands or traffic light crossings, accidents are only prevented if various traffic participants look out for each other. The precondition for this are good visual conditions, also during twilight or nocturnal hours. Initial situations however are often not ideal: pedestrians in dark clothes can be difficult to see, parked cars limit the field of visibility or there is rain or snow. With innovative MLT^{IQ} technology, the Lumega IQ LED (page 140) and Viatana LED (www.trilux.com/viatana) ensure continuously optimum illumination and maximum safety without disruptions.

Outdoor lighting for residential facilities is a question of style and moderation. The primary task of course is to ensure that all paths are reliably illuminated in darkness. The complete residential complex should however not be flooded with light which would disturb residents' night-time rest. Efficient luminaires in such cases can be controlled with regard to beam characteristics and individually set. Furthermore, the light, style and design are supposed to blend harmoniously with the architecture and exterior design. This task is ideally fulfilled by the bollard luminaires and light columns of the 884··· LED (page 146) that also feature maximum light impact with minimum energy costs. The Skeo Pura LED (page 150) also attractively and atmospherically illuminates outdoor areas. The luminaire defies adverse weather conditions with its high protection rating and high quality of materials.

Ideal visual conditions are a must for cycle paths, especially in autumn and winter when obstacles in the form of leaves or branches can occur and cyclists have to dodge them swiftly. In addition, the growing popularity of e-bikes means that speeds are increasing on cycle paths. Uniformly illuminating a complete cycle path is a challenge. The Lumega IQ LED (page 140) and Cuvia LED (www.trilux.com/cuvia) ideally illuminate such areas thanks to innovative MLT^{IQ} technology. In addition to safety and reliability, cost efficiency is also obligatory for local councils with regard to cycle path lighting. The energy efficiency of the Lumega IQ LED and Cuvia LED can be further increased via high-performance light management systems and application-oriented, intelligent switching concepts.

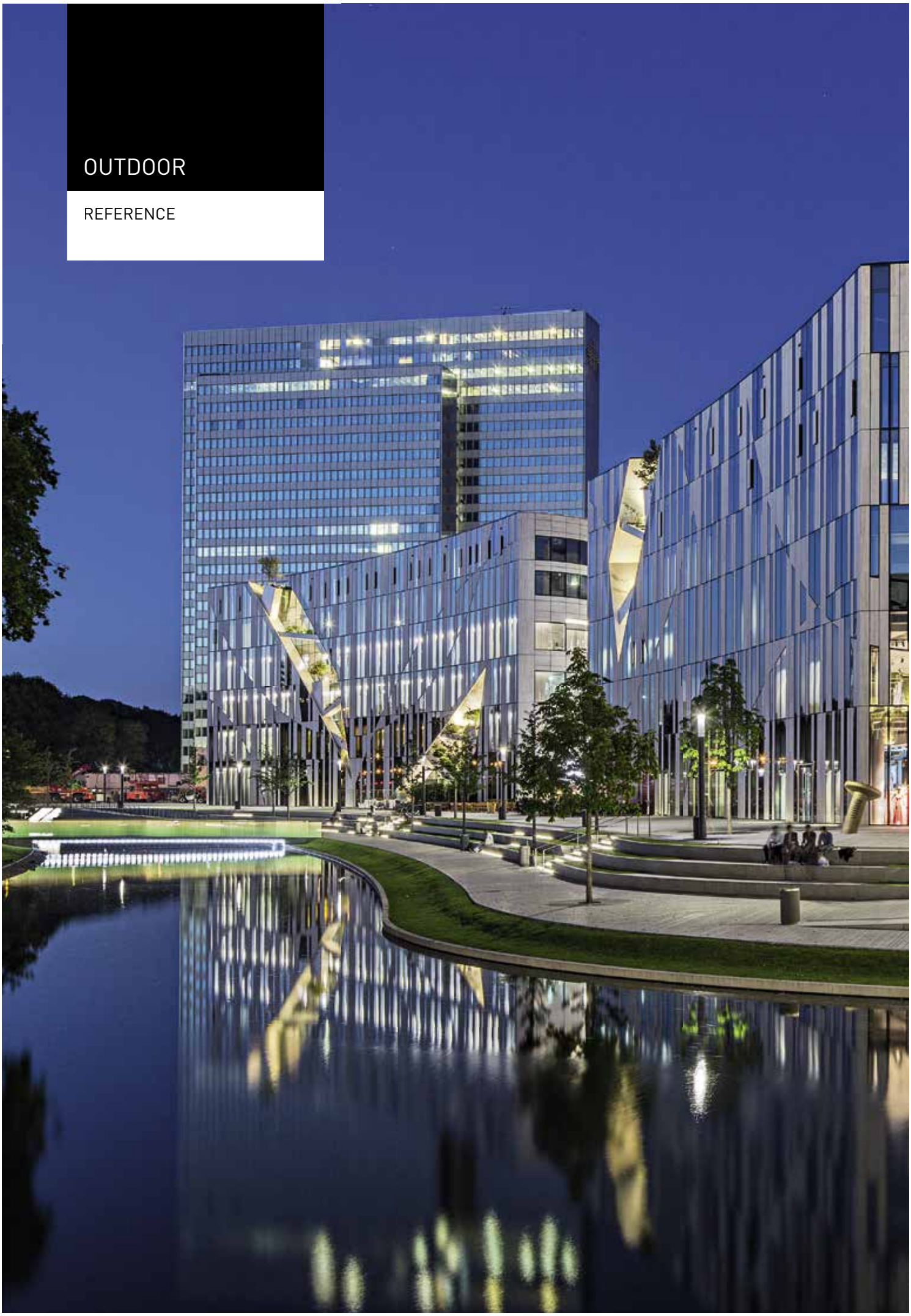
Light determines form, accentuates and can also be the business card of a building when used correctly. With variable lighting concepts, prestigious buildings such as shopping villages, hospitals, offices and restaurants can be specifically highlighted. TRILUX offers an extensive spectrum of customisable lighting solutions for this purpose, for example the 884··· LED range (page 146). The attractive wall luminaire, bollard and column solutions enable holistic lighting projects with a uniform overall appearance.

FACADE LIGHTING

The facade is more or less the face of a building, and as such should also appear in the best possible light during twilight or nocturnal hours. TRILUX enables contemporary facade illumination with a variety of products that effectively meet such needs with high levels of energy efficiency, ranging from the wide-area lighting of facades and surfaces and the specific illumination of objects and complete buildings to individual spotlighting. As implemented by efficient LED systems such as the Faciella LED (www.trilux.com/faciella) and Lutera LED (www.trilux.com/lutera).

OUTDOOR

REFERENCE



The Kö-Bogen in Düsseldorf

An architectural icon, a constructional highlight, an urban jewel – the Kö-Bogen in Düsseldorf has been adorned with a variety of catch phrases. A project like this deserves to be shown in the best possible light, a job for which ConStela LED is the most excellent match.

Any casual stroll along the world-famous Königsallee now ends in front of the imposing Kö-Bogen facade constructed of glass and natural white stone, designed by the renowned architect Daniel Libeskind. The construction represents the northern endpoint of the magnificent boulevard and is a two-part building accommodating flagship stores, restaurants and office spaces distributed across 9,000 square metres. The landscape architects from FSWLA GmbH and the Düsseldorf municipal planners focused on a high quality of stay for the open areas, and paths directly adjacent to water, the integration of the Hofgarten and floating gardens within the building facade are just a few examples of this.

The urban jewel is compellingly complemented by the purist TRILUX light column concept. The carefully selected locations of the anthracite-coloured ConStela LED columns are oriented to the curved water route. The terrace of the Hofgarten with the layered design of its benches invites passers-by to linger and during the day, the columns with a decorative but discreet design blend into the background to give urban nature the stage. During nocturnal hours the ConStela LED luminaires create a highly special atmosphere.

In addition to its purist design, ConStela LED also features further appealing benefits. Thanks to Multi-Lens Technology MLT^{IQ}, the location adjacent to the water is illuminated in highly uniform but glare-free light. Security aspects are taken into account by standard-compliant specifications and levels of energy efficiency are also impressive, because in comparison to conventional outdoor lighting the ConStela LED consumes 40 % less energy. Together with a long service life and simple maintenance, the system is also compelling in terms of sustainability.

Passers-by wishing to go from the column-bordered water bank to the other side of the water take the fenestrated Landskronenbrücke bridge. Countless LEDs integrated into the balustrades create highly attractive illumination in darkness, with the bridge representing a discreet visual transition between the Kö-Bogen and the green of the Hofgarten.

With its lighting design for the Kö-Bogen TRILUX has aided in giving the world-famous Königsallee an architecturally successful finish, and the ConStela LED in both form and function provides a considerable contribution.

IN SHORT
Construction project: Design of a prestigious outdoor zone
Luminaires: ConStela LED

INPLANA/ONPLANA LED

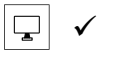
RADIANCE TO GET EXCITED ABOUT

The challenge
If the main focus is on the room itself the light must be descreet. Planar light is unobtrusive and of high quality, but until now large light emission surfaces were needed to achieve the desired or standard-compliant illuminance level without glare.

The solution
The Inplana and Onplana LED range puts an end to this and with its special construction design provides highly efficient, glare-free planar light in the downlight sector. The compact luminaires are available in two construction sizes with two optical systems and three luminous flux levels for the implementation of individual lighting concepts. With UGR19 and EN12464-1 glare reduction, some luminaire types are also suitable for the standard-compliant lighting of VDU workstations. Both downlights also feature a very flat design. This means they can be installed flush to the ceiling even with very low ceiling cavities, to blend ideally into the room and interior design.

The result
Planar light as a recessed or surface-mounted downlight for both ceiling and wall mounting: the highly integrable TRILUX Inplana and Onplana LED give architects and planners unexpected possibilities for implementing uniform, glare-free light with small construction sizes.

Design: MID Möller and Demmer

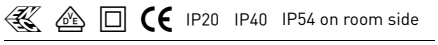


1,000 lm - 3,000 lm

> 50,000 h

Switchable and dimmable (DALI)

Individual battery system, 3 hours, white-white control, plaster frames



Unique optic for maximum visual comfort.

Simply attractive – the flexible adaptation artists.

LESS G2 LED

A PURIST DESIGN
EMPHASISES TIMELESS
ARCHITECTURE

The challenge
Whether it's prestigious office buildings or stylish sales areas, light ideally matched to each space and maximum quality of light is needed when illuminating sophisticated architectural projects. Light effects and the architecture must harmonise completely and any superfluous detail can disturb this balance. Luminaires are required providing many lighting facets but without pushing to the fore in terms of appearance.

The solution
The Less G2 LED range features a discreet design and high flexibility with regard to light effect – their unobtrusive appearance means the luminaires blend optimally into the room and give centre stage to the lighting task. The effect of light within the interior design is not disturbed by superfluous details such as material transitions. The modular system of the Less G2 LED copes with divers lighting requirements: available as a downlight and wallwasher, various mounting methods, construction sizes, light colours, illuminance levels and beam angles can be combined.

The result
The Less G2 LED series is precisely the right choice when it comes to the effect of light and not the luminaire itself – its diversified features provide architects and planners with creative and tailor-made lighting in a uniform, purist design for prestigious, sophisticated buildings.

200 lm - 2,500 lm

3000 K 4000 K

> 50,000 h

Switchable and dimmable (DALI)

Plaster versions

IP20

Two recessed versions
The downlights can be mounted either classically with a ceiling mounting frame or trimless. Some versions are available with a frosted glass cover.

Three construction sizes
The Less G2 LED is available in three construction sizes with 55 mm, 100 mm or 150 mm reflector diameters. The luminaire therefore fulfils both technical and design-oriented lighting tasks.

LIGRA G2 LED

DOWNLIGHTS WITH
FORMAT AND SIZE

The challenge
When replacing downlights with LED the size is often important – or more specifically, the construction size. This is because on-site conditions have very different demands on construction form, mounting method and dimensions. With new installations on the other hand, a focus is put on cost savings by reducing the number of light points.

The solution
The Inperla and Athenik from the Ligra G2 LED family are the ideal solutions for this challenge, whether for refurbishment projects or new installations. A flexible installation diameter and the low construction depth enable easy installation in a variety of existing ceiling apertures. In particular, older conventional TRILUX downlights can be simply replaced without having to change the construction of the ceiling. The wide light distribution also enables wide luminaire spacings during the design stage, which helps to reduce investment costs. In addition to its formal qualities, the Ligra G2 LED range also offers outstanding quality of light. High uniformity and planar light emission provide pleasant light atmospheres and low fatigue with visual tasks. A wide selection of lumen packages, reflectors and decorative attachements and mounting accessories round off the range and offer a diverse variety of design possibilities.

The result
Inperla Ligra G2 LED luminaires enable electrical contractors to replace old for new very quickly and at low costs. Additionally, the builder will also be pleased that there are no additional costs for a ceiling installer. The Ligra G2 LED range also offers architects and lighting designers the opportunity to provide outstanding illumination of rooms.

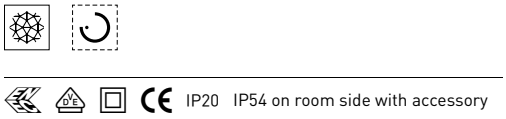
Design: MID Möller and Demmer

1,000 lm - 4,800 lm

> 50,000 h

Switchable and dimmable (DALI)

Individual battery system, 3 hours, white-white control



Maximum efficiency and high quality of light
The premium downlights reduce payback times with refurbishment projects thanks to their high efficiency levels. The Ligra G2 LED luminaires emit pleasant light with low direct glare thanks to large light emission surfaces.

Simple installation
The intelligent construction of the luminaire enables simple mounting and disassembly, also in acoustic ceiling systems. In addition, installing complex distribution boxes is not necessary thanks to the intelligently designed mains through-wiring option.

SCENATICPOINT 905 LED

SETTING ACCENTS AND CREATING ATMOSPHERE

The challenge
Those aiming to simply and energy-efficiently illuminate prestigious rooms are well-advised to use compact recessed LED spotlights – these are usually small, easy to install and blend well with their surroundings. Selection becomes difficult if such lighting solutions should additionally set striking light accents, for example on pictures, exhibition items or products.

The solution
The TRILUX ScenaticPoint 905 features everything, a state-of-the-art LED spotlight requires and can also be swivelled in all directions thanks to cardanic bearings. This makes it ideal for lighting prestigious areas and atmospherically emphasising details.

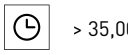
The result
A pleasant room atmosphere with individual accents: the compact ScenaticPoint 905 LED spotlights from TRILUX solve such challenges in light planning and provide prestigious lighting in foyers, conference rooms or sales areas.



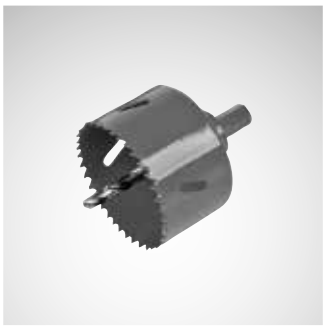



✓


700 lm - 1,100 lm


> 35,000 h


Switchable and dimmable (DALI)



Ideal conditions for refurbishments
With a recess diameter of 68 mm, the ScenaticPoint 905 replaces all standard, commercially available low voltage halogen luminaires 1:1.

Setting flexible light accents
The ScenaticPoint 905 can be flexibly pivoted in any direction to attractively display pictures, products or exhibition items.

LOBU LED

EFFICIENT LIGHT
IN A SMALL FORMAT

The challenge
Attractive and optimum goods displays don't depend on giant display areas – in fact, quite the opposite. Perfect displays can also be achieved by using the right lighting solution in small stores and shops. Here, the a balance is crucial: the luminaires must not dominate in terms of appearance but need to provide premium photometrics.

The solution
With the Lobu LED track spotlight, Oktalite offers a purist luminaire design with a compact size and strong photometric properties for the point of sale. Despite its high light output, the small spotlight emits energy-efficient light. High quality segmented reflectors provide best possible light distribution in all rotation angles. Various light distribution characteristics ideally illuminate the goods. The spotlight is available with six white light colours.

The result
With the 3-circuit track spotlight Lobu LED, Oktalite offers a lighting solution reduced to the essentials for all retail areas. With its purist look, the luminaire is highly discreet and places the lighting task in the foreground. Whether fashion, shop or food – the spotlight provides optimum light in all situations.

3,000 lm - 4,000 lm

2700 K | 3000 K | 3100 K EC | 3100 K BC | 3500 K | 4000 K

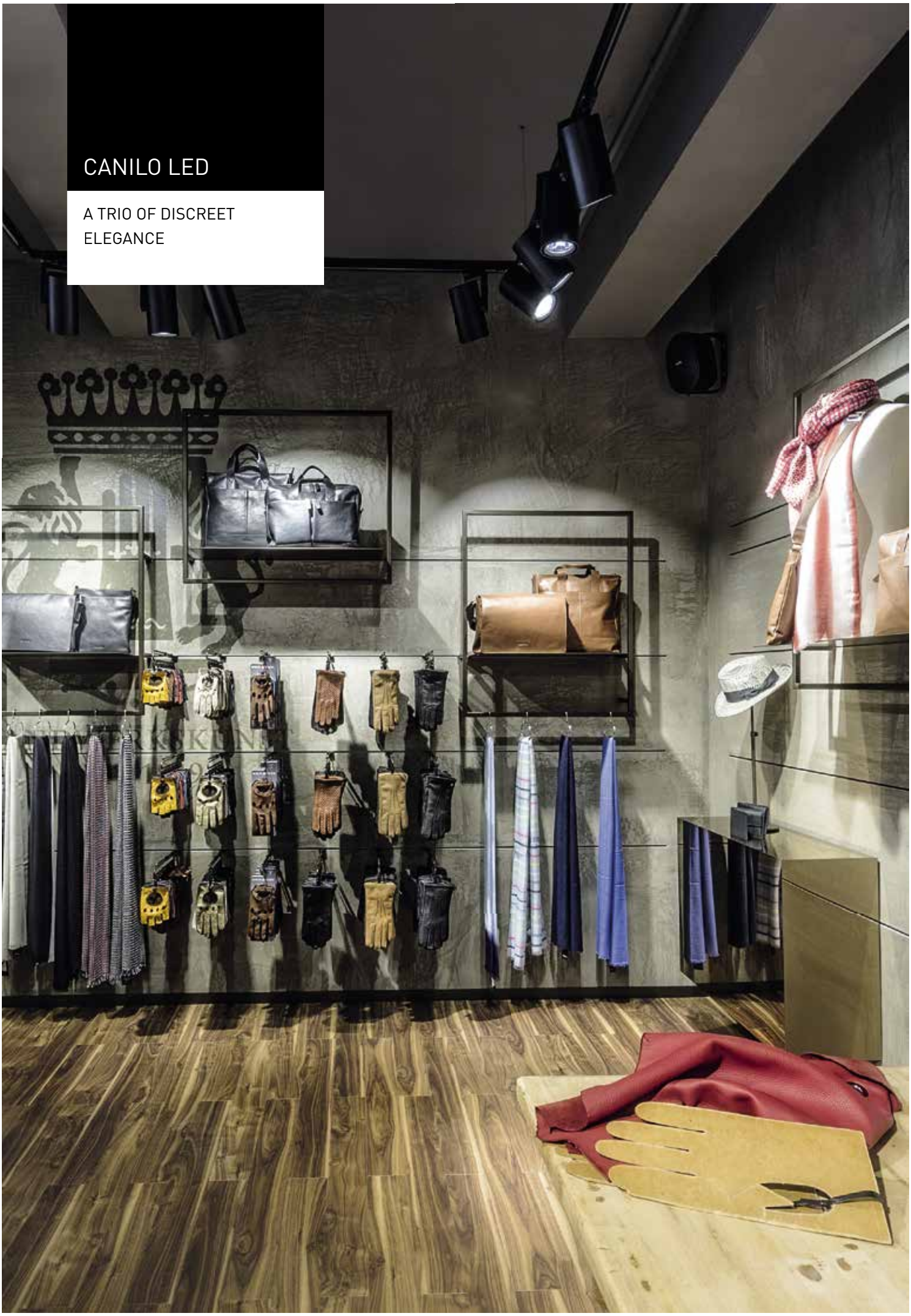
50,000 h

Switchable and dimmable (LED^{IQ})

IP20

The Lobu LED spotlight features a compact design. The luminaire blends discreetly into the surrounding at the point of sale thanks to its small luminaire dimensions and purist design.

High-quality, segmented reflectors (Spot, Medium Flood and Flood) achieve optimum light distribution at any position. The spotlight features six white light colours and is suitable for all shop areas.



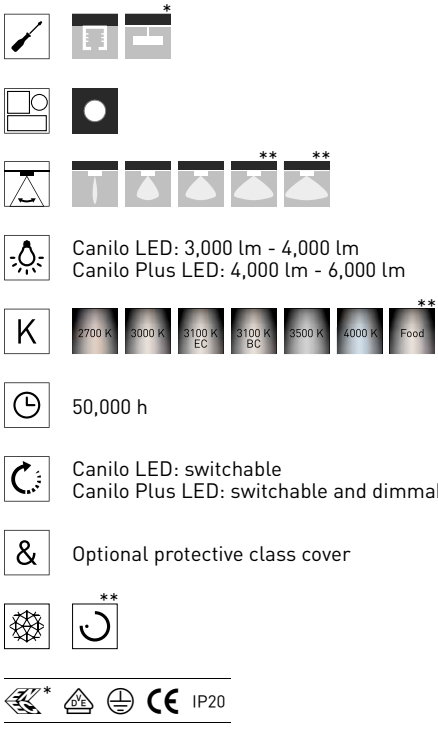
CANILO LED

A TRIO OF DISCREET
ELEGANCE

The challenge
Fashion, food or lifestyle – all products need to be displayed in the right light in modern, sophisticated sales environments. In addition to this: frequently changing groups of goods and decorations require a diverse lighting solution that can be quickly and simply adapted to such changes. And as if that wasn't challenge enough, the luminaire's design as a decorative element must be of high quality and blend ideally into the shop's surroundings, without being too conspicuous.

The solution
The Canilo LED product range can do one thing exceptionally well: impress. All thanks to its elegant design and enormous flexibility and diversity. The Canilo LED is optionally available as a suspended luminaire or surface-mounted directional spotlight with various interchangeable reflectors and different beam characteristics, along with a wide spectrum of white light colours. The latest members of the range are for special tasks: the larger and higher lumen output Canilo Plus LED spotlights also ideally illuminate fresh goods areas, thanks to its special light spectra, as well as high rooms. All versions have an attractive, discreet design. The characteristic side flap on the luminaire body can be designed in individual colours (e.g. company colours) to provide an unmistakable overall ambience.

The result
Thanks to its diversity within a uniformly elegant design, the Canilo LED is ideal for all lighting tasks in sophisticated sales surroundings – ranging from goods lighting and accent lighting to displaying architectural elements. Its high-quality and simultaneously diverse light makes the luminaire range ideal for food, shop, automotive and fashion areas.



The Canilo and Canilo Plus spotlight, as well as the Canilo suspended luminaire provide flexible use in a uniform design.

The classically elegant housing blends optimally into prestigious sales surroundings. The characteristic side flap can be modified to customers' colour specifications.

*only Canilo LED **only Canilo Plus LED

ANTELOPE LED

A FUNCTIONAL DESIGN
WITH ATMOSPHERIC LIGHT

The challenge
In many sales areas, successful goods displays are not only a matter of effective accent lighting. Especially in the fashion and lifestyle segments, the point of sale benefits from an inviting atmosphere. It's here that well thought-out, discreet, complete solutions are needed which can do both: highlighting goods with light and creating a pleasing atmosphere of well-being.

The solution
With the Antelope LED, the choice of reflector determines whether the luminaire emits a narrow, accenting light cone or soft, wide light. The lighting system itself has a uniform look because the reflectors look the same on the outside. Oktalite uses a new type of technology with the Antelope spotlight; a LED light engine. This single unit, consisting of LED module and integrated driver, makes the luminaire's especially compact, small design possible, allowing it to blend ideally into rooms, without any disturbing components or separate control units. Thermal management is also an integral part of the design: the spotlight housing, in the form of a fork, acts as a heat sink. The simplicity principle also applies to its use - the spotlight can be simply mounted and directed towards the goods with just a few flicks of the wrist.

The result
The clever design enables customers to implement several different lighting tasks with just one luminaire range in shops, providing a uniform overall look. Thanks to the reduced amount of materials used in its construction, installing the spotlight is quick and therefore cost-efficient. At the same time, the luminaire therefore also serves as a design element that perfectly blends in any shop surrounding.

3,000 lm

3000 K 4000 K

30,000 h

switchable

IP20

The fork-shaped design of the die-cast aluminium spotlight housing also acts as the luminaire's heat sink.

The spotlight features an innovative combination of LED module and integrated driver – allowing the use of less material in the construction.

FANO LED

A MULTI-FACETED
LIGHT CUBE

The challenge
In the retail sector, light should arouse desire and stimulate purchases. Light must display the goods brilliantly and as well as possible for this purpose. The luminaires must also look good – they're also elements of design in sales areas. Lighting solutions must therefore feature outstanding quality of light and at the same time have attractive designs.

The solution
Oktalite sets standards with the Fano LED series with view to design and technology: the main feature of the surface-mounted directional spotlight is its cubic housing, giving the luminaire a linear, striking and compact appearance. On the rear the luminaires are almost completely closed – this emphasises their elegant design. The range of luminaires also features high quality and flexibility on the inside: they have six white light and other food light colours to also display fresh food goods in an appetising way. Their interchangeable optics are attached simply via magnetic fixing. The latest member of this range is the extra-compact Fano Mini LED spotlight, bringing Fano quality to rooms where space is tight.

The result
The Fano LED range of spotlights appeals to design lovers and technical enthusiasts and provides diverse lighting solutions for various spatial and light requirements for store owners thanks to a stylish appearance and customisable inner technology. This all makes the stylish light cube the top choice for the whole retail sector.

Fano Mini LED: 3,000 lm - 4,000 lm
Fano LED: 2,000 lm - 5,000 lm

2700 K | 3000 K | 3100 K EC | 3100 K BC | 3500 K | 4000 K | Food*

50,000 h

Fano LED: switchable and dimmable (LED^{IQ})
Fano Mini LED: switchable

Optional protective glass cover

IP20

The product family has a new type of interchangeable optic with Easy Optic Plate magnetic mounting.

The Fano LED spotlight family has a concise, compact square design. Special design features are the concealed heat sinks.

*only Fano LED

MIDO LED

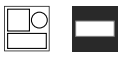
PIONEERING RETAIL LIGHTING WITH A NEW DESIGN

www.trilux.com/mido
www.oktalite.com/en/mido-ab/
www.oktalite.com/en/mido-eb/
www.oktalite.com/en/mido-pl/

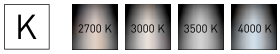
The challenge
Continuous lines for illuminating aisle zones and directional spots for targeted goods displays are the indisputable standard when lighting large areas. This combination is primarily functional, but: is a contemporary solution available that is different from the others in terms of light effect and design?

The solution
Already the outter appreance of the Mido LED is different to traditional retail lighting. Instead of linear continuous lines, single luminaires with a modern appearance, with a designer heat sink create a lively light landscape. The lighting itself is produced via an indirect distribution LED module, emitting light which is elegantly controlled via reflectors into the goods shelving. The lighting focus is on eye-catching displays at customers' eye-level and because different spatial and photometric framework conditions exist in each retail outlet, the Mido LED is available with various beam characteristics, a wide spectrum of white light colours and several mounting options.

The result
Emphasis is placed on both the shop and goods: the Mido LED's new design sets exclusive light accents in any store. The indirect, optimally glare-reduced light also creates an especially pleasant shopping atmosphere.



5,000 lm - 9,000 lm



50,000 h

Switchable, switchable and dimmable (LED[10]) on request

IP20

The double asymmetric Mido LED is optionally available with a 30° or 40° beam angle and the asymmetric version with 30° or 40°.

The double asymmetric version emits up to 9,000 lm and the asymmetric luminaire up to 5,000 lm.

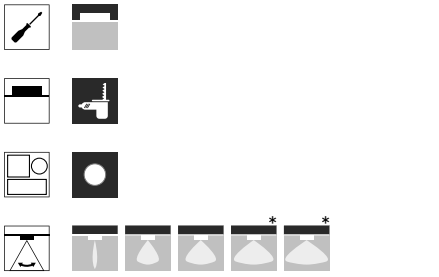
QUIRA LED

DESIGN FLEXIBILITY
IN THE VERY BEST LIGHT

The challenge
Those who want to successfully sell must offer customers variation: not only in terms of assortments and collections, but also shop design and goods displays should be changed at regular intervals, ranging from table displays and walls of goods to structures and displays on mannequins. Lighting systems on the other hand are created for the long term for cost reasons. Contemporary lighting solutions must adapt to sector-related, frequent changes of goods and optimally highlight any setup.

The solution
The Oktalite Quira LED product range offers flexibility across the board – as a discreet downlight, the luminaire can be swivelled in by up to 15° to position it flush with the ceiling, e.g. for lighting mid-space furniture. If more spot light is required, the Quira LED can be swivelled out to illuminate high decorative components with just one flick of the wrist thanks to the intelligent grip edge. The wide selection of six white light colours provides additional creative flexibility. The Quira Plus LED can even be equipped with an extra-high 5,000 lumen level, while still maintaining high efficiency. Thanks to additional special light colours, the luminaire can also attractively display fresh food. The perfect refurbishment solution; the Quira Plus LED is also available with a mounting ring in three different sizes for mounting into existing ceiling apertures.

The result
Quira LED provides efficient and high quality lighting solutions for all retail areas, ranging from goods illumination on display tables to rear walls and high decorative elements. Whether displaying single products, groups of goods or structures – the Quira LED shows everything in optimum light.



Quira LED: 3,000 lm - 4,000 lm
Quira Plus LED: 1,500 lm - 5,000 lm

50,000 h

Quira Plus LED: switchable and dimmable (LED^{IQ})
Quira LED: switchable and dimmable (LED^{IQ}) on request

Optional protective glass cover

(optional)

IP20

*only Quira Plus LED

Quira Plus LED is available with mounting rings in three different diameters (175, 185 and 195 mm), and is therefore ideal for installing into existing ceiling apertures of different sizes.

Thanks to its intelligent grip edge, the luminaire can be swivelled in simply and according to requirements. The Quira LED can thus be used as a spotlight and pivotable downlight.

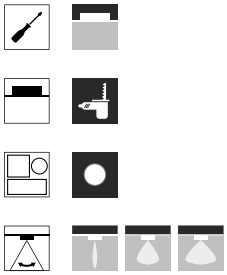
AGIRA LED

A COMPACT LED
SPOTLIGHT FOR MAXIMUM
LIGHT SOPHISTICATION

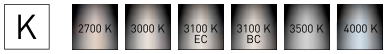
The challenge
Not everyone wanting to successfully sell their products has large display areas available. Lighting is a major factor when it comes to whether attractive, diverse goods displays are also successful in small retail outlets: luminaires must meet the diverse applications at the point of sale and also comply with the spatial surroundings at the same time.

The solution
The Agira LED recessed spotlight is ideal for both requirements thanks to maximum mobility: The luminaire can be horizontally pivoted around one axis, quickly transforming the spotlight into a discreet downlight for calm ceiling appearances. The Agira LED can also be rotated through 355 degrees. The result: light always radiates towards the target, whether this is a single product or groups of goods. Efficient segmented reflectors ensure maximum quality of light from any angle. With its small diameter, the spotlight is especially suitable in small shops with low ceilings.

The result
With the Agira LED, Oktalite provides store owners with a complete range of contemporary, high quality light even in limited spatial surroundings. The Agira LED emits both basic and accent lighting and is ideally suitable for a diversity of display methods, ranging from table displays and walls of goods to constructions and displays on figures.



3,000 lm - 4,000 lm



50,000 h

Switchable, switchable and dimmable (LED[10]) on request

Optional protective glass cover

(optional)

IP20

The luminaire can be pivoted to the left or right by 30° and can be rotated through 355°. When swivelled in, the spot functions as a downlight for calm ceiling appearances.

With a diameter of just 130 mm, the recessed spotlight is especially small and compact, making it predestined for rooms with low ceiling heights.

ARIMO SLIM CDP LED

THE ULTRA-FLAT
REFURBISHMENT SOLUTION
FOR PLANAR LIGHT

The challenge
Planar light offers many advantages. Most available solutions can however not provide the requisite bandwidth and quality for refurbishments. A product range is needed that can comply with individual needs such as construction designs and dimensions while saving energy and improving visual comfort and atmosphere.

The solution
Thanks to its diversity, the Arimo Slim CDP LED is the perfect 1:1 refurbishment solution for the entire office. It emits homogeneous light and is available as square or linear version for laying into module ceilings or recessing in plasterboard ceilings. The portfolio is completed by versions with IP54 protection rating on room side, surface-mounted versions and a suspended luminaire with an indirect light component. The luminaires feature high quality of light and are connected simply via Plug&Play to the control unit for easy installation. The unique CDP-X optic is especially decorative: a slender illuminated light gap on the homogeneous surface creates additional accents. This can be individually designed according to customer needs, e.g. with an own company logo.

The result
The Arimo Slim CDP LED enables even extensive refurbishment projects to be carried out quickly, simply and with a uniform design. Various construction designs and versions enable a precise, attractive and holistic lighting of office buildings. High savings are achieved with minimum effort and the CDP-X optic also creates a completely new type of ceiling look.

✓

3,000 lm – 7,000 lm

> 50,000 h

Switchable and dimmable (DALI), switchable

Individual battery system, 3 hours,
IP54 (on room side)

up to IP54 on room side

The Arimo Slim CDP & CDP-X LED features recessed and surface-mounted solutions – both as square or linear versions.

For a holistic realization a suspended luminaire with an indirect light distribution is also available.

ARIMO SLIM MRX LED

BREATHES FRESH AIR
INTO EVERYDAY WORK

The challenge
With workplace lighting, operators look for both technically innovative, energy-efficient solutions and luminaires with attractive designs. It's a matter of finding a lighting solution optimally combining both factors.

The solution
The Arimo Slim MRX LED from TRILUX is the answer. The innovative optic of the recessed and surface-mounted luminaires consists of a micro-reflector (MRX) framed by planar light elements. The MRX Technology ensures optimum glare reduction to provide maximum visual comfort even with high lumen packages. A further plus of the LED luminaire is its outstanding energy efficiency. Light management and emergency light components can also be integrated into the Arimo Slim MRX LED.

The result
Whether refurbishing or installing a new system, the Arimo Slim MRX LED from TRILUX combines state-of-the-art technology with an unusual design to provide best quality of light and above-average energy efficiency.

Design: MID Möller and Demmer

✓

2,800 lm - 4,000 lm

3000 K 4000 K

> 50,000 h

Switchable and dimmable (DALI), switchable

Individual battery system, 3 hours,
Linect luminaire connection system

IP20

Innovative MRX Technology
Micro Reflector Technology (MRX) has been specifically developed for LED luminaires. With the Arimo this guarantees glare-free light (UGR19 < 1,500cd/m²) with pleasant visual comfort even with high lumen packages.

One design – diverse possibilities
The Arimo Slim MRX LED is also available as linear recessed or square surface-mounted luminaire. This makes the luminaire the perfect solutions for refurbishment as well as new installations.

SOLVAN FLOW LED

THE ALL-ROUND TALENT
FOR GREATER PLANNING
FLEXIBILITY

DESIGN AWARD 2016

www.trilux.com/solvanflow

The challenge
The need to refurbish obsolete installations is increasing. Ever more operators of office buildings, school buildings, care homes and shops are upgrading to efficient LED lighting solutions. Not only high energy efficiency with luminaires is focused on here, but also the ability to adapt light to individual needs. Flexibility is required in such cases, because these needs may also change within a building.

The solution
TRILUX's Solvan Flow is a highly diverse multi-talent for the refurbishment and new installation of lighting systems in the educational, care, office and retail sector. The LED luminaire sets effective accents as a single luminaire and can also be configured as a seamless continuous line without shadow gaps for increased lighting tasks. Recessed, surface-mounted and suspended luminaires as well as several optional lumen packages and optics ensure additional flexibility – allowing the flat, slender luminaire to be conveniently modified to specific needs in e.g. classrooms, offices or corridors. The possibility of integrating the TRILUX LiveLink light management system and optional emergency light components make the Solvan Flow LED an intelligent all-rounder.

The result
The Solvan Flow LED enables lighting designers to plan uniform but individually adapted lighting solutions across several rooms, providing high planning flexibility in this way. Whether as a single luminaire or continuous line, as a new installation or refurbishment solution for upgrading old systems, the all-rounder blends into the background to place the lighting task in the foreground.

Design: MID Möller and Demmer

✓

3,000 lm - 6,400 lm

K 3000 K 4000 K

> 50,000 h

Switchable and dimmable (DALI), switchable

Individual battery system, 3 hours,
switching relais for emergency power systems

IP20

Planning diversity
The Solvan Flow LED can be used as a single luminaire (recessed, surface-mounted or suspended version) or as a seamless continuous line, providing uniform lighting installations using only the Solvan range. The UGR19 version is also suitable for areas where computer screens are used. With various accessories, the Solvan Flow LED can be modified for installation in various ceiling systems.

Innovative photometrics
With a soft, lateral light emission across the complete luminaire length, the optical system creates a pleasantly elegant appearance.

LUNEXO LED

SMARTER LIGHT FOR
INCREASED COMFORT

The challenge
Light is a fundamental necessity of life and influences our long term well-being. Modern office environments that are used diversely require adaptable, dynamic and prestigious lighting. Employees, have different lighting requirements, based on their age and individual needs in order to work productively and with a high level of concentration.

The solution
As an intelligent surface-mounted and suspended luminaire, the Lunexo LED meets all individual lighting requirements. The luminaire emits glare-free light with maximum quality, is able to optimally illuminate very different situations and can be modified to a wide variety of lighting needs. In addition to simple, intuitive control, automatic mode controlled via sensors is also possible to keep energy costs to a minimum.

The result
The TRILUX Lunexo LED writes a new chapter in office lighting. Maximum light comfort and individual setting options make the luminaire ideal for highly different needs and situations. Light that can be flexibly adapted, maximum user convenience due to simple operation and first-class looks set standards for office lighting of the future.

Design: Designit Munich, Dominik Schütz

4,800 lm - 8,800 lm

> 50,000 h

Switchable and dimmable (DALI)

White-white control

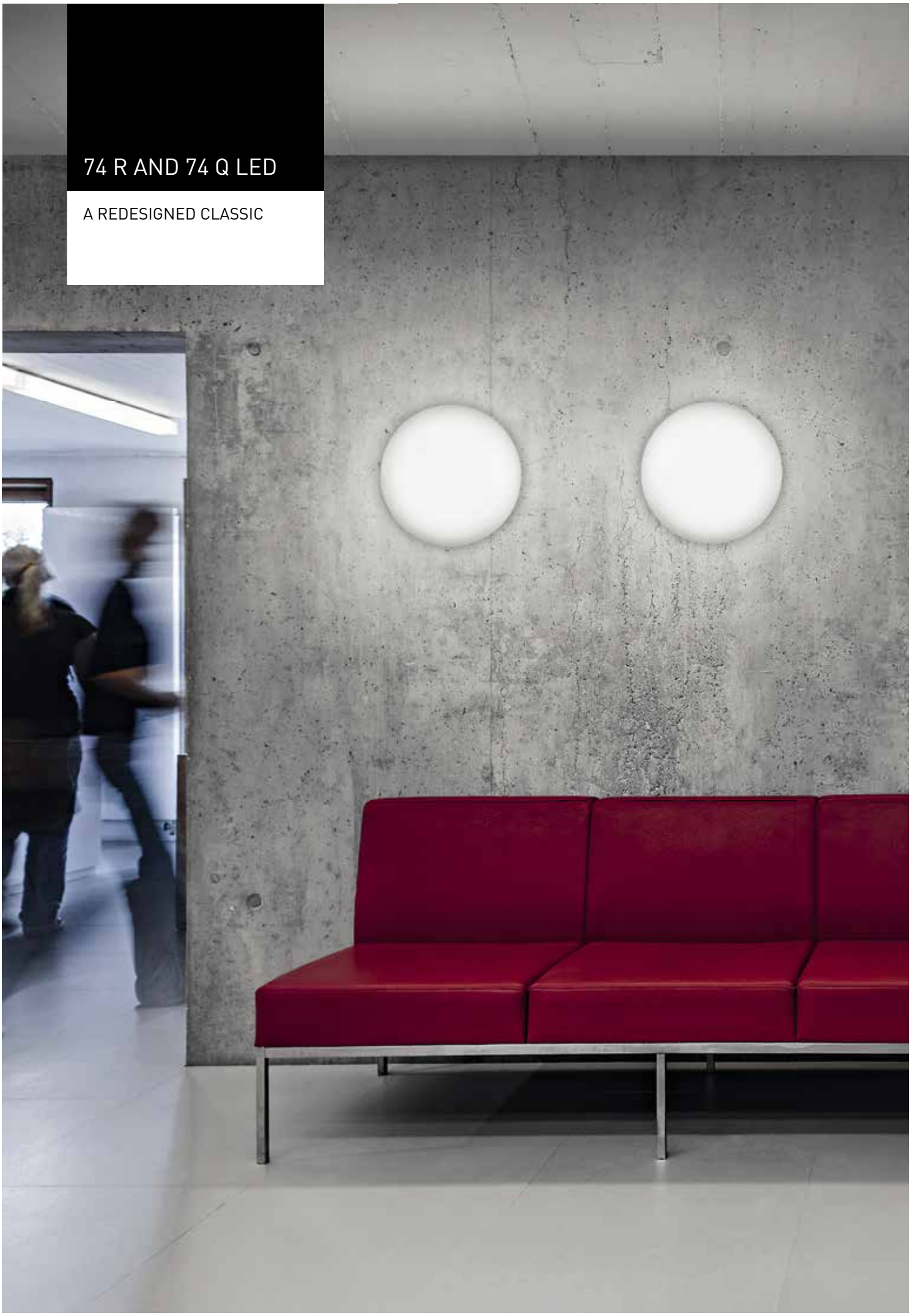
IP20

Connectivity
The luminaire can connect with a mobile end device via WLAN. It can then be controlled via the TRILUX LiveLink operator app.

Top quality of light in a discreet shell
The smooth light emission surface creates especially pleasant and glare-free light in accordance with UGR19, for the standard-compliant illumination of workstations. At the same time the luminaire sets attractive accents with its all-round light edge that highlights the interior design.

74 R AND 74 Q LED

A REDESIGNED CLASSIC



GOLD AWARD 2016

DESIGN PLUS
powered by: light+building

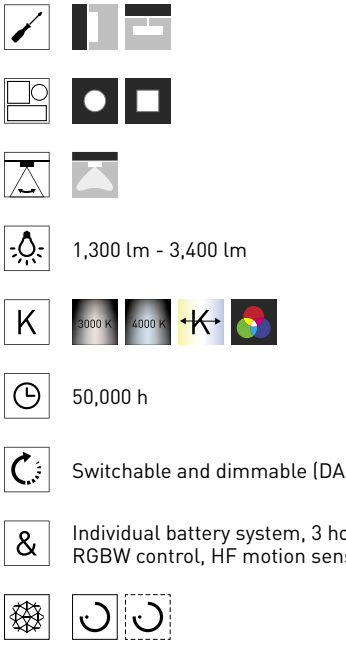
www.trilux.com/74r
www.trilux.com/74q

The challenge
In some corridors and stairways, purely functional lighting is often sufficient. This is completely different though with path zones with a prestigious character or with frequent occupancy, e.g. entrance and waiting areas as well as multi-use offices with creative and relaxation zones. Here, it is a matter of making the most of the aesthetic, technical and functional options of modern lighting. This ranges from light controlled via presence control and predefined light scenes to biologically effective light.

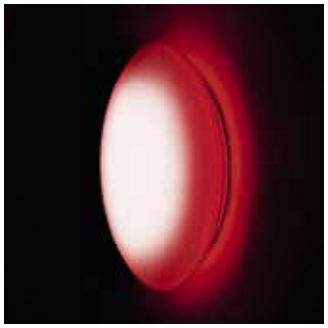
The solution
The reliable TRILUX series 740··· and Deca ranges have been completely newly interpreted and therefore open up a new chapter with regard to technology, looks, light effect and control. The resulting product range now has the 74 R as the round luminaire and the 74 Q as the square version (Q = quadratic) which replaces the Deca. Both designs feature a softly formed luminaire body with an indirect light component for pleasant light which provides a general feeling of well-being. The luminaires are each available in three construction sizes and several different versions. When combined with a light management system, e.g. LiveLink, the benefits of Human Centric Lighting can be realised – from activating and relaxing light to coloured lighting accents.

The result
The 74 R LED and 74 Q LED open up many new possibilities for implementing functional and atmospheric (version specific) lighting solutions. The significantly flatter design combined with a very concise look free the luminaires from their surface mounting and lend them the almost floating appearance. As a result, the new luminaire range suits perfectly into diverse application areas.

Design: Sieger Design



An attractive design
The reinterpretation of the classic was created with attention to detail: the timeless yet still fresh design with a consistently soft luminaire body and suitable construction sizes imparts an impression of quality and value, which in turn reflects the high quality of the luminaire in terms of light and workmanship.



Light for feelings of well-being, activation and relaxation
Selected product versions are available with white-white and RGBW control. This enables biologically effective and attractively decorative lighting concepts to be implemented. The wide range of design versions offers completely new flexibility for individual interior designs.

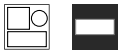
6651··· LED

SAME SIMPLICITY.
BETTER EFFICIENCY.

The challenge
Sanitary rooms in public buildings, administrative buildings, hospitals and care homes must, first and foremost, be highly functional. This also applies to the lighting. LED solutions are especially suitable due to their energy and maintenance efficiency.

The solution
With the 665··· LED, TRILUX has consistently developed the established mirror luminaire towards LED technology. The luminaire has been optimally designed for requirements in standard sanitary areas with factors ranging from its IP rating to its dimensions. It also ensures low investment costs. This means the mirror luminaire is also ideal for refurbishing old lighting systems.

The result
The TRILUX 665··· offers very simple installation and complete LED efficiency. With refurbishments, it therefore not only saves time but also ensures lower energy costs compared to an old system, making it extremely economical.



1,100 lm - 2,100 lm

50,000 h

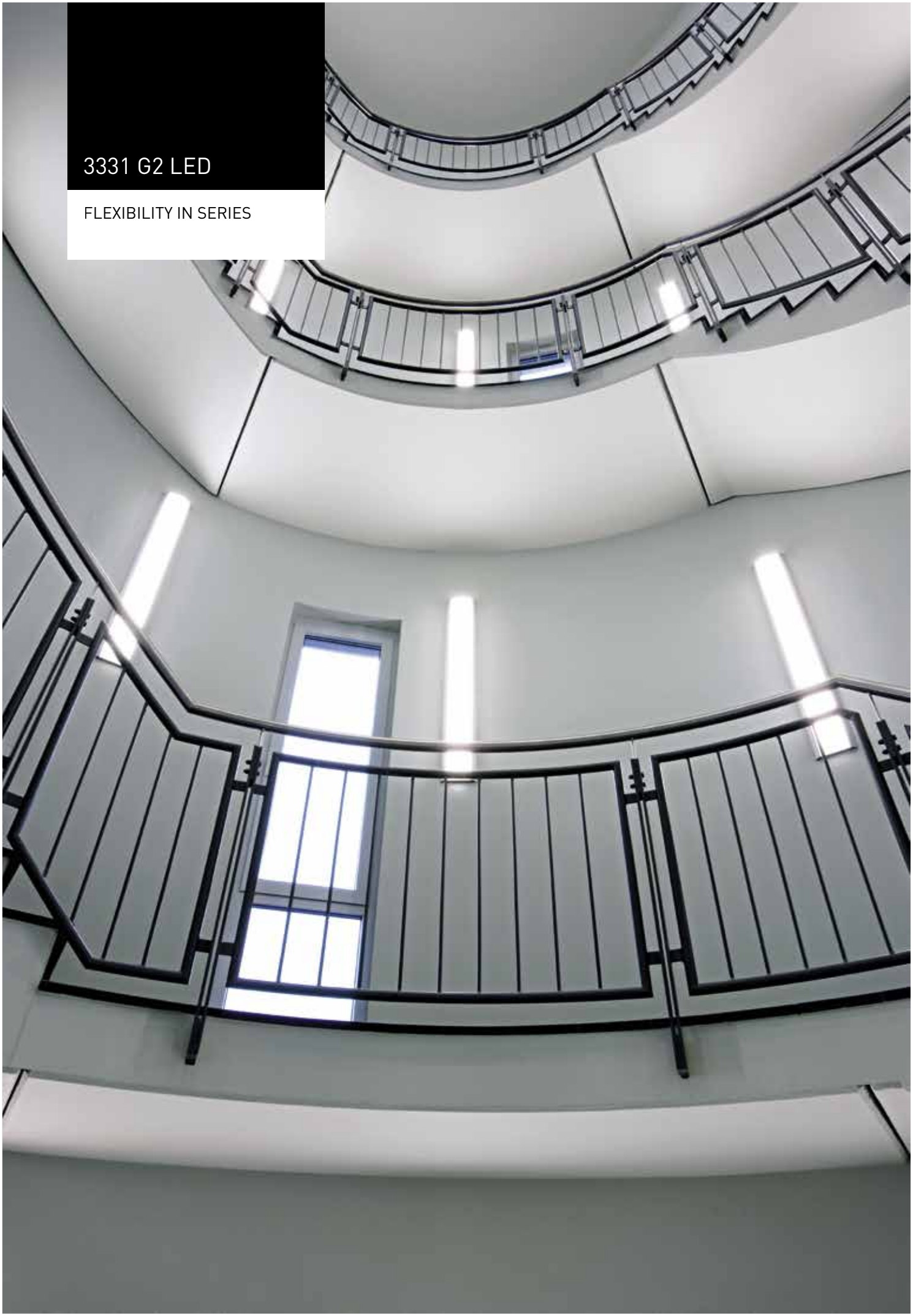
Switchable

IP40

Plastic end caps in white or chrome design.

3331 G2 LED

FLEXIBILITY IN SERIES



The challenge
When lighting corridors, stairways, entrance and relaxation areas, lighting designers on the one hand look for the most practical and simple solution, on the other hand though, the market increasingly demands applications that also feature high levels of intelligence, energy efficiency and design quality.

The solution
The 3331 G2 LED is the new, especially energy-efficient further development of the reliable 333··· range. The luminaire emits pleasant, uniform light – and is especially adaptable thanks to various mounting methods and technological diversity. The sensor version with presence detection and daylight control helps to minimise operating costs. Together with an optional light management system for white-white control, Human Centric Lighting solutions featuring biologically effective light can be implemented. The 3331 G2 LED is also an ideal refurbishment solution thanks to effortless installation and rapid commissioning.

The result
The 3331 G2 LED also achieves maximum standards for energy efficiency, light quality and light control in traffic zones, relaxation areas and ancillary zones, with a unique level of simplicity.

1,200 lm - 4,900 lm

> 50,000 h

Switchable and dimmable (DALI), switchable

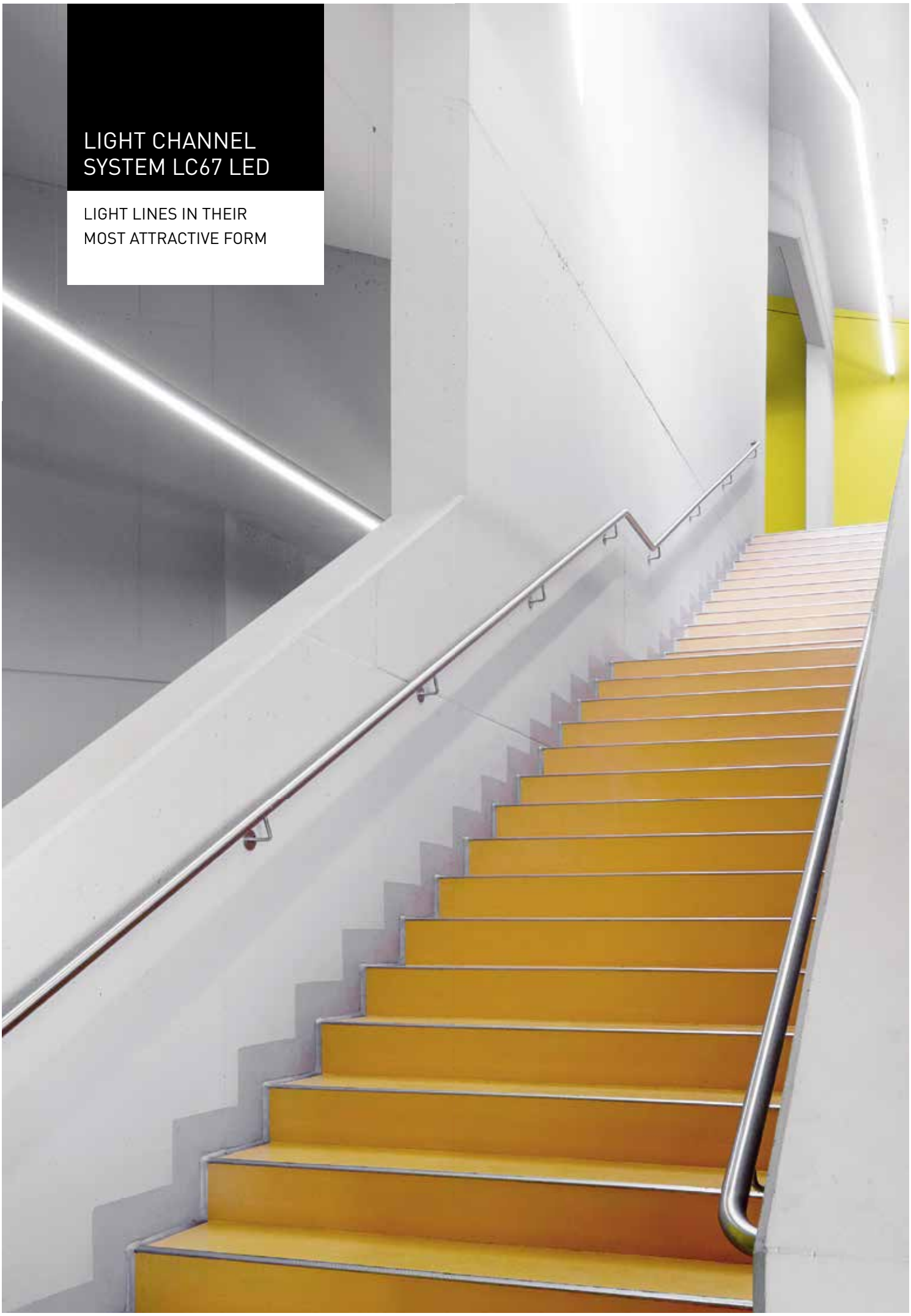
HF motion sensor, individual battery system, 3 hours, white-white control

IP50

High energy efficiency
With energy efficiency of up to 130 lm/W and a service life of 50,000 h, the 3331 G2 LED has especially low operating costs.

LiveLink

Intelligent control
The 3331 G2 LED features various intelligent light control possibilities. In addition to the ET version with standard sensor technology for presence detection and daylight control, the ETDD version can be controlled using a light management system, e.g. LiveLink.



LIGHT CHANNEL SYSTEM LC67 LED

LIGHT LINES IN THEIR MOST ATTRACTIVE FORM

The challenge
Lighting in sophisticated architectural projects has a challenging double role – it must supply maximum quality of light and can itself also be an element of design. When light becomes a part of the architecture, the lighting solution must adapt to the architectural language of the building and not the other way around.

The solution
Modular light lines: with the LC67 light channel system, TRILUX provides a lighting solution with infinite options. The core module, a 67 mm-wide aluminium channel, is available in ten different module lengths. T, L and X connectors enable the light channel to be either horizontally or vertically continued around corners. Even the level of luminaire visibility in the room can be varied – the luminaire can be either recessed, surface-mounted or suspended.

The result
Timelessly elegant light lines emphasise sophisticated architectural projects with highly uniform, almost shadow-gap-free light. The LC67 light channel from TRILUX is a highly flexible lighting solution providing designers with complete creative flexibility.

2,500 lm - 4,000 lm per metre

> 50,000 h

Switchable and dimmable (DALI)

An adaptable light channel system.

Shadow-gap-free, pleasant light.

SISTEMA COMPACT LED

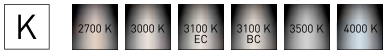
MAXIMALLY MODULAR

The challenge
Everyday retail lighting: uniform illumination is required in one area and elsewhere a spot. In shop window areas the mounting space is tight and high decorative elements on walls should be illuminated. Soon the requirements will change completely, because changing assortments demand maximum flexibility. Based on this it's also a matter of achieving a calm ceiling appearance with a uniform luminaire design.

The solution
Sistema LED has perfected the modular principle: the core of the extremely diverse product range is a single, double or triple-cell frame which can be flexibly equipped with highly different light modules. Own-system recessed and surface-mounted spotlights are also available as well as light modules from other Oktalite product ranges. If requirements change, the light modules or reflectors can be retroactively exchanged without tools. The range of luminaires is available as Sistema LED in standard size or the extra-small Sistema Compact LED.

The result
The modular, diverse luminaire family provides maximum flexibility with minimum effort, so that desired light effects can always be simply implemented. Despite differing light modules, a calm and uniform ceiling appearance is achieved thanks to the range-typical square frame.

3,000 lm - 4,000 lm



50,000 h

Sistema LED: switchable and dimmable (LED^{IQ})
Sistema Compact LED: switchable, switchable and dimmable (LED^{IQ}) on request

Optional protective glass cover

(optional)

IP20

The system is based on single, double or triple-cell frame modules that can be equipped with various light components.

The recess mounting depth of the Sistema Compact LED is just 180 mm. Sistema Compact can be equipped with LED lumen packages of up to 4,000 lm.

E-LINE LED

A CONTINUOUS LINE FOR
EVERY APPLICATION

The challenge
Lighting refurbishments for industrial companies, retail outlets, offices and educational facilities can achieve high cost savings. However, replacing a complete lighting installation across different work areas rapidly becomes complicated due to the variety of different demands. Replacing lighting systems also frequently interrupts ongoing processes.

The solution
Thanks to selectable lumen packages, optics and protection ratings, the continuous line can be adapted more quickly to application-specific requirements. As a HACCP-compliant solution, the trunking can now also be specifically used in the food industry. In cold stores or canopied outdoor areas for example, the E-Line version with IP54 protection is a highly reliable solution. The continuous line also illuminates offices, educational/training facilities and cashpoint areas in the shop and retail sector in next to no time and with high energy efficiency thanks to its glare-reduced UGR<19 reflector. A fundamental strength of the E-Line is very simple installation – those operating conventional T5 or T8 E-Line trunkings for example can upgrade a module to especially energy-efficient E-Line LED in just 44 seconds.

The result
With the E-Line, lighting designers, electrical contractors and end users have an extremely high-performance, flexible all-rounder, which, with its wide range of versions, provides high reliability in challenging industrial environments as well as the office and retail sectors. The quick, simple planning and installation of the continuous line system minimises the effort required and also reduces cost-intensive interruptions to everyday work.

✓

4,000 lm - 20,000 lm

3000 K 4000 K 6500 K

> 50,000 h

Switchable and dimmable (DALI), switchable

Individual battery system, 3 hours,
switching relay for emergency power supply systems

IP20

High planning flexibility
The E-Line LED copes with any lighting task thanks to diverse lumen packages and different optics – in both, Shop & Retail and Industry applications.

High quality
The luminaire emits harmonious, low-contrast light and features high lighting quality.

E-LINE LED IP54

A CONTINUOUS LINE FOR
EVERY APPLICATION

The challenge
Lighting refurbishments for industrial companies, retail outlets, offices and educational facilities can achieve high cost savings. However, replacing a complete lighting installation across different work areas rapidly becomes complicated due to the variety of different demands. Replacing lighting systems also frequently interrupts every-day running operations.

The solution
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✓

4,000 lm - 8,000 lm

3000 K | 4000 K | 6500 K

> 50,000 h

Switchable and dimmable (DALI), switchable

Individual battery system, 3 hours,
switching relay for emergency power supply systems

IP54

Simple mounting
With only three luminaire components – the gear tray, the trunking and the transparent optic – the luminaire is installed especially quickly and simply, without tools.

Tough
The version with IP54 protection rating is dust and splash water resistant.

MIRONA FIT LED

MINIMUM DIMENSIONS
WITH MAXIMUM POWER

The challenge
High temperatures, humidity, sparks, fumes and vibrations – tough conditions exist in industrial production and storage halls. It's not just the production plant that needs to cope with such conditions but also the lighting needs to be 100 % reliable. The problem: particularly in halls with ceiling heights of more than 13 metres, maintaining the lighting system is difficult and comes with high costs.

The solution
The TRILUX Mirona Fit LED is the perfect lighting solution for challenging surroundings. This applies to storage and logistics halls, e.g. in heavy industry and food production, as well as for sports halls. With a 50,000 hour service life (L80) even at high ambient temperatures of 55 °C, the luminaire is not only especially durable but also extremely reliable with a low maintenance requirement. The luminaire can also be adapted to individual requirements via light distribution characteristic, lumen output and optional sensor and CLO function (Constant Light Output). The 52,000 lumen version even makes 2:1 refurbishments possible. The LED luminaire provides high quality light and therefore safety in halls.

The result
The Mirona Fit LED complies with maximum lighting specifications in industry and can be precisely modified to specific demands. The new highbay luminaire offers lighting designers flexibility and end users complete reliability with low operating costs, high energy efficiency and quality of light.

Design: MID Möller and Demmer

13,000 lm - 52,000 lm

4000 K

> 50,000 h

Switchable and dimmable (DALI)

IP65

A range of versions
Three different lumen packages, 13,000 lm, 26,000 lm or 52,000 lm, ensures complete flexibility. Three different light distribution curves provide further options.

Energy efficiency
With up to 150 lm/W, the Mirona Fit LED is extremely efficient. The version with the highest lumen package (52,000 lm) even enables 2:1 refurbishments.

MIRONA RL LED

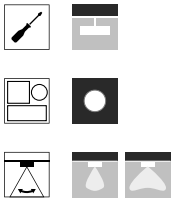
ALL-ROUND PERFORMANCE

The challenge
When searching for ideal lighting solutions for warehouses and logistics halls, aspects such as functionality and energy efficiency are often focused on. These two parameters however do not exclude an attractive industrial design that also proves its worth in surroundings with public traffic such as car parks, DIY centres and trade fair halls.

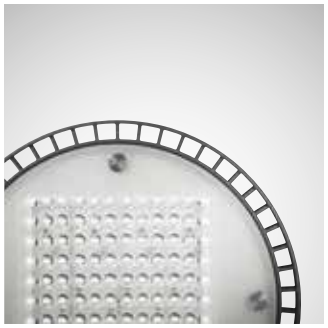
The solution
The Mirona RL LED sets accents within the range of Mirona highbay luminaires. Unique features are the rotationally symmetric light distribution characteristic and the direction-independent construction of the luminaire body with its round light emission surface. With its high lumen packages the Mirona RL LED is outstandingly suited for illuminating logistics and storage halls with low mounting heights, as well as for applications in prestigious sales and display areas.

The result
The Mirona RL LED combines the great demands of industry and economy with regard to functionality and an especially attractive design. This in turn provides designers and architects with new, prestigious application areas.

Design: MID Möller and Demmer



Flexible applications in industry and retail
With 6,000 and 12,000 lumen packages, IP65 protection rating a robust housing and a concise, round design, the high bay luminaire has a wide spectrum of applications.



High visual comfort
The Mirona RL LED emits pleasant light without glare and with high colour rendering (CRI >80). Light emission through the diffuser panel ensures uniform illumination.

NEXTREMA G3 LED

THE ROBUST WEATHER-PROOF LUMINAIRE FOR EXTREME SITUATIONS

The challenge
Making more from less – efficiency with resources is a matter of course in the industrial sector. The first starting point for around two thirds of companies surveyed is energy consumption. Lighting in this regard is highly important. In factories, lighting takes up around 15 % of electricity requirements, in warehouses it is even up to 80 %. Furthermore, high-maintenance obsolete systems frequently cause disruptions to operations and production runs, and in worst cases even idle times.

The solution
The Nextrema G3 LED as the third generation of the tried and tested TRILUX weather-proof luminaire is a specialised, high-efficiency lighting solution for industrial environments. Its extremely robust die-cast aluminium body makes the luminaire extremely resistant to low and high temperatures, humidity, dust, knocks and impacts. The LED luminaire also provides a significantly higher service life than average with almost no maintenance. The Nextrema G3 LED is also very quickly installed thanks to the supplied mounting template, mounting clips and Wieland rapid connection system.

The result
Whether for cold stores, food production, logistics halls or car parks – the Nextrema G3 LED emits pleasantly uniform, glare-free light and in operation not only saves costs but keeps operations going in the long run thanks to high reliability.

2,300 lm - 8,000 lm

4000 K

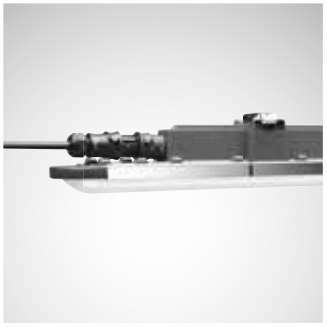
> 70,000 h

Switchable and dimmable (DALI), switchable

Through-wiring, HF motion sensor, Wieland rapid connection system, individual battery system, 1 hour/3 hours

IP66

Intelligent thanks to integrated sensors.



Rapid and simple mounting.

ARAXEON LED

A SMART SOLUTION FOR
GREATER DIVERSITY

The challenge
Previously, when lighting car parks, cold stores and food production facilities the following was true: compliance with standards was the main point. Today, lighting designers and electrical contractors have high demands and look for energy-efficient, application-specific planning solutions that are also simple and can be intelligently controlled.

The solution
Araxeon LED enables the advantages of LED technology to also be used in damp rooms. Thanks to high light and material quality, the Araxeon LED can also be used in the food industry. The slender weather-proof luminaire is also intelligent: together with sensors or a light management system, practical and energy-saving functions can be effortlessly implemented, e.g. motion detection in car parks.

The result
Lighting designers can carry out sophisticated damp room projects with minimal effort by using the Araxeon LED. In addition to impressive energy-efficiency, service life and resistance values, the LED weather-proof luminaire also features flexible lighting technology and optional control possibilities using sensors and an intelligent light management system. The Araxeon LED also makes full use of today's LED technology benefits due to its modern design.

2,300 lm - 6,000 lm

4000 K

50,000 h

Switchable and dimmable (DALI), switchable

Through-wiring, HF motion sensor, Wieland rapid connection system, individual battery system for emergency light, 3 hours

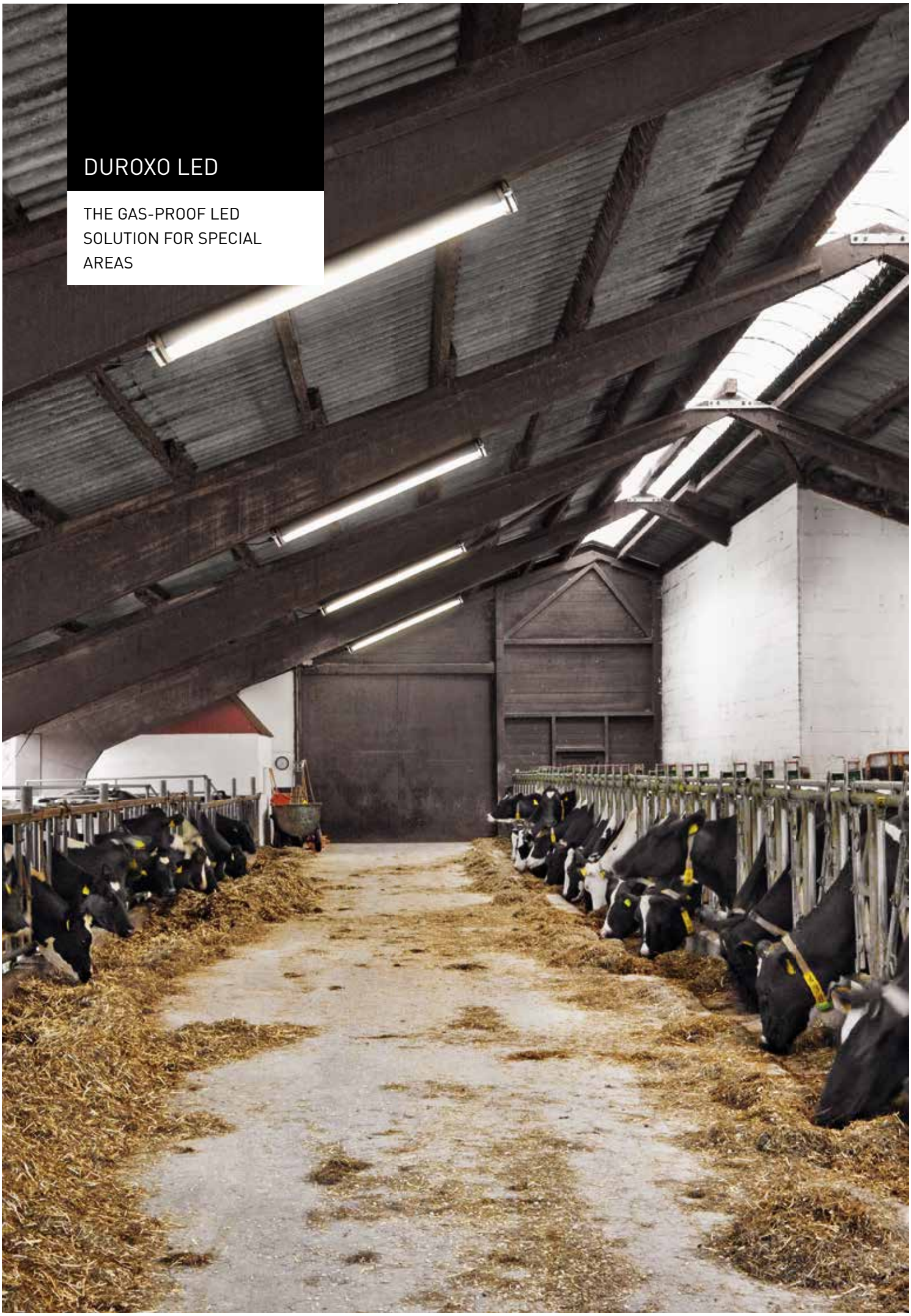
IP66

High energy efficiency
Economically, the Araxeon LED is very attractive: The luminaire is very energie-efficient with up to 146 lm/W.

Intelligent light management
High operating cost savings are achieved in combination with intelligent sensors for presence and daylight detection. In addition, integrating the Araxeon LED into the LiveLink light management system is simple.

DUROXO LED

THE GAS-PROOF LED SOLUTION FOR SPECIAL AREAS



The challenge
Equipping or refurbishing rooms and halls with energy-saving LED solutions is especially challenging in special areas such as animal husbandry. The reason for this is that fumes and gases in the air are often a problem for LED luminaires. Sulphur and ammonia mainly lead to premature reductions in luminous flux with LEDs. In such cases, lighting must not only supply high quality light but also be completely gas-proof.

The solution
The new weather-proof luminaire Duroxo LED from TRILUX is also gas-proof, thus protecting its LEDs from premature ageing. The luminaire features maximum LED efficiency in applications with special atmospheres containing fumes, gases or solvents, e.g. in intensive animal husbandry. As a reliable refurbishment product, the Duroxo LED has a long, low-maintenance service life as well as minimum operating costs compared to conventional solutions. The luminaire is also highly robust, offering protection not only to gases and vapours but also water and cleaning chemicals.

The result
The Duroxo LED provides lighting designers and end users with a robust and durable product for use in rooms with special atmospheres. With its high LED energy-saving potential, the luminaire is also a cost-efficient refurbishment solution for such environments.

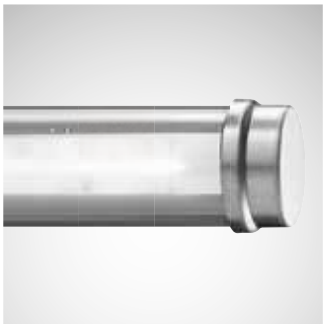
5,500 lm

4000 K

> 50,000 h

Switchable and dimmable (DALI), dimmable

IP69K



A long life without premature ageing
Its gas-proof construction protects the phosphor layer of the LEDs from damaging gases such as ammonia. This counteracts the premature reduction of luminous flux.

Tough without compromises
The weather-proof luminaire is robust in every respect. It has an IP69K protection rating, high impact resistance of IK10 and is also resistant against cleaning material and disinfectants.

713··· LED

SIMPLE UPGRADES AND
GREATER EFFICIENCY

The challenge
When upgrading lighting in damp rooms such as large kitchens or sanitary areas, two aspects are essential: the new installation must be economic and reliable. In such cases, energy-efficient LED solutions are best suited which can save costs and ensure reliable operation due to robust constructions.

The solutions
With the 713 LED, TRILUX now offers its reliable weather-proof luminaire in an especially efficient LED version which is also ideal for a wide range of applications thanks to its modification options. The luminaire is predestined for uses in tough conditions thanks to its high levels of resistance. Upgrading old systems to LED is also quick and simple thanks to easy installation.

The result
The TRILUX 713 LED offers end users reliable customised light – also in challenging damp rooms. This is achieved with the robust construction and wide range of versions. Thanks to its LED-typical economy, the luminaire comes out on top when it comes to cost-efficiency.

3,000 lm - 6,000 lm

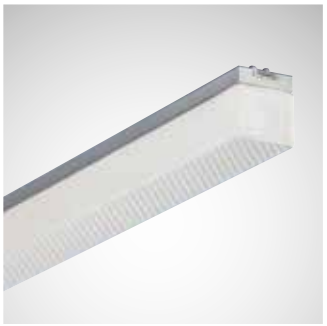
3000 K 4000 K

50,000 h

Switchable and dimmable (DALI), switchable

IP54

A robust construction
With its high protection rating, the weather-proof luminaire offers protection against soiling, dust and splash water. This means it is ideal for use in large-scale kitchens, sanitary areas, corridors, ancillary rooms and canopied outdoor areas.



Economic LED technology
The 713 LED features luminous efficiency of up to 132 lm/W and a service life of 50,000 operating hours. DALI-dimmable versions can be integrated into local light management systems.

VIACON LED

AN INTELLIGENT
FUTURE-PROOF
LUMINAIRE

The challenge
Those investing in top-modern outdoor lighting today may be surprised tomorrow with the next generation of luminaires. This problem is slowing down the complete transformation of urban outdoor lighting to energy-efficient LED technology. Many conventional linear luminaires are still in operation, but upgrading to LED offers enormous technological possibilities and energy savings potential of more than 50 %. Furthermore, intelligent LED light with its extensive networking options enables many Smart City applications for tomorrow's towns and cities.

The solution
TRILUX ViaCon LED is an energy-efficient outdoor lighting solution with a revolutionary simple modular concept. Numerous light distribution curves and diverse mounting options are available, ranging from traditional post-top brackets to catenary luminaires. The luminaire is also available with various E-block variants, ranging from a basic version to versions with almost limitless networking and control options. For maximum future safety, the ViaCon LED as "Smart Lighting Ready" version can be simply and quickly modified or upgraded via Plug&Play.

The result
Everything's possible: with its extremely flexible, individually adaptable, modular design, the ViaCon LED provides maximum design flexibility with future safety and is therefore a secure investment. The low-cost basic version already provides the advantages of LED technology. The "Smart Lighting Ready" premium version guarantees maximum intelligence with lighting thanks to many Smart City functions and applications such as the setting of luminaire luminous flux and dimming profiles via Bluetooth.


1,000 lm - 8,200 lm


3 - 8 m


> 100,000 h


Switchable and dimmable (DALI)


Power reduction via control phase (LR)
Self-regulated power reduction (LRA)

The post top luminaire and the catenary luminaire complete the product family.

LUMEGA IQ LED

FLEXIBLE OUTDOOR
LIGHTING WITH INTELLIGENT
FEATURES

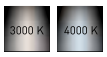
The challenge
If access ways, paths, squares or streets need to be illuminated, the quality of light must be right and also provide safety and orientation. This also applies to areas and road sections where conditions for light planning are not optimal for designers and architects. If for example tight areas, buildings or walls limit the available scope, an especially adaptable lighting solution is needed.

The solution
The Lumega IQ LED post luminaire is modified with just a few flicks of the wrist from a bracket-mounted to a post-top luminaire. This is possible thanks to a single screw accessible from outside: the screw enables the inclination angle of the post luminaire to be quickly and simply adjusted. The wide selection of optics and LED systems provides even further flexibility. As a result, with the Lumega IQ LED almost all outdoor areas can be illuminated with high energy efficiency and according to standards. The post luminaire becomes especially efficient with high-performance light management systems and intelligent switching concepts.

The result
With the Lumega IQ LED TRILUX provides designers and architects with an extremely adaptable, high-performance outdoor lighting solution in the portfolio that can be flexibly used in almost any surroundings.

Design: Rino Bossy

1,000 lm - 4,600 lm, 3,200 lm - 12,000 lm,
13,500 lm - 22,000 lm



4 – 6 m, 5 – 8 m, 8 – 14 m

> 100,000 h

Switchable and dimmable (DALI)

Power reduction via control phase (LR)
Self-regulated power reduction (LRA)

IP66

Individual applications
The new MLT[IQ] modular lens system with in-house developed TRILUX lenses enables luminaires to be individually modified to customer-specific light requirements.

Complete and intelligent
The new, small Lumega IQ50 completes the Lumega IQ family with a third construction size. The inclination angle of the luminaire head can be adjusted in 5° steps from outside with a single screw. This enables simple conversion of the Lumega IQ LED from a post-top to a bracket-mounted luminaire.

COMING SOON: LUMANTIX LED

THE INTELLIGENT POST-MOUNTED LUMINAIRE FOR DECORATIVE OUTDOOR LIGHTING

The challenge
Everywhere in towns and cities, the refurbishment of conventional decorative outdoor lighting is being focused on in the coming years. Selecting the right lighting solution points the way to the future – not only in terms of energy efficiency but also with regard to the townscape and future technical possibilities for Smart Cities.

The solution
The Lumantix LED represents diversity in every respect: the post-top luminaire is available in a range of versions from the low-cost basic luminaire to the high-end premium version for Smart Lighting. In terms of appearance, the luminaire blends harmoniously into its surroundings. High flexibility with regard to reflectors also ensures optimum lighting conditions. A special feature: lenses and E-blocks can also be replaced at any time following installation and commissioning. This adaptive capability makes the luminaire fit for the future and also helps with financing via step-by-step expansion: the cost-attractive basic luminaire is ideal as a start-up luminaire. If the lighting system is to be integrated into an intelligent network as part of a Smart City at a later time, simply replacing the E-block without tools is sufficient for a range of networking and control possibilities.

The result
The Lumantix LED brings planning flexibility to urban outdoor lighting. It already offers all possibilities of LED technology in an existing cost frame – while keeping all options open for the future. Integrated into intelligent networking systems such as Smart City concepts, urban areas can be especially energy- and cost-efficiently illuminated with the Lumantix LED.

Design: Rino Bossy

1,000 lm - 4,200 lm

3000 K 4000 K

> 100,000 h

Switchable and dimmable (DALI)

Power reduction via control phase (LR)
Self-regulated power reduction (LRA)

IP66

Perfect light
The Lumantix LED's LED modules have high quality optics featuring optimised light control thanks to high-performance Multi Lens Technology, thus emitting perfect light. Various rotationally symmetric and asymmetric wide light distribution characteristics are available.

Future-proof
All electronic components can be replaced without tools in the form of a compact E-block and luminaires can be retrofitted with sensor technology, light management and programming from outside.

CONSTELA LED

BREATHTAKINGLY
ATTRACTIVE AND INTELLI-
GENTLY CONFIGURED

The challenge
Light is a central element of design for the presentation of urban spaces: aesthetics are becoming increasingly important in addition to functional aspects. The luminaire design must harmonise with both classic and modern architecture – and also have its own qualitative design appeal.

The solution
The ConStela LED is an extremely adaptable, modularly designed luminaire range with an unmistakable, purist, modern design. The light column is available with supporting columns of various heights ranging from bollards to posts, and can be flexibly equipped with the desired lighting technology and reflector. This enables public spaces to be generously illuminated and single buildings or areas to be specifically highlighted. The uniform design creates an elegant background.

The result
The ConStela LED combines functionality, individuality and aesthetics: its modular construction enables city architects to implement highly diverse urban lighting tasks with a uniform and outstanding design.


1,100 lm


> 100,000 h


Switchable

The ConStela bollard also features the MLT^{IQ} platform strategy.

8841 LS LED

AN ELEGANT LIGHT COLUMN
FOR PRESTIGIOUS TASKS

The challenge
Those wishing to illuminate prestigious entrance areas, squares and parks/green spaces require lighting solutions that have an attractive appearance when used in the dark, during twilight hours and throughout the day. The luminaires must also provide optimum light and therefore safety, but differing luminaire features may be required depending on the location. A product range is needed which combines a highly flexible technical interior with a uniform and attractive design.

The solution
The 8841 LS LED makes a big impression: with its discreet, slender design the light column is an attractive addition to outdoor areas during the day as well and is available in versions 2.60 m or 3.60 m high. Its technical stats ensure safety and optimum lighting during the hours of darkness: whether asymmetric or rotationally symmetric wide distribution, each version of the 884··· LED column creates optimum light. The reflector of the column can also be modified to requirements on-site thanks to innovative MLT^{IQ} Technology.

The result
The elegant light column offers architects a prestigious design for lighting outdoor spaces and green areas. Thanks to its own variability and together with the bollard and wall versions from the 884··· LED range, complete lighting projects can be carried out with a uniform look.

1,000 lm - 3,500 lm

3000 K 4000 K

2.60 m or 3.60 m

> 100,000 h

Switchable

IP65

8851··· LED

STYLISHLY
HIGH-PERFORMANCE

The challenge
Designing decorative or prestigious outdoor areas provides buildings with a visual framework, whether decorative for a park-style look or a more sober design. Luminaires have the task of setting optical accents both during the day and at night. This however only succeeds if the luminaires can be diversely used despite a uniform overall design that is expressive enough not to become boring. As a matter of course the quality of light has to be a match.

The solution
The 8851 LED product range achieves both – a characteristically concise appearance and a diversity with luminaire versions. The luminaire is available as a bollard, short bollard and wall luminaire. The 8851 LED also displays diversity with its inner values: these range from divers wide light distributions to various lumen packages for maximum visual comfort. As a consequence, the 8851 LED illuminates paths not only safely but also attractively in twilight and darkness.

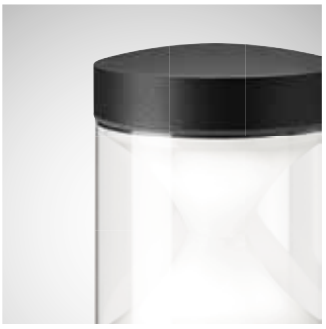
The result
The 8851 LED family expands design options for outdoor areas. Whether in the form of a bollard, short bollard or wall luminaire, the multi-faceted range of luminaires sets characteristic accents during the day and illuminates safely, attractively and efficiently during twilight and at night-time.


700 lm - 850 lm

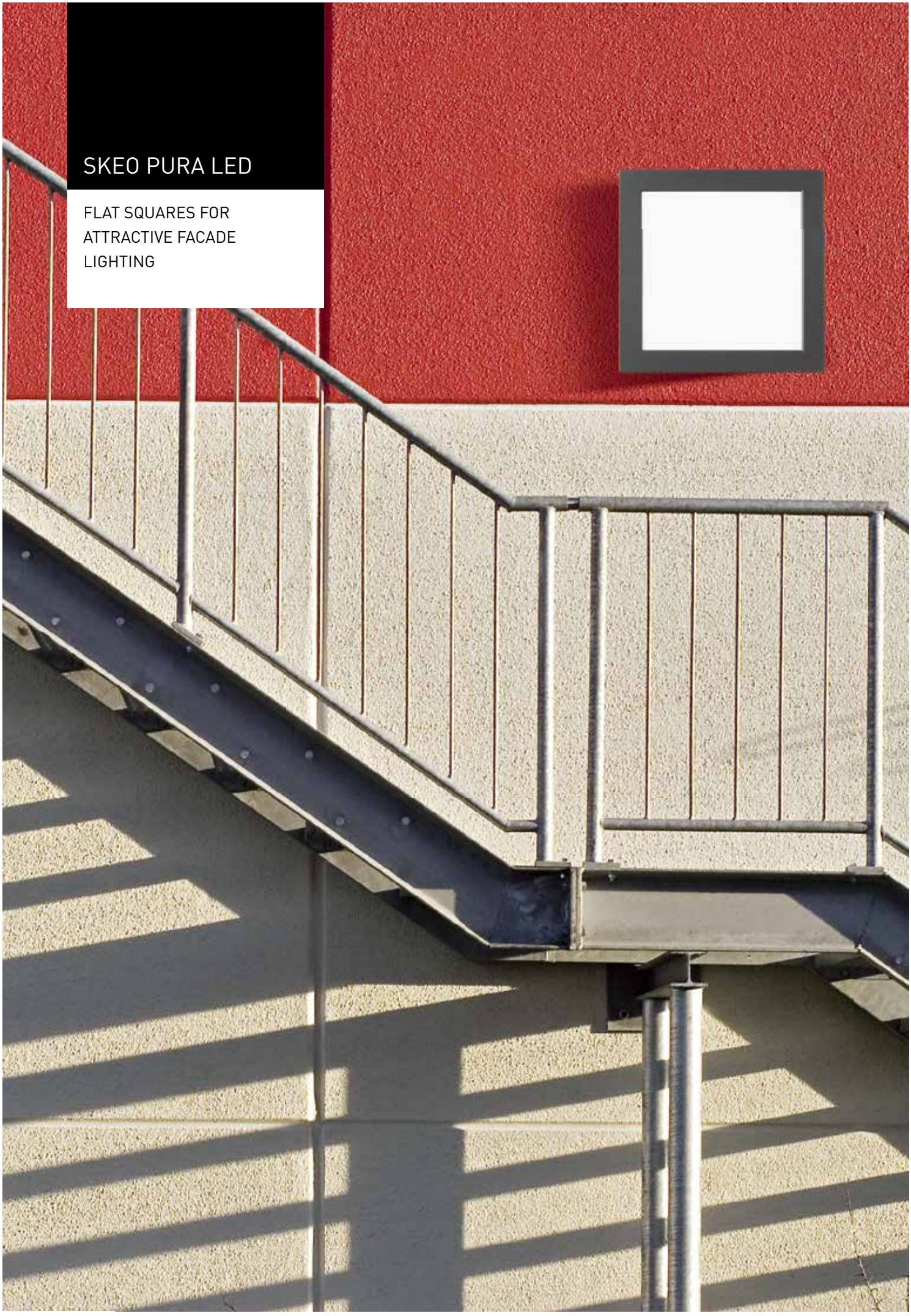

> 100,000 h


Switchable

The bollard is available in two different heights – the short bollard is 660 mm and the standard bollard is 1060 mm high.



Indirect light without glare creates well-being with observers and emphasises the design.



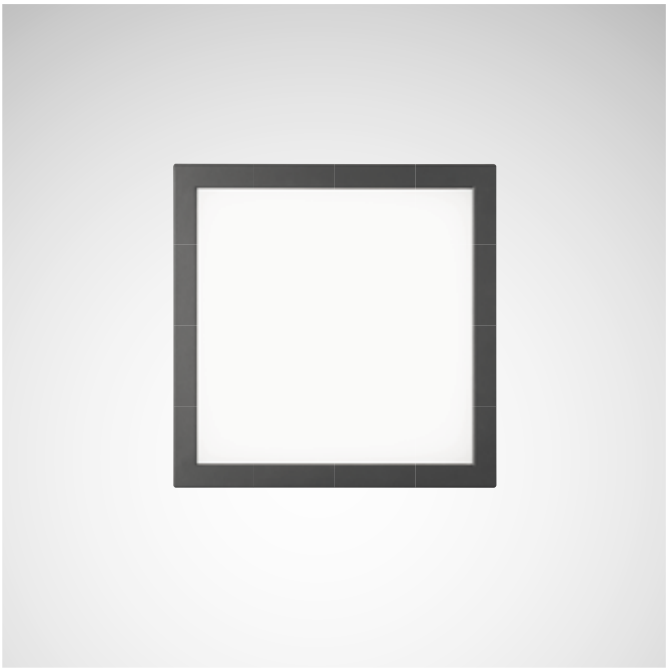
SKEO PURA LED

FLAT SQUARES FOR ATTRACTIVE FACADE LIGHTING

The challenge
When illuminating exterior surfaces, it's often a matter of "the more stable the better". The challenge lies in the fact that the high levels of resistance that are required usually lead to robust, functional luminaires but often neglect the design aspect. After all, robust outdoor lighting should also have an attractive appearance – even if the light has been switched off.

The solution
The Skeo Pura LED is a proof that good looks and stability can be perfectly combined. The square wall and ceiling luminaire offers extremely high levels of resistance thanks to the use of high quality materials. The housing and mounting plate are made of multi-layered die-cast aluminium and the uniformly illuminated cover is manufactured from shatter-proof and impact-resistant glass. Despite this advantage the Skeo Pura LED has a unique, flat design with a timeless, concise look: the frosted white glass cover contrasts pleasantly with the surrounding aluminium housing to provide effective design accents. The luminaire is available in two sizes and is dimmable.

The result
This luminaire is a statement: the Skeo Pura LED enables outdoor areas to be illuminated attractively and with a pleasant atmosphere. Design, light effect and quality of materials are all premium-grade.




500 lm - 1,650 lm


> 50,000 h


Switchable


Two construction sizes with differing wattages provide appealing light for any facade.


The Skeo Pura also features an especially flat, attractive design.

CONSTELA LED

BREATHTAKINGLY
ATTRACTIVE AND CLEVERLY
CONFIGURED

The challenge
Lighting in urban surroundings serves as both orientation device and design: light points us in the right direction and also displays architecture. Spot qualities are needed in outdoor lighting everywhere where precise building illumination is desired.

The solution
ConStela floodlight modules are the perfect supplement to the modular TRILUX ConStela LED light column system. As intermediate elements either between the post and luminaire head or as the termination element, they enable precise building illumination and thus also expand design flexibility. The LED floodlights are extremely moveable. Horizontally they can be adjusted through 360° and can also be vertically tilted. No tools are needed to position and align the floodlight modules.

The result
With the ConStela floodlight modules TRILUX provides the spot principle for urban lighting, offering lighting designers and city architects more creative freedom for effectively displaying buildings and facades. As a result, highly impressive lighting effects are achieved easily.

2,000 lm - 5,100 lm

3000 K 4000 K

> 100,000 h

Switchable and dimmable (DALI)

IP65

Objects and facades can be illuminated and accented individually out of the light column.

LUMENA STAR LED

MINIMUM EFFORT
MAXIMUM EFFECT

The challenge
At first glance it seems only a matter of functionally illuminated open areas or attractively presented facades. However, architects and lighting designers take a look behind the scenes: they see unnecessarily high operating costs for operators caused by many of the currently used standard lighting solutions. Refurbishment provides high potential for savings but is frequently relatively complex.

The solution
With the Lumena Star LED, refurbishing projector installations is achieved especially simply and quickly because existing light posts and connections can be used one-to-one. This means that upgrading is carried out with minimum effort in terms of time and costs. Also in terms of light quality, the Lumena Star LED convinces thanks to innovative specular optics, emitting pleasantly glare-free light in outstanding quality. The projector can also be individually modified to specific framework conditions thanks to various wattages and lumen packages from 12,000 to 24,000 lumens. Optionally integrating a light management system provides further savings potential.

The result
Rapid planning and simple luminaire replacement – energy savings of up to 40 % are already achieved compared to conventional projectors. With high quality of light, the luminaire also ensures ideal visual comfort.

8,200 lm - 24,000 lm

4000 K ≥ 5000 K

8 - 12 m

> 50,000 h

Switchable

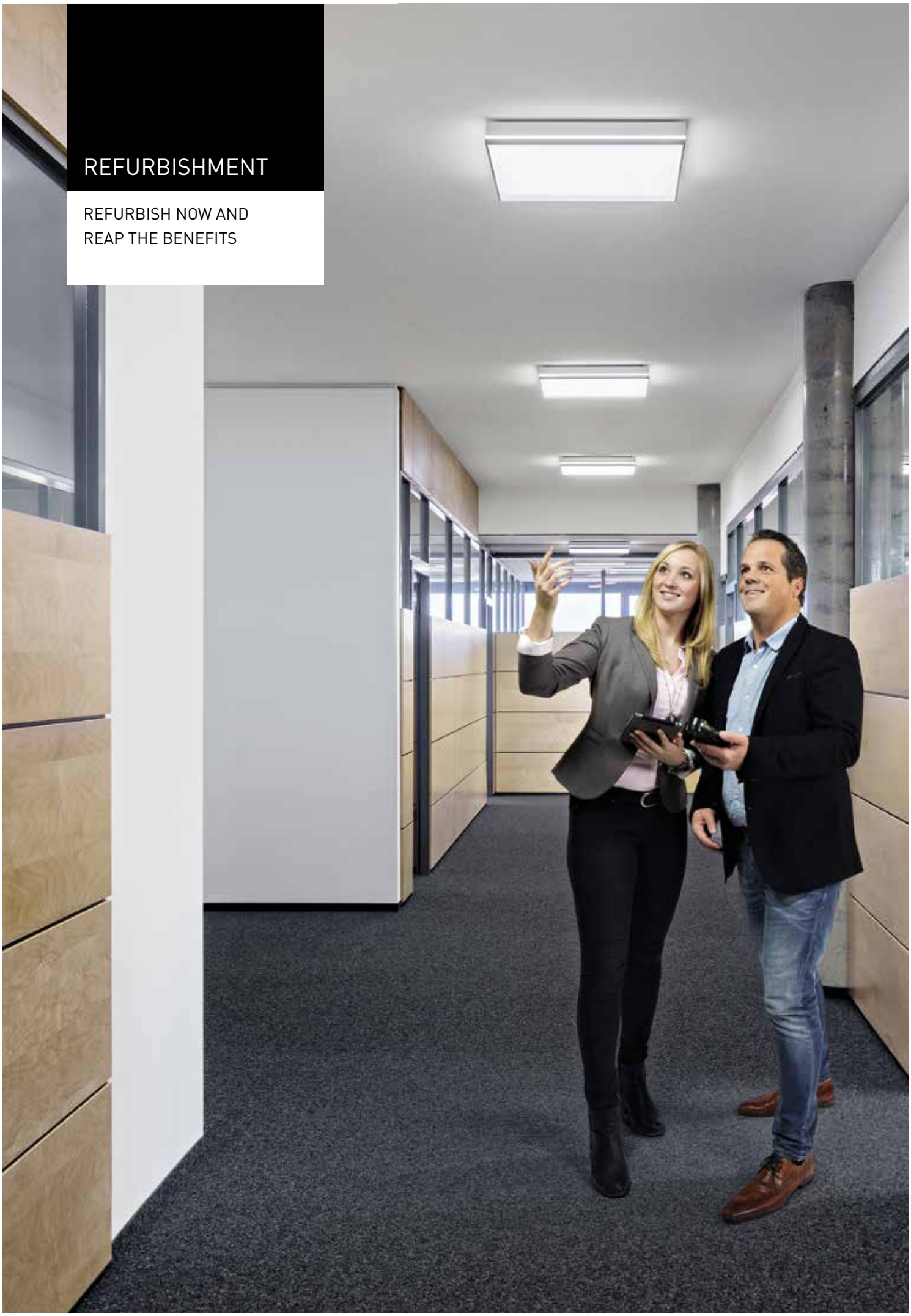
IP66

Thermal management
"Chimney effect" provides optimum heating up of the LEDs, with spatial separation of the connection compartment and optical system.

Lumena 40
The Lumena Star 40 is perfectly suitable for light point hights of 3 -8 m.

REFURBISHMENT

REFURBISH NOW AND
REAP THE BENEFITS



The basis for economic upgrading is highly efficient LED products, with optimum savings potential achieved in combination with light management systems such as LiveLink. With this in mind, TRILUX works intensively on researching and developing new principles and methods which help bring the benefits of the latest technology and the many years of experience the TRILUX Group has to our customers.

Applicable legislation and guidelines specify not just the responsible handling of resources – legislative authorities also often offer attractive subsidy programmes to support upgrading to modern lighting solutions. Refurbishment projects are often highly complex. This ranges from a precise knowledge of the application and exact development of individual solutions to expert implementation incorporating the best possible efficiency levels. TRILUX provides support for upgrading lighting installations, from assessing the current status and planning to installation and financing. Even with subsidy applications for the financing of lighting projects, TRILUX is the right partner for professional lighting. With high levels of experience and performance in production and technology, leading the way in research and development and with a close, direct proximity to customers in all applications.

That's the TRILUX philosophy – Simplify Your Light.

Energy efficiency example 3-desk office	**Old installation LLCG**	**Old installation ECG**	**New system LED**	
Luminaire	Old recessed luminaire T8 – 4x18 LLCG	Old recessed luminaire T8 – 4x18 ECG	ArimoS CDP LED 4,000 lm	
Power consumption per luminaire	84 W	76 W	40 W	
Number of luminaires in building	6	6	6	
Total power consumption	504 W	456 W	240 W	
Kilowatt hours p. a.	1,386 kWh	1,254 kWh	660 kWh	
Energy costs p. a.	€ 438*	€ 396*	€ 209*	
			T8 – LLCG	**T8 – ECG**
Energy saving potential			**52 %**	**47 %**
Saved kilowatt hours p. a.			726 kWh	594 kWh
Energy savings p.a.			€ 230*	€ 188*
CO_2 savings p. a.			0.43 tonnes	0.35 tonnes

* Based on a nominal price per kWh of € 0.23 in 2016 and an annual inflation rate of 5 % over 15 years (each with 2,750 hrs.) of service life.

Calculate your LED refurbishment project for energy efficiency, CO_2 savings, costs and pay-back periods at **www.trilux.com/efficiency-calculator.** Our light experts will be happy to support you with optimum planning and implementation. **Simply contact us!**

TRILUX TOOLS

SIMPLE PLANNING WITH THE TRILUX EFFICIENCY CALCULATOR

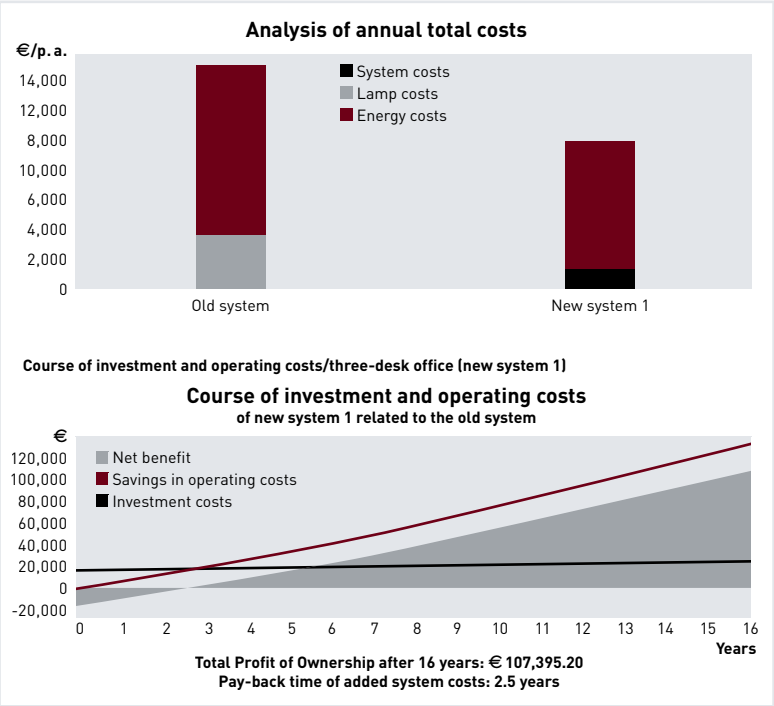
With the Efficiency Calculator, TRILUX provides a tool to compare the economy of up to five lighting systems. The savings potential of new systems can be simply determined and documented. For example, the efficiency calculator calculates the pay-back period of a new system with LED lighting. The profit level achieved by accrued savings over and above the added investment during the complete system life cycle can also be calculated.

Analysis and graphic processing

For calculation purposes, all economically relevant parameters are entered into a concise input form. Luminaire, system and utilisation data are taken into account as well as system, lamp, maintenance and energy costs. Connection to the TRILUX online catalogue ensures that product data is always up-to-date. Clear graphic displays of the results, e.g. the analysis of annual total costs or the sequence of investment and operating costs make it all clearly understandable at first glance.

Easy use of data

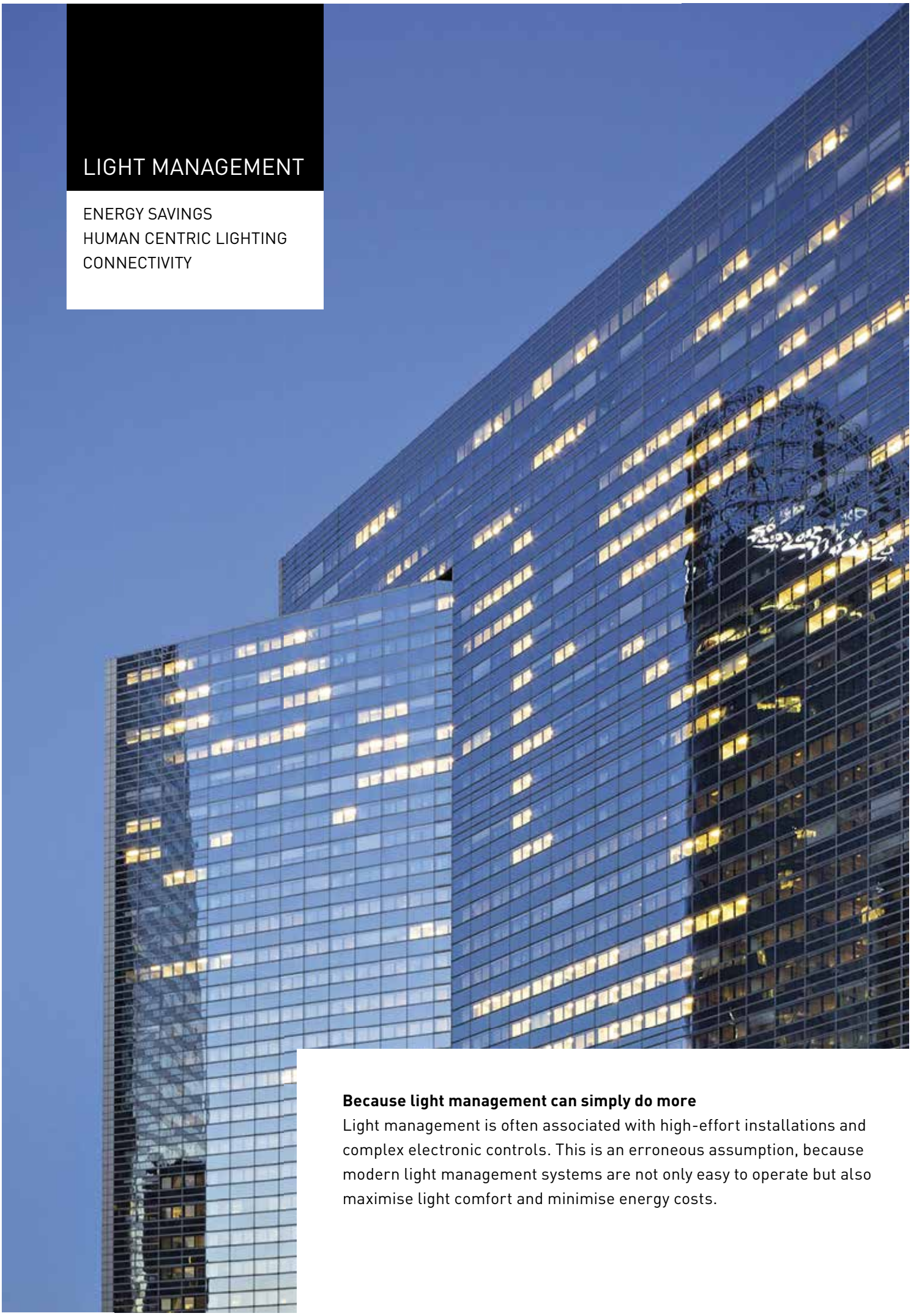
Calculation results are summarised in easily understandable tables to support customer-specific decision processes. These include statements concerning energy efficiency, reduction of carbon dioxide, costs and pay-back periods for relevant planning fundamentals. Individually created projects can of course be saved to a local PC, archived and then processed later. Creating a project report is also useful. This includes all project data, evaluations, diagrams as well as data sheets of the products used.



www.trilux.com/efficiency-calculator

LIGHT MANAGEMENT

ENERGY SAVINGS
HUMAN CENTRIC LIGHTING
CONNECTIVITY



Because light management can simply do more

Light management is often associated with high-effort installations and complex electronic controls. This is an erroneous assumption, because modern light management systems are not only easy to operate but also maximise light comfort and minimise energy costs.

Energy savings

Both spatial conditions and personal lighting requirements are relevant. In the end, however, various factors determine individually suitable light management systems. Dimmability, daylight-dependent control, simple maintenance as well as switching according to presence or time provide a wide spectrum of saving options. Intelligent luminaires equipped with sensors not only simplify installation but are immediately ready to operate. In addition, light management systems can be integrated into existing building controls. In larger building complexes they enable completely new chances for lighting. If daylight and presence sensors are used, light management systems reduce operating costs by up to 85 % right upon installation.

Human Centric Lighting

In addition to the demand for higher energy efficiency, the stimulating effect of daylight is also focused on. Medical findings show that human biorhythm and therefore further life functions are significantly influenced by light. It therefore makes sense to adopt daylight as an example for the artificial lighting of our modern living environments. In particular, the blue component of light, i.e. the colour of the sky has turned out to be our synchroniser. Modern light management systems utilise these findings and specifically control the various light components of lighting to achieve perceptibly more attention and well-being.

Connectivity

The future is networked – this also applies to the theme of light. Intelligent systems with high-quality sensor technology together with high-efficiency luminaires ensure the next technology transition following the LED revolution. This results in smart, convenient and energy-efficient lighting solutions that can be precisely matched to on-site conditions. However, a frequent obstacle for getting started with networked light is complicated installation and use. Light of the future must be simple and also provide added values beyond illumination. TRILUX accompanies planners, installers and operators into the networked future of light and offers well-designed, high-quality system solutions for indoor and outdoor applications centered on human beings. As an example, the LiveLink light management system provides the complete benefits of connectivity without its complexity. User-friendly software makes it simple to start with networking, and independently of previous technical knowledge. LiveLink therefore becomes the solid basis for future potential with networking, for example with predictive maintenance and cloud connections. With the light management system for the outdoor sector, luminaires, complete road sections and even complete towns and cities can be conveniently configured, controlled and monitored from an office.

LIGHT MANAGEMENT INDOOR

LIVELINK:
SIMPLE PLANNING
RAPID INSTALLATION
INTUITIVE OPERATION

Download on the App Store

GET IT ON Google play

LiveLink

The challenge

The future of light lies in personally designable and individually controllable light: because intelligent, convenient and energy-efficient lighting solutions that can be adapted to on-site requirements will be wanted in all application areas, ranging from office and education to health, industry and retail. The problem: complicated installation and control often makes it difficult for users to get started in the world of networked light.

The solution

The LiveLink light management system TRILUX developed with sensor manufacturer STEINEL enables the intuitive and reliable control of all light points in a lighting installation. Only mains connection and a DALI connection are required to install the system. Commissioning, seen as one of the biggest challenges with control systems, is now simple: Use Cases with pre-configured rooms for typical applications – including Human Centric Lighting applications – simplify the planning of individual projects. Commissioning and operation are carried out using a graphical user interface on mobile iOS or Android end devices. LiveLink can also be easily integrated into complete building automation systems.

The result

With LiveLink, TRILUX offers planners, installers and users a simple and smart introduction to the world of lighting control. The light management system is easily installed, effortlessly commissioned and features intuitive operation. This means that even complex lighting tasks can be intelligently and conveniently implemented, and the potential of energy management and colour control can be utilised ideally.

Simplified planning
The control system already contains preset room configurations (use cases) that make planning easier. Project-specific settings can be configured by TRILUX on request – these are then made available in the TRILUX portal.

Human Centric Lighting at the press of a button
The Human Centric Lighting use cases preset in LiveLink contain colour sequences that have been designed for the specific application, and are quickly and conveniently installed with the press of a button.

Rapid installation and commissioning
The system and system components of LiveLink are simply wired together via DALI. Programming and commissioning are carried out simply and in a time-saving way using a graphic user interface on mobile iOS and Android end devices.

A strong technology partnership
LiveLink, as a joint development between TRILUX and STEINEL, combines maximum lighting and control expertise with high-quality sensor technology.

LIGHT MANAGEMENT INDOOR

AN OVERVIEW
OF THE SYSTEM

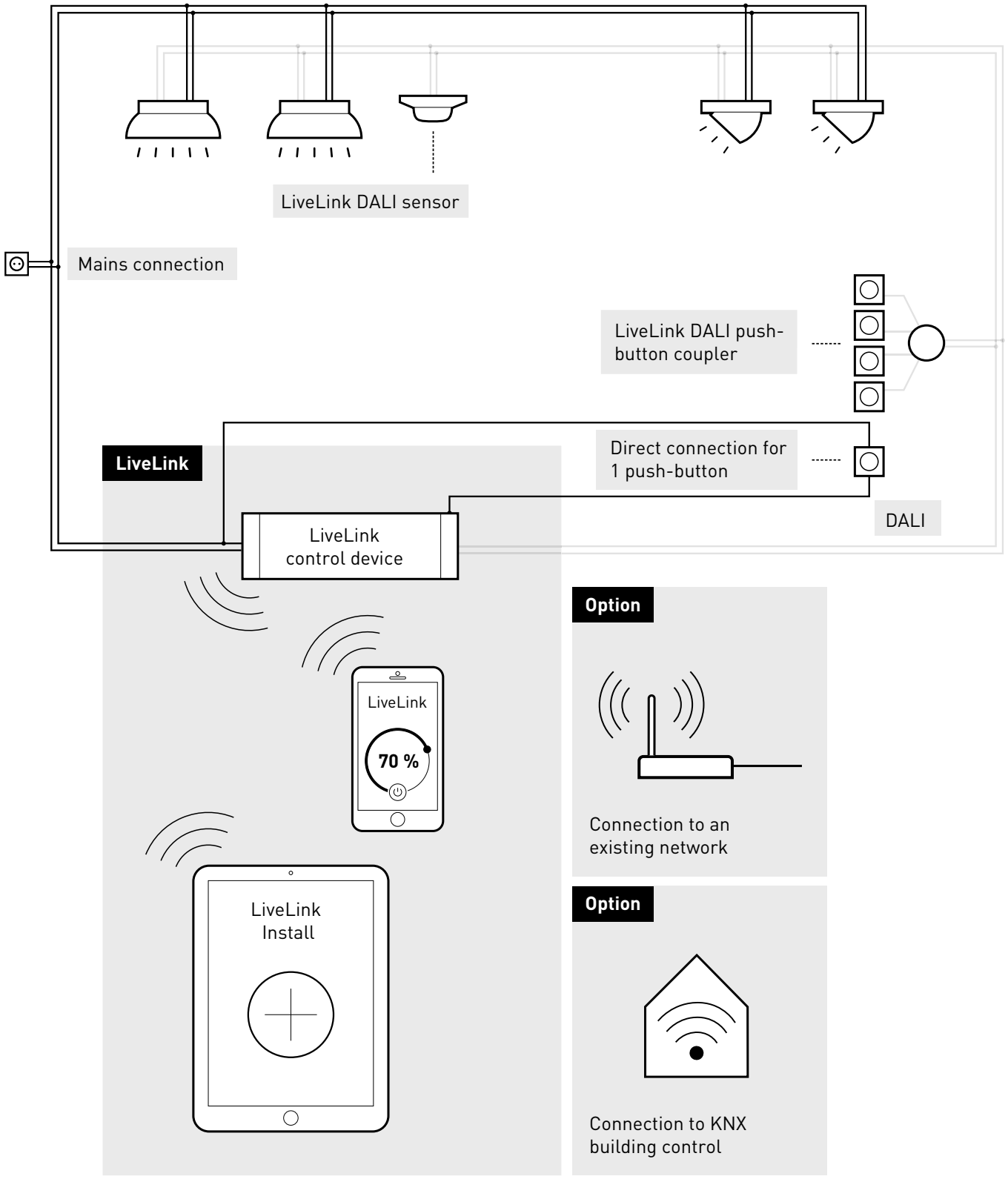
LiveLink – intuitively to the best result
Light management was never as reliable and quick to plan, set up and operate as with LiveLink. Only one control device and two convenient apps are needed to rapidly configure and control individually definable rooms.

Combine diversely: the control unit is based on DALI technology. This control protocol makes the system compatible to all DALI luminaires, of which TRILUX offers a wide selection. Connection of the LiveLink components via the DALI control line is implemented as usual – luminaires and the control device itself also require a mains connection.

Plan instinctively: The LiveLink software is highly intuitive in terms of use. The mobile apps for Android and iOS operating systems have a wide selection of preset room configurations, e.g. for applications in the industry, education and office sectors. Decades of experience with user-specific requirements as well as state-of-the-art expertise come together to provide ideally preconfigured lighting solutions. In this way, typical lighting situations can be effortlessly designed and commissioned, and always with the certainty that lighting complies with all valid standards.

Easy commissioning: The LiveLink Install commissioning app guides installers through the start-up process easily and step-by-step. The system detects all DALI-wired devices and integrates these with direct visual information for the installer. Many intelligent functions help with assigning and grouping luminaires, setting desired parameters and performing error search.

Simple to operate: either with push-buttons or the LiveLink Control app on a mobile end device. Individual functions such as brightness for example can also be conveniently controlled, as well as calling up pre-saved light scenes. The two commissioning and operation apps are optionally available as iOS or Android versions.


LiveLink DALI sensor
Mains connection
LiveLink DALI push-button coupler
Direct connection for 1 push-button
DALI
LiveLink
LiveLink control device
LiveLink
70 %
LiveLink Install
Option
Connection to an existing network
Option
Connection to KNX building control

LIGHT MANAGEMENT INDOOR

THE PATH
TO SUCCESS

LiveLink's most important function: creating added value for everyone.

LiveLink transforms light management from a supreme discipline for specialists into something quite natural for a growing number of users. The automated needs-oriented light control saves costs and optimises lighting conditions. It enables customised light and maximum levels of convenience within all framework conditions and in any situation. LiveLink provides all this with minimum complexity.

Operators – cutting costs with lighting solutions
Upgrading from conventional lamps to LED is a major step for many investors. This alone brings significant qualitative benefits and also reduces operating costs. Those aiming to consistently exploit the potential of LED go a step further – a light management system achieves further energy cost reductions by up to 55 % more. This means extremely short payback times and a quick Return On Investment. It additionally improves the quality of light for the individual needs of users.

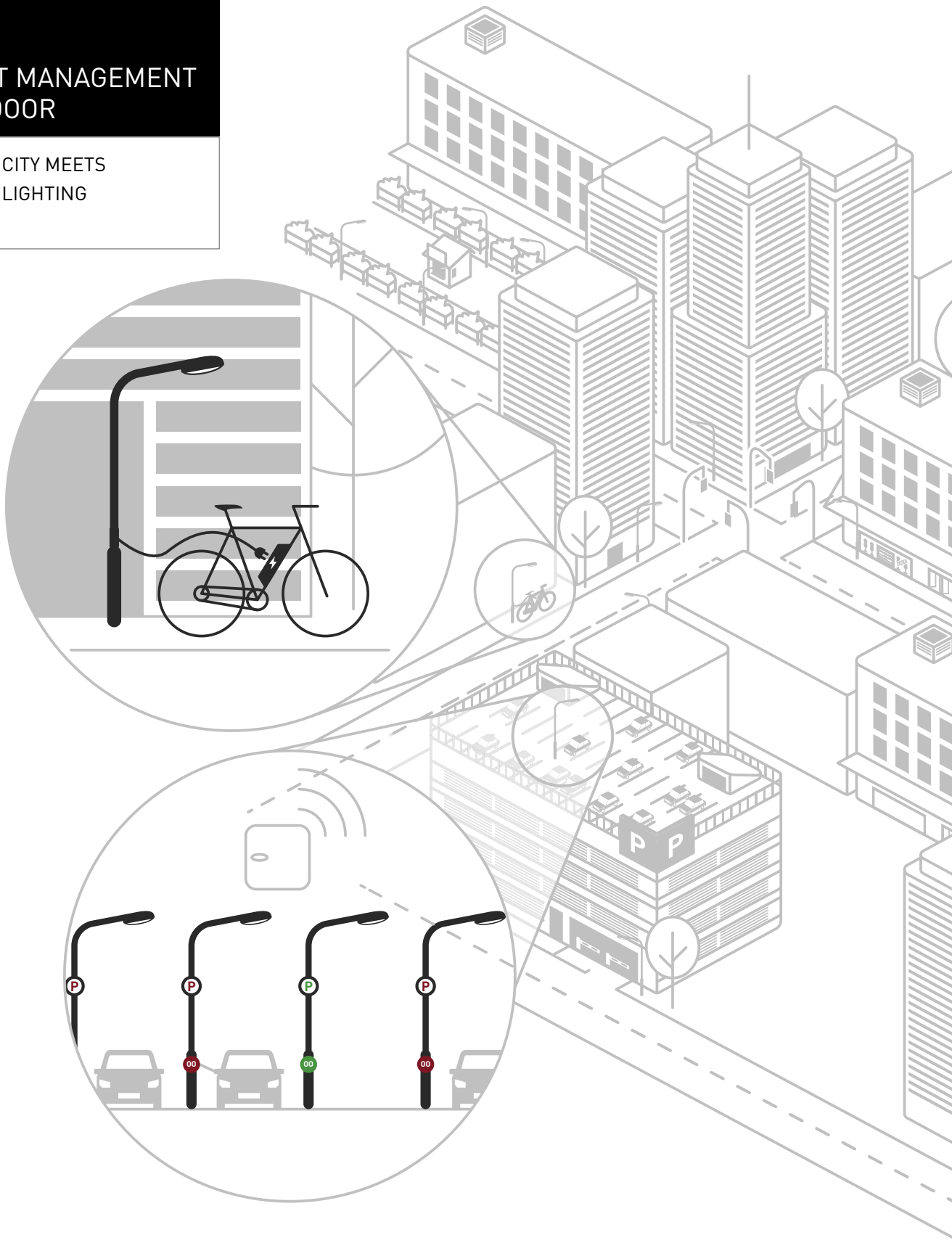
Planners – helping to design the light of the future
Light management is a booming market segment and also the future of the lighting sector. Those mastering light management at an early stage and communicating this in tendering, can win new customers and provide these with tangible added value. The effort pays twice over, as this is minimal with LiveLink. Planning is done simply, quickly, conveniently and reliably.

Installers – simply expanding the range of services
With the LiveLink system, all components for light control precisely interconnect, making commissioning simple, quick and risk-free. This makes light management part of the range of services of an installer – without special training.

Users – always the right light at the right time
It is the same situation with cars, cameras or TV sets: we do not use everything offered to us by the technology. And quite simply because the possibilities are not immediately evident. LiveLink uses a mobile app for operation featuring an intuitive user interface, and the system can also be controlled by commercially-available push-buttons or automatically via sensors. As a result, users can optimise light according to their needs in a simple way.

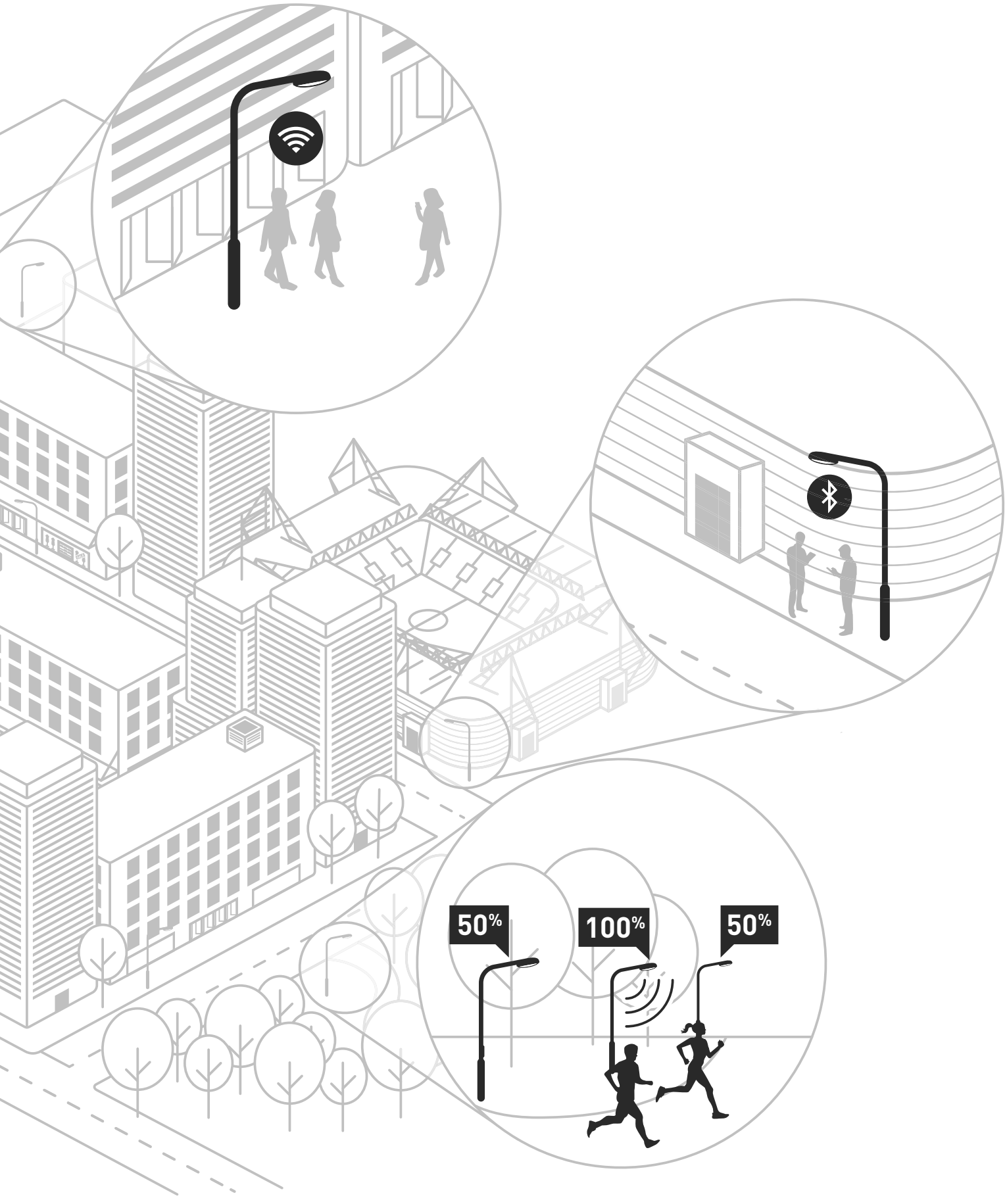
LIGHT MANAGEMENT OUTDOOR

SMART CITY MEETS
SMART LIGHTING



First clever, and now smart as well

Road lighting will become increasingly intelligent. Not only the diverse advantages of light management systems are utilised, but with Connectivity and Smart City, completely new application options have been created. Light posts and columns with sensor technology help to locate parking spaces, provide wireless internet access, feature small screens that can be used for city marketing or city tours and serve as "filling stations" for E-bikes and electrically powered cars. As you can see, TRILUX lighting solutions are not only clever but are becoming increasingly smarter. Simply contact us.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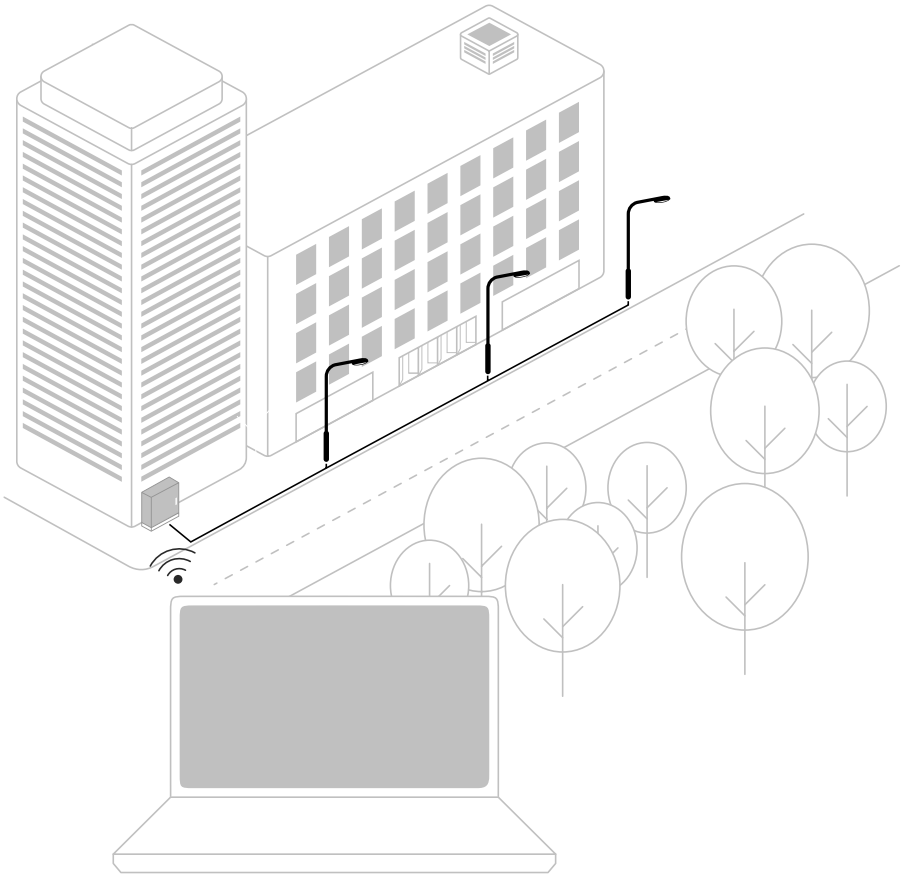
LIGHT MANAGEMENT OUTDOOR

POWERLINE AND RADIO

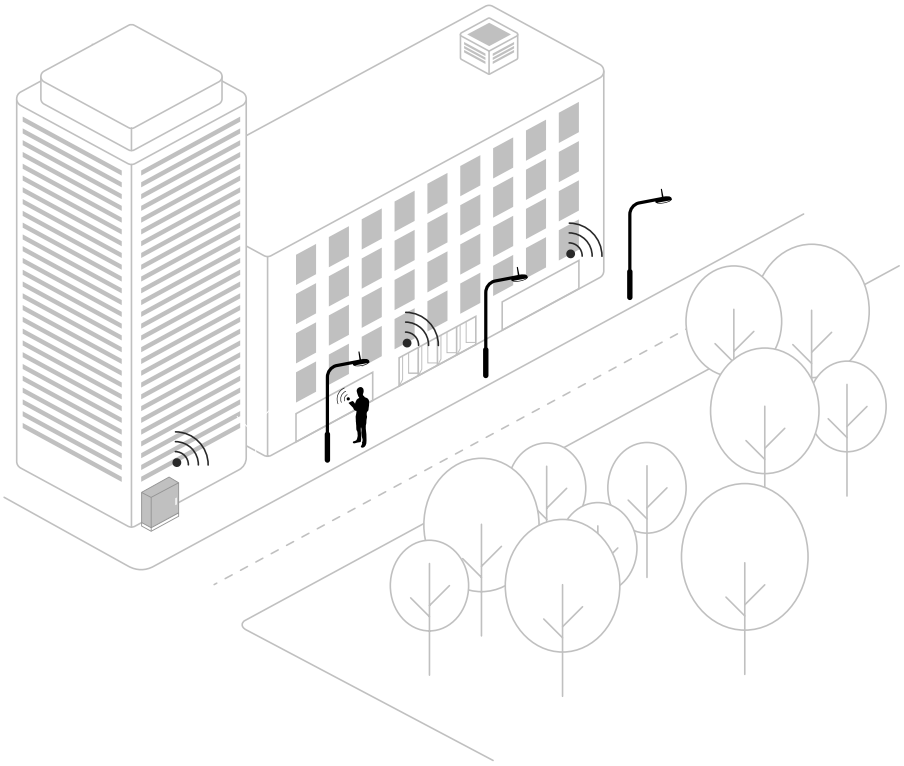
POWERLINE

Powerline light management
Existing electricity grids can be used by Powerline technology for establishing a data transmission network.



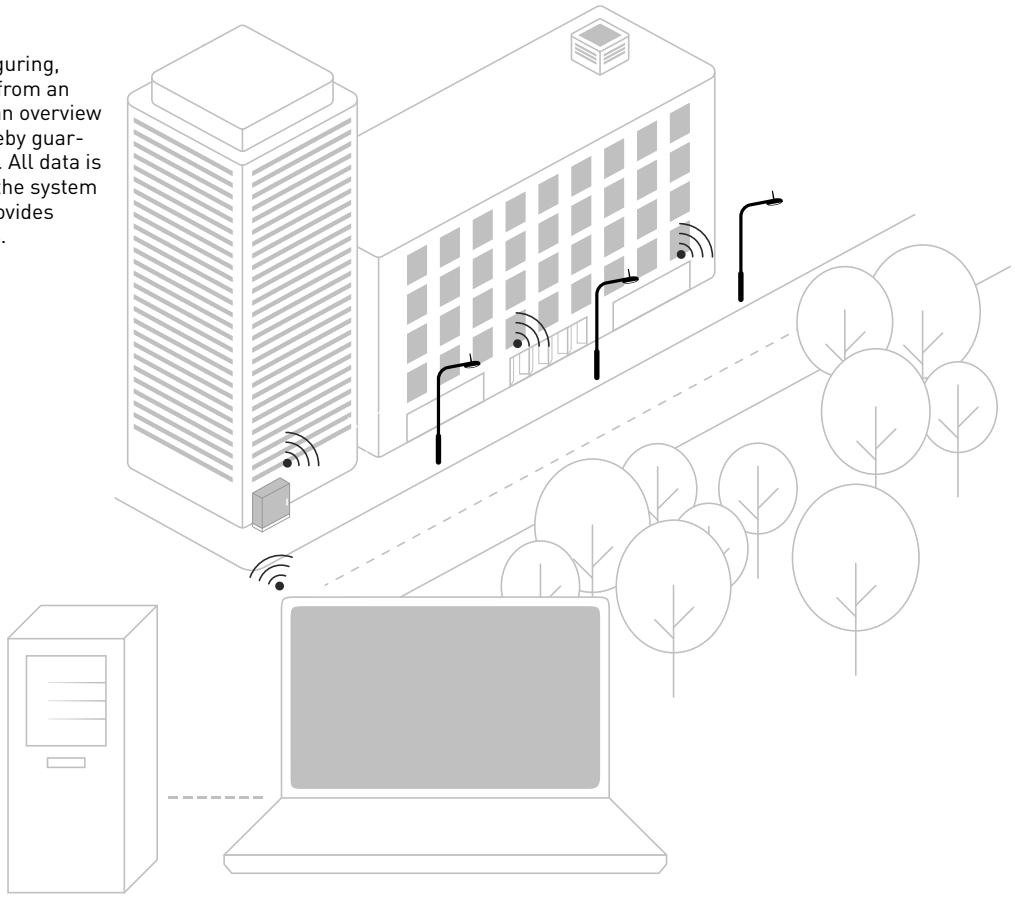
RADIO ON-SITE

Radio light management – settings directly on-site
Luminaires equipped with a special controller automatically connect via a radio network. Access to the specific network is possible via tablet or laptop with the appropriate USB dongle. In this way luminaires are individually configured on-site.



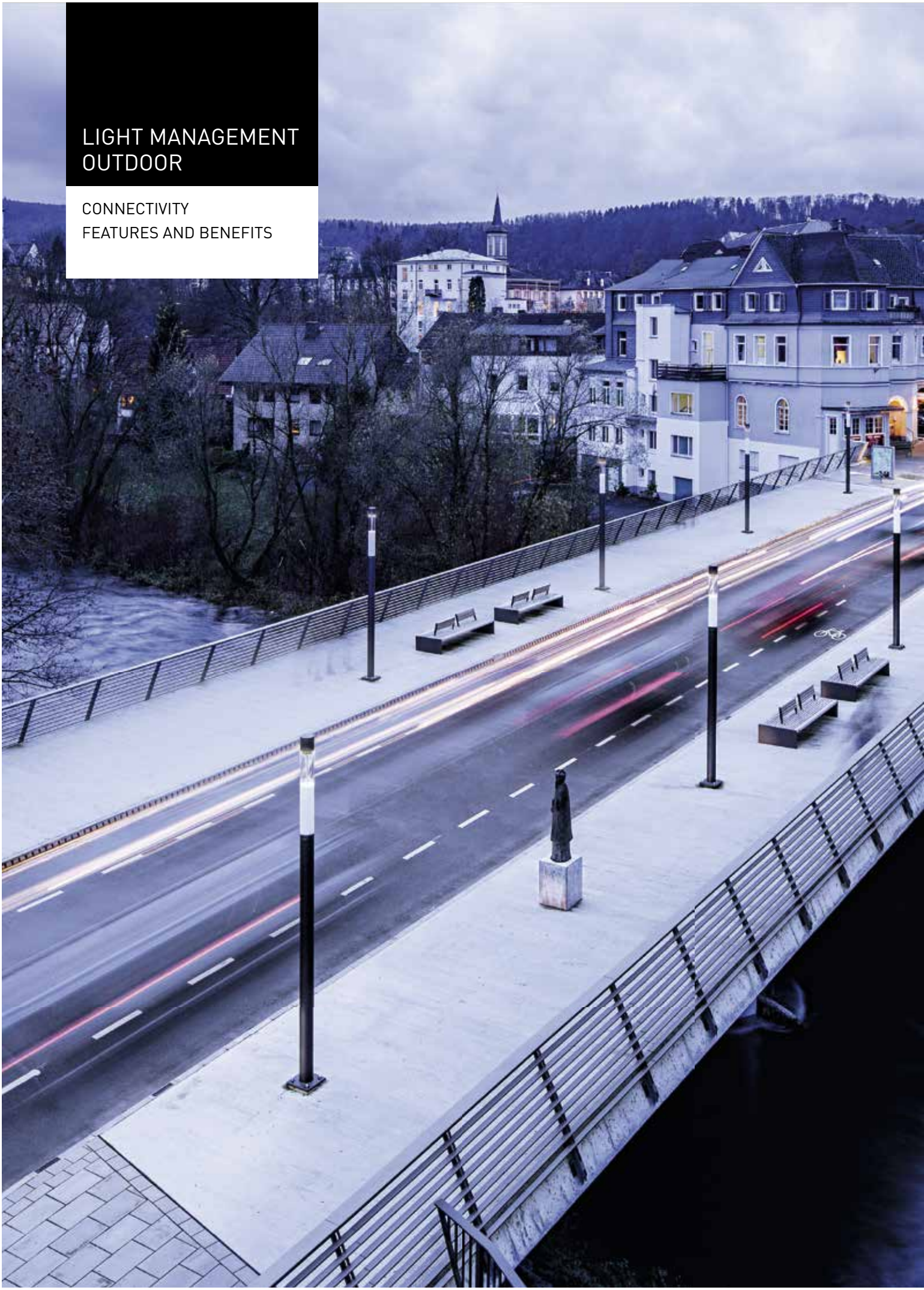
RADIO VIA OFFICE

Radio light management – settings from the office
The user-friendly interface enables configuring, controlling and monitoring of luminaires from an office. The associated software provides an overview of the complete lighting installation, thereby guaranteeing optimum maintenance planning. All data is transmitted in encrypted form to protect the system from unauthorised access. A PIN code provides further protection from third party access.



LIGHT MANAGEMENT OUTDOOR

CONNECTIVITY
FEATURES AND BENEFITS



Broadband internet access, mobile data, the Internet of Things and cloud computing – the future is networked and connectivity is one of the major trends of the imminent future. Connectivity relates to the new organisation of society within permanent networks. This will be particularly experienced in the public sector where modern marketing and information technologies interconnect people and machines and make life simpler with intelligent solutions. A good example is intelligent road lighting that will provide the basis for impressive possibilities for use thanks to the combined application of sensors, luminaires and control modules.

The use of TRILUX LED luminaires combined with a light management system enables saving possibilities exceeding 80 % compared to obsolete lighting installations. Using a user-friendly software for light management systems, lighting installations can be very simply configured, controlled and monitored on a PC, laptop or tablet.

Software features
Read-out of current luminaire state
Setting of dimming levels
Grouping of luminaires
Display and positioning of luminaires on a map
Energy consumption read-out for single luminaires or luminaire groups
Active monitoring of operating duration and luminaire temperature

HUMAN CENTRIC LIGHTING

THE NON-VISUAL EFFECT OF LIGHT

The wavelength of light determines whether and how we see it. For humans, the visible range of light lies between 380 and 780 nm and its colour spectrum ranges from blue (short-wave light) through green to red (long-wave light). The light waves are received via the eye, and then processed and converted into images. At the same time, the spectral components of light stimulate different effects, ranging from activating to relaxing.

In 2001, scientists were able to verify a photoreceptor in the eye which sensitively responds to wavelengths between 460 and 490 nm. This photoreceptor is not for viewing purposes but stimulates our inner clock, and since this time the scientific community and industry have been concerned with researching and understanding the non-visual effect of light on people.

A FOCUS ON PEOPLE

THE FOUR FACETS OF HUMAN CENTRIC LIGHTING

Artificial lighting initially served only to extend the daytime period. This was a major step that changed society but the non-visual effect of light was initially neglected. This however significantly influences our levels of well-being. The spectrum and light colour of daylight change according to time of the day and season of the year. This change in turn influences the psyche and physique of people. Human Centric Lighting enables us to utilise this non-visual effect of light. In general, four fundamental applications are differentiated between:

Melanopic-effective lighting maintaining health
Light that supports the day/night rhythm. This promotes and maintains health and performative capability by automatically modifying its light colour and intensity (as with daylight) across the 24-hour rhythm.

Melanopic-effective lighting for activation
Light affects attention levels and concentration and increases our cognitive performance capabilities. If required, these effects can also be achieved by individual modifications towards cooler light colours.

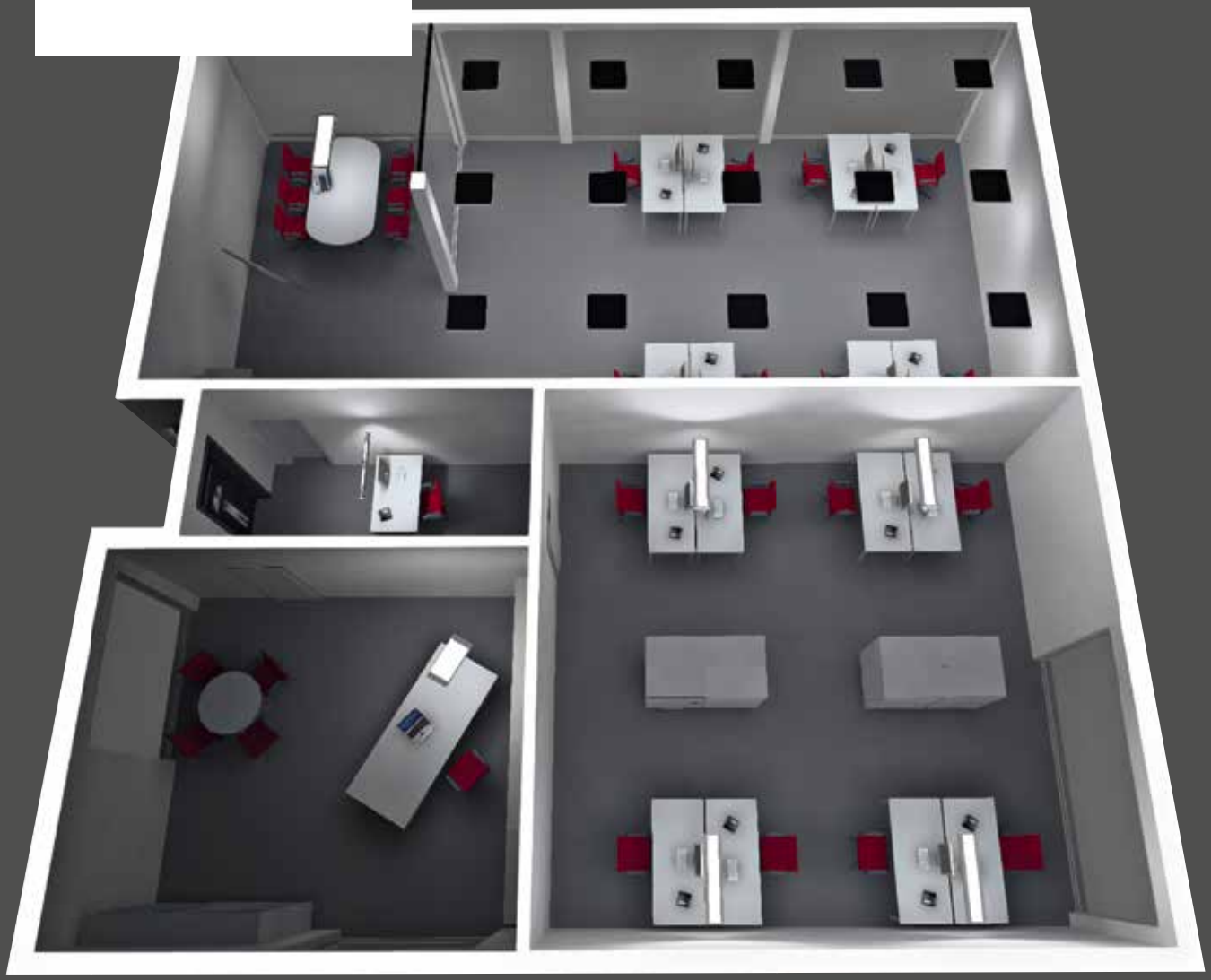
Melanopic-effective lighting for recovery
Light improves well-being by changing the light colour to warmer colour tones according to individual requirements.

Emotional light
Light displays and accentuates, and therefore creates atmosphere, enthusiasm and well-being.

If used intelligently, Human Centric Lighting makes an important contribution to better lighting quality and quality of life. We transform these technically complex challenges into user-friendly lighting solutions.

OFFICE

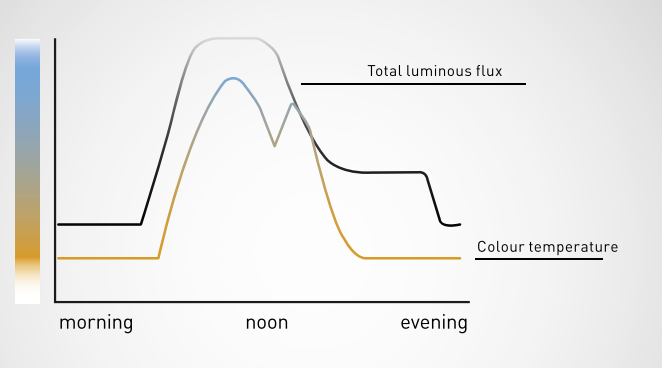
APPLICATION EXAMPLE



Human Centric Lighting used sensibly

1. Lighting in open-plan offices can positively influence satisfaction and productivity of employees. This in turn benefits their health, and stress is reduced.
2. A meeting room is ideal for a concentrated round of discussions. Human Centric Lighting allows the work atmosphere to be individually modified to the specific task.
3. In rooms with low levels of natural daylight or none at all, Human Centric Lighting is able to support the circadian rhythm and improve the level of well-being.
4. Individual lighting design at the workplace significantly improves working conditions and raises the performance of employees due to optimum lighting conditions.
5. The business card of any company is its entrance area. Accent lighting creates emotion that gives a warm welcome to guests and guides them through the building.

Light profile



Explanation
In the night and early morning hours, a high-quality, energy-efficient light for cleaning with 100 lx is available.

In the morning the daylight-synchronous, activating sequence begins. At noon the light colour is reduced for mild relaxation in the lunch break.

During the afternoon, a soft increase in the light colour counteracts any midday tiredness.

During the evening a standard-compliant lighting level is set with less melanopic effect.

Lunexo LED

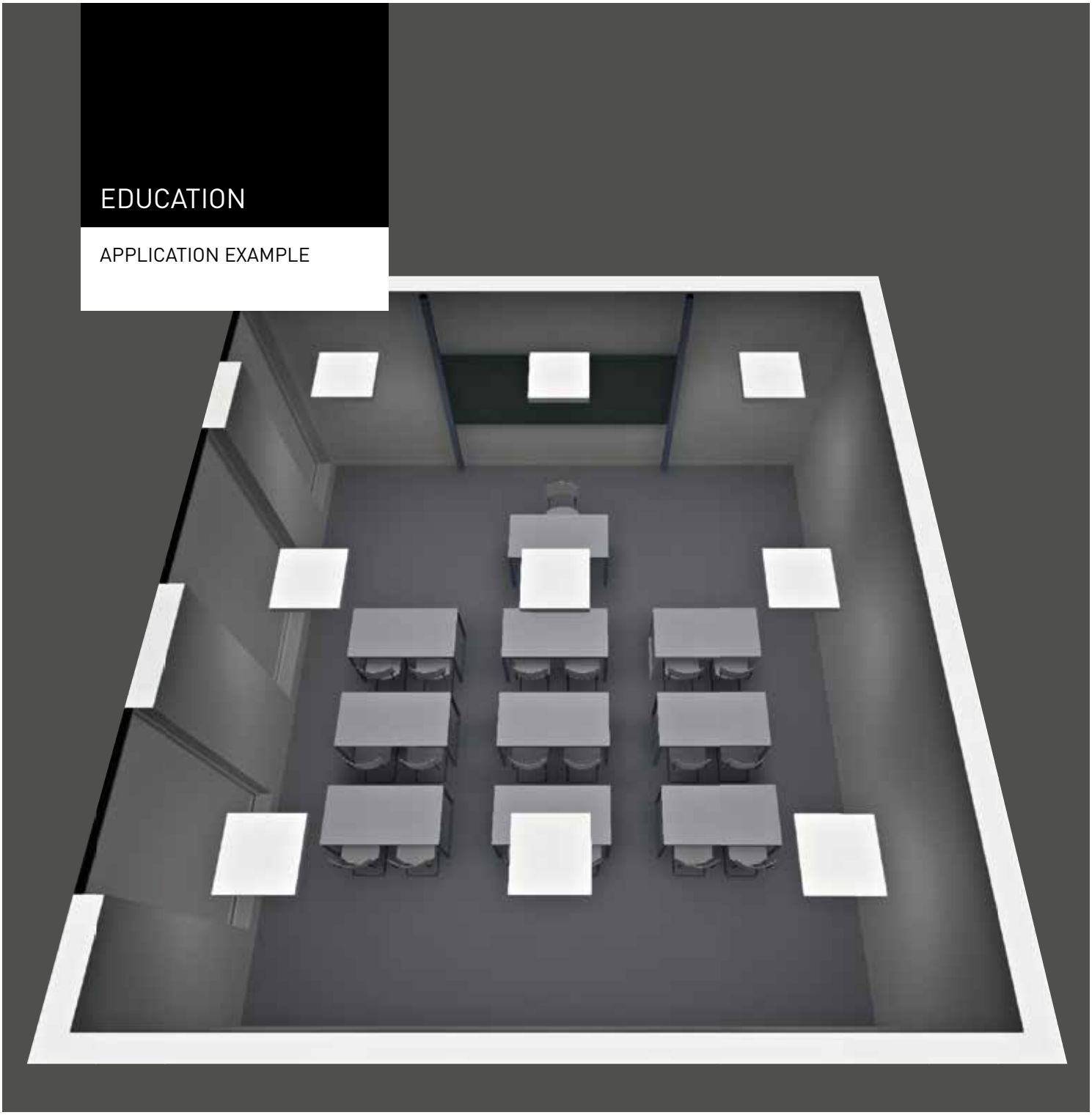
Solvan Flow LED

Inplana/Onplana Active LED

! With 'Active' luminaires, light colours can be varied in the range of 3,000 K to 6,500 K with e.g. a LiveLink system.

EDUCATION

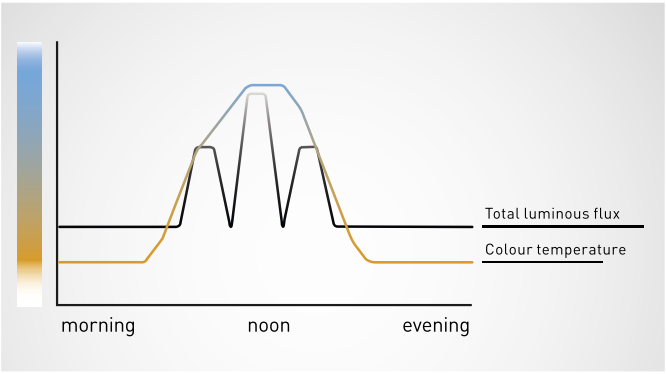
APPLICATION EXAMPLE



Human Centric Lighting used sensibly

1. If concentration is required, Human Centric Lighting helps in classrooms. The light can stimulate and promote concentration but also have a calming effect.
2. Break times are ideal for pupils to refuel. Warm white light relaxes and promotes well-being.
3. Pupils can run riot in the gym. Cool white light supports sports lessons in an activating way that also promotes motivation.
4. Calmness is the order of the day in auditoriums. This enables pupils to listen with high levels of attention and concentration. Hyper-active pupils benefit particularly from calming light.
5. The staff room is not only a relaxation room, but also a workplace requiring optimum lighting conditions.

Light profile



Explanation
In the late evening and at night, standard-compliant light for cleaning is available.

In the morning the melanopic factor is implemented for more rapid adaptation to the day.

The melanopic factor is reduced in the breaks for quicker regeneration.

At the end of school time, light is reduced to normative illuminance values.

Solvan Flow LED

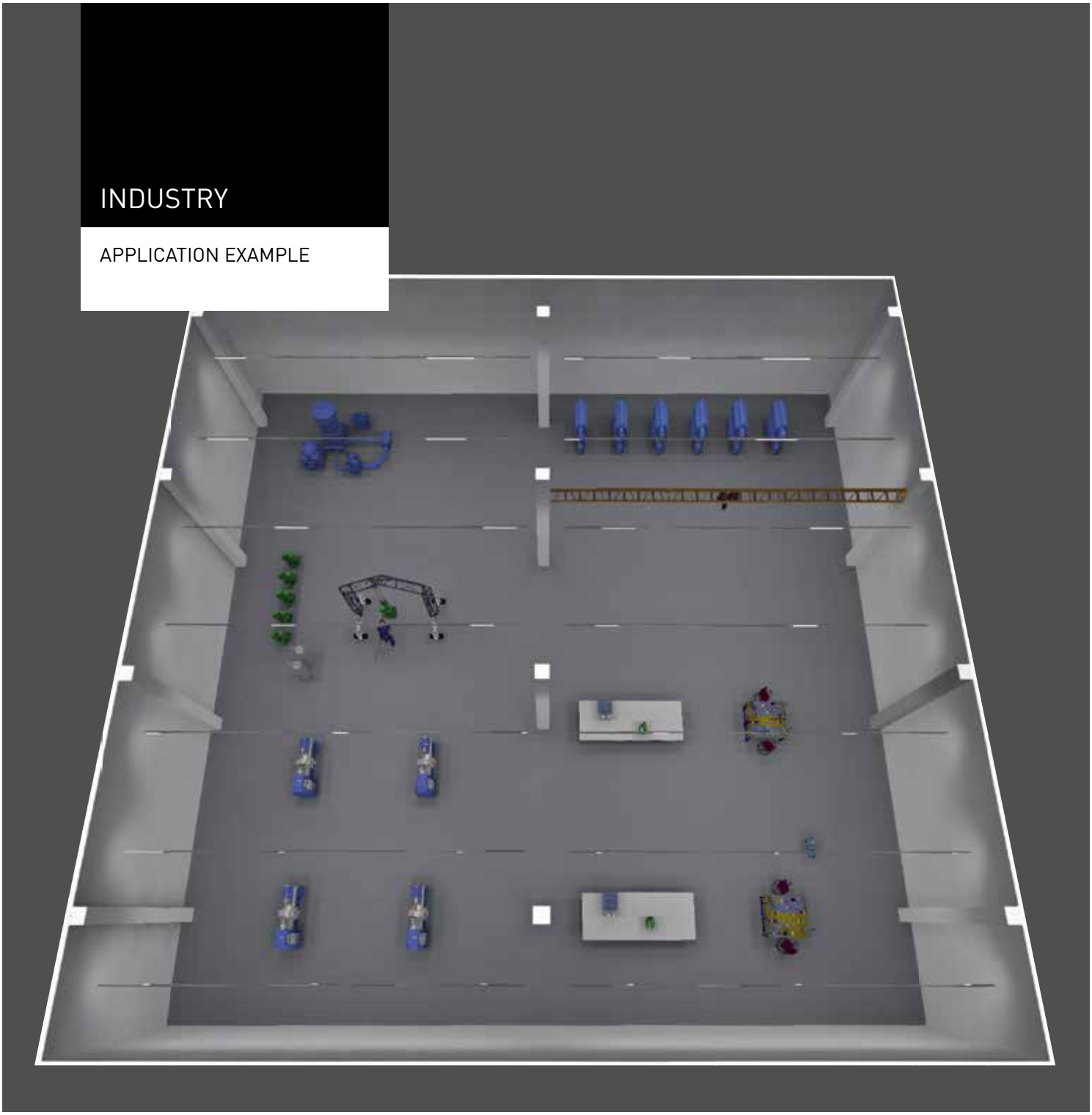
Belviso Active LED

74 R LED

! With 'Active' luminaires, light colours can be varied in the range of 3,000 K to 6,500 K with e.g. a LiveLink system.

INDUSTRY

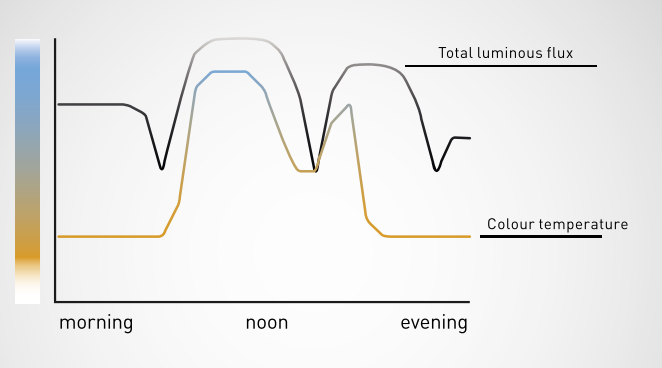
APPLICATION EXAMPLE



Human Centric Lighting used sensibly

1. Common rooms serve for relaxation and allow for rest periods. Human Centric Lighting adapts to the requirements of workers and supports the regenerative effect.
2. Meetings and negotiations as well as concentrated work in foremen's offices are no problem. Lighting ideally adapts to the situation.
3. Precise, concentrated work in control rooms is mandatory. Human Centric Lighting supports the capability to concentrate and reduces the risk of accidents.
4. Low levels of light and long night shifts negatively affect the inner clock. Human Centric Lighting serves to rebalance it and therefore lowers the psychological effects of shift work.

Light profile



Explanation
In the morning at the beginning of the early shift, the daylight-synchronous, activating sequence starts.

Noon – decreasing activation at the end of the early shift. Activation for the late shift starts during the afternoon.

The melanopic effectiveness is reduced during early evening. Modifying the light colour to warm white with increased illuminance leads to higher alertness levels and less impact on the suppression of melatonin.

Decreasing activation with the late shift in the late evening.

Start of the night shift, increase in alertness only by modifying lighting intensity.

74 R LED/ 74 Q LED

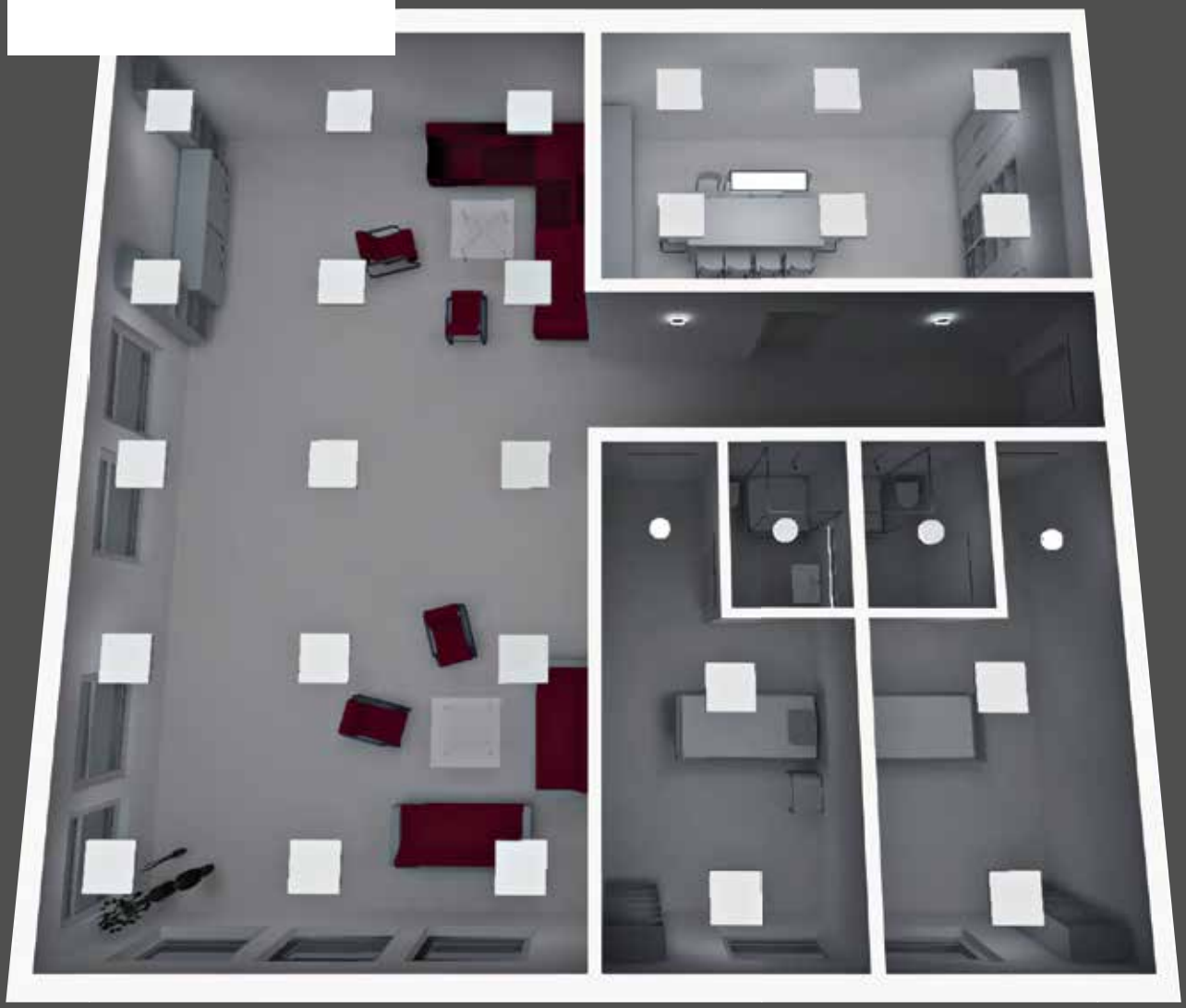
Solvan Flow LED

E-Line LED

! Warm white is recommended as the light colour for night-time shifts. Cool white light colours on the other hand can increase productivity during day-time shifts. Using "Active" luminaires is however ideal. The light colours in such cases can be varied in the range of 3,000 K to 6,500 K with e.g. the LiveLink system.

HEALTH & CARE

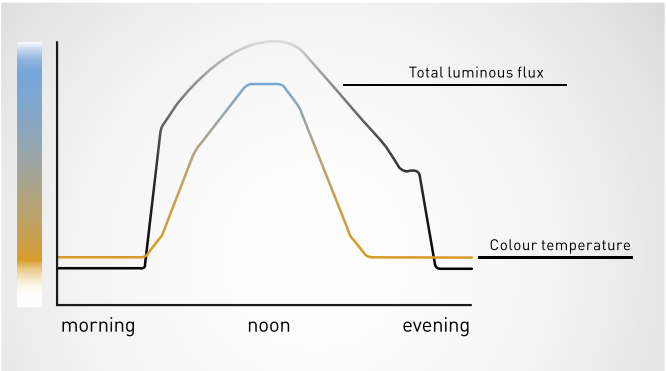
APPLICATION EXAMPLE



Human Centric Lighting used sensibly

1. In the health and care sector, Human Centric Lighting is the ideal solution for patient rooms. Well-being can be improved and rapid recovery supported.
2. As meeting places, common rooms are designed in a welcoming way. Warm white light communicates a pleasant ambience and invites people to linger.
3. Bright corridor zones that give structure to buildings help residents to orient themselves.
4. If used intelligently, lighting in bathrooms can be configured to activate in the morning and to emit just as much light as necessary in the evening. This improves vision and minimises the risk of accidents.

Light profile



Explanation
In the morning the daylight-synchronous, activating lighting curve begins.

Towards noon, maximum melanopic influence becomes effective.

In the evening, standard-compliant lighting with low melanopic influence (daylight-synchronous illuminance curve).

In the late evening, night-time reduction from 200 lx to ¼ of daytime standard illuminance.

Sanesca Active LED

Belviso Active LED

74 R LED/74 Q LED

! With 'Active' luminaires, light colours can be varied in the range of 3,000 K to 6,500 K with e.g. a LiveLink system.

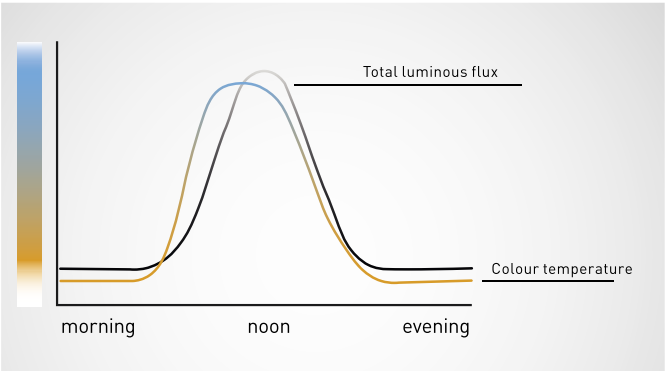
SHOP & RETAIL

APPLICATION EXAMPLE

Human Centric Lighting used sensibly

1. On the one hand, light has to provide customers with quick, simple orientation; on the other hand it must display goods attractively and make for a pleasant stay.
2. Well-planned lighting can promote sales success by emphasising the quality of products, supporting brand images and inspiring positive emotions.
3. Accent lighting aligned to Human Centric Lighting specifically guides the glances of customers.
4. Dynamic light scenes can further stimulate sales spaces.
5. Human Centric Lighting can make colours radiant, set strong contrasts, stimulate or be calming as well as display goods and put them in the centre of attention.

Light profile



Explanation
In the night and early morning hours, a high-quality, energy-efficient light for cleaning is available.

In the morning the daylight-synchronous lighting curve begins.

Towards noon, maximum melanopic influence becomes effective.

Towards evening, light is reduced to normative illuminance values and modified colour temperature.

Belviso Active LED

Lobu LED

Agira LED

! With 'Active' luminaires, light colours can be varied in the range of 3,000 K to 6,500 K with e.g. a LiveLink system.

1. THE LED REVOLUTION

With the establishment of LED lighting, the lighting industry is currently experiencing a revolutionary and deep transition in technology that can be compared with the discovery of the incandescent lamp, or with the changeover to fluorescent lamps. The adaptation of standards and norms can hardly keep up with such a wide-ranging and rapid transition. During such times there are usually no uniform terms of language, meaning that with LED until now, communication has differed concerning quality criteria and data. The verification of products and their compatibility in such cases is hardly possible, and this causes uncertainty in the market. The aim of the LED Guide is therefore to achieve a uniform understanding concerning LED lighting, in addition to supplying fundamental LED information.

The incandescent lamp – a thermal radiator

The incandescent lamp is a classic thermal radiation source. The filament, a multiple-twisted tungsten wire of 1 m length and 0.02 mm thickness, is heated with a current flow. The radiation emitted depends on the temperature of the filament: if the wire is warm it emits infrared waves. With increasing temperature the wavelength of the emitted radiation becomes shorter, until, with a glowing wire, it achieves the range of 380 nm (violet) to 780 nm (red) that is visible for the human eye. The ratio of radiation emitted as light is, however, relatively low. Only 7 % of electrical energy is emitted in the form of light, and the majority of the input energy is lost as heat via IR rays.

The LED – a luminescence radiator

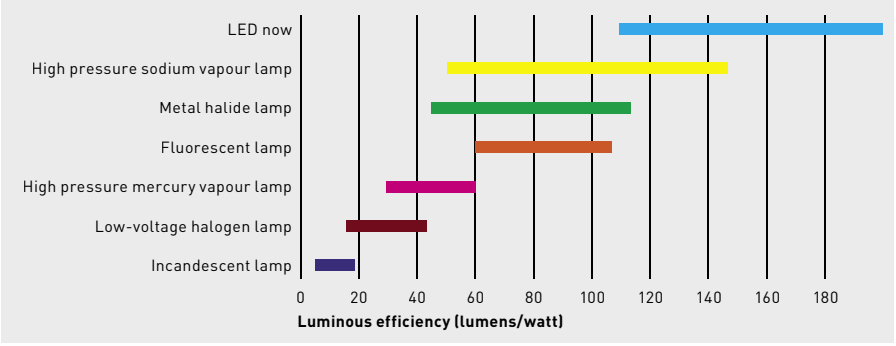
An LED is completely different. The light emitted from a diode is not the by-product of a thermal process as with incandescent lamps but is generated as part of an electrical reaction within the diode, with recombination of positive and negative charge carriers in the junction area of the semiconductor. The energy released is emitted as electromagnetic radiation in the visible range, meaning in the form of light. The luminous efficiency of LEDs exceeds that of an incandescent lamp many times over. With new modules, up to 50 % of input electrical energy is transformed by LEDs into light.

Fluorescent lamps are also luminescence radiators

In a similar way to LEDs, the light in a fluorescent lamp is not generated via a thermal process but via an electrical or chemical process. The functionality of fluorescent lamps equates to low pressure mercury vapour discharge lamps. Here an evacuated glass tube coated on the inner side with a phosphor is filled with low quantities of mercury. If a sufficiently high voltage is applied, the mercury vapour is exposed to free electrons and begins to emit ultraviolet radiation at a wavelength of between 185 and 254 nm. This highly energetic light is briefly absorbed by the phosphor on the inner surface of the glass tube. When the phosphor returns to its basic state it releases the energy in form of light in the visible range.

Fluorescent lamps feature good energy efficiency of approx. 100 lm/W and are characterised by a service life of around 20,000 hours.

Light source efficiency comparison



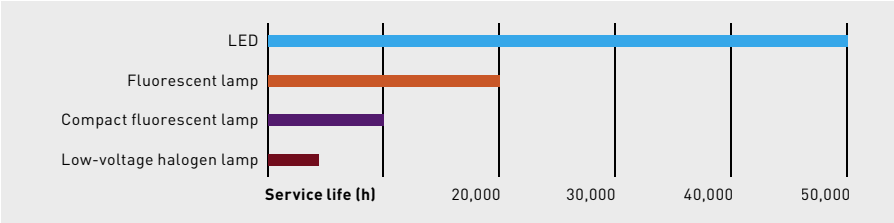
The LED is one of the most efficient light sources.
It also has high energy-saving potential.

2. MEASUREMENT FACTORS AND SERVICE LIFE OF LED LUMINAIRES

With a service life of approximately 50,000 operating hours – often much more with outdoor luminaires – the LED is far superior to most other light sources. This corresponds to 5.7 years of continuous operation or 2,083 days, 24 hours per day. The service life of an LED is influenced for example by temperature, electric current and voltage, humidity, chemicals, radiation and mechanical forces. The sensitivity of an LED to mechanical factors is, however, relatively low compared to other lamps due to a lack of movable or breakable parts and its compact construction size.

Improved ease of maintenance

An average 50,000 hours service life means that relamping is no longer necessary. Other service life durations may be more suitable according to application and utilisation times.



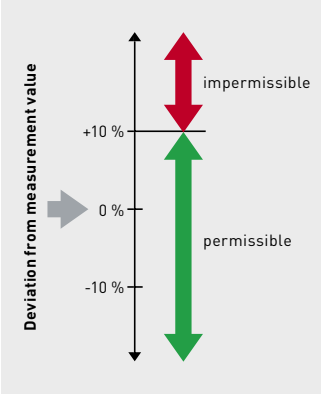
LED luminaires significantly cut maintenance and repair costs. The specified service life in hours though says nothing about the quality of an LED product. Further key factors are needed for this purpose, such as connected load and luminous flux emitted from an LED luminaire. LED luminaires though can still not be evaluated just with these parameters, because the service life of LED luminaires is primarily limited by falling below a pre-defined minimum luminous flux (i.e. degradation). In addition, the total failure of all LEDs or LED modules in luminaires and the corresponding electronics also plays a role. When planning with traditional lamps, failure of the electronics was not considered up until now, and this is the reason why this is currently not applicable for observing the service life of LED products. It becomes clear that these observations can be used for photometric planning but not for guarantee evaluations. For comparison purposes of various LED luminaires and when defining the service life, the listed key parameters are mainly applicable, and these should also be specified in the technical information of LED luminaires:

Rated input power of luminaires P (in watts):

The rated input power P in watts (W) of a luminaire defines a quantity value that is applicable for the complete manufacturing spectrum of this luminaire type, including tolerance-related deviations of all assembled components in the new state. The rated input power of an LED luminaire is documented on the type plate, in the applicable data sheet and in the electronic data. This value is also used for further observations and calculation purposes.

The input power of any luminaire from production is the effective power in watts, including all internal consumers. This parameter is measured at the power input terminals or at the mains plug at a predefined ambient temperature, and must not exceed the specified rated input power by more than 10 % under consideration of unavoidable tolerances of the components used.

Representation of tolerance fields for rated input power



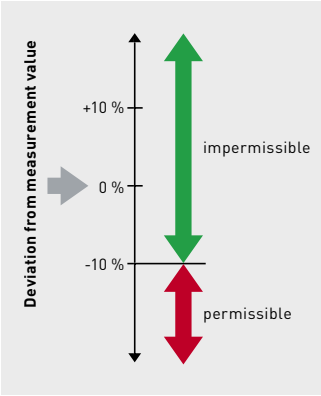
Specifying the effective power for dimmable luminaires is not yet handled uniformly. This frequently causes uncertainty, especially with luminaires with constant luminous flux technology. In such cases often only power for a predefined work point is specified that the luminaire has at the start of use, e.g. the required effective power to achieve 80 % of the maximally defined luminous flux of the luminaire. However, this effective power increases up to the end of the nominal rated service life in order to maintain constant luminous flux. As a result, for luminaires with constant luminous flux technology, the rated power at the time of the nominal rated service life must also be specified.

Rated luminous flux of luminaires Φv (in lm):

The rated luminous flux Φ_v in lumens (lm) for a luminaire defines a quantity for the new value of the complete luminous flux for this luminaire that is emitted according to pre-specified operating conditions in the visible range and in all directions, and that applies to the complete production spectrum of this luminaire type, including tolerance-related deviations. The rated luminous flux is documented in the data sheet and the electronic data. If no other ambient temperatures are specified in the data, then 25 °C applies. The specified rated luminous flux is then used for further observations and calculations.

The measured initial value for luminous flux of any luminaire of this luminaire type from production must not fall below the rated luminous flux of the reference luminaire by more than 10 %.

Display of tolerance fields for measured luminous flux



Luminous efficiency of LED luminaires η_v (in lm/W)

The luminous efficiency is the ratio of rated luminous flux to the rated input power of the same LED luminaire.

$$\eta_v = \frac{\Phi_v \text{ of the luminaire in lumens}}{P \text{ of the luminaire in watts}}$$

Using the luminaire luminous efficiency as the sole criterion for comparison purposes or for evaluating energy efficiency is only possible with comparable luminaires and with similar luminous intensity distribution. In other cases, a calculation of the complete lighting installation is needed.

Rated ambient temperature of luminaires, thermal management

One of the most important factors for the performance and service life of an LED is the temperature in the junction area, the Junction Temperature T_j. The luminous efficiency and service life of LEDs decrease with increasing temperature. This is why thermal management of the luminaire is highly important.

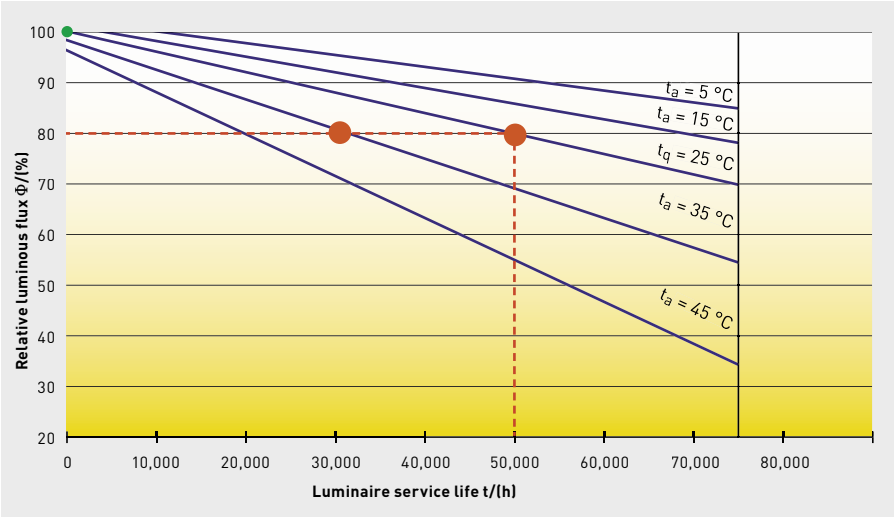
The influence on operational behaviour of an LED luminaire due to ambient temperature must be taken into account as well.

The maximum rated ambient temperature t_a specifies the value at which the luminaire is permitted to be operated in compliance with all safety-relevant parameters. This value in operation may only be exceeded for a short period of time by a maximum of 10 Kelvins.

The temperature specification t_q (quality) designates the maximum rated ambient temperature applying to the specified key factors such as service life and photometric characteristics. t_q can be equal to t_a, but it is also possible for various rated ambient temperatures to specify the corresponding operating data in each case.

With values of t_a = 25 °C or t_q = 25 °C, specifying the temperature on the luminaire is not required in each case because this value is used as a standard value.

Correlation between luminous flux, service life and temperature



Example for the luminous flux and service life behaviour of an LED luminaire L80 = 50,000 h (at t_q = 25 °C) in various areas with permissible ambient temperatures t_a

TRILUX-TIP
Measurements with real systems instead of under laboratory conditions

Often the service life specifications of an LED luminaire are determined only based on theoretical data of the LEDs used. Here several values such as temperature and air currents can strongly deviate from real, practice-related conditions. This is why TRILUX tests its LED systems under real conditions. Since 2004, the temperature in the junction area (t_j) is being determined for various products as part of long-term analysis (up to 50,000 hours). In these cases the measured values correlate very well with the previously calculated values.

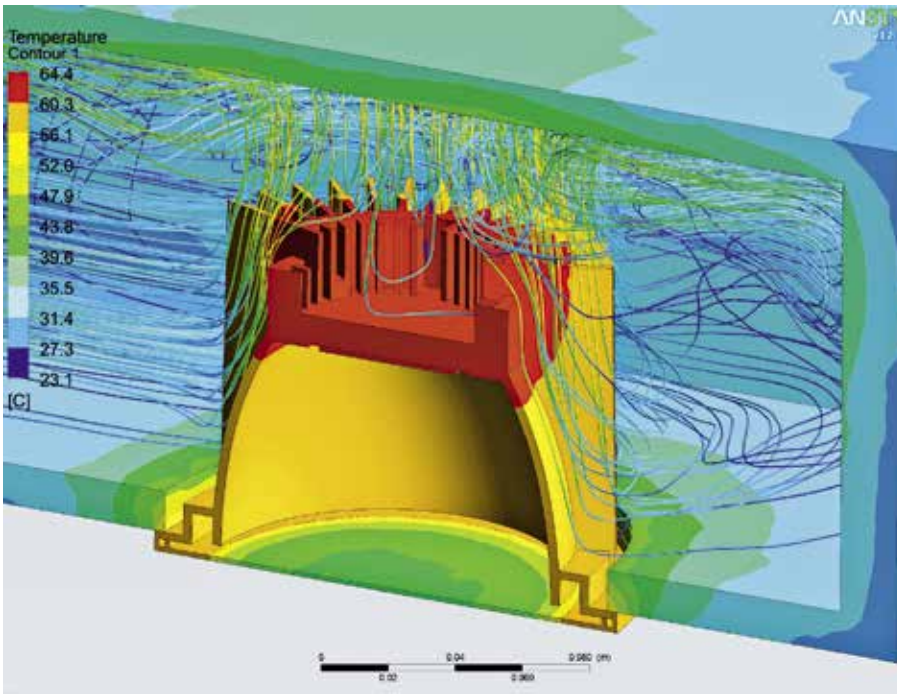
Efficient thermal management as a performance-critical factor

Although light emitted from an LED contains no infrared components and therefore no heat, high temperatures are created during recombination in the semiconductor crystal. This almost punctiform heat load has to be dissipated via a sophisticated cooling system and uniformly distributed. In principle the LED cooling system is similar to a computer processor: the PCB on which the LED is mounted is pressed with a heat sink to ensure ideal heat transition. The form and construction of the heat sink depend among other factors on the luminaire geometry, the installation location and the material used.

TRILUX TIP
Objective quality label: ENEC +

The ENEC+ label is an objective quality label launched in 2014 by the European Electrical Products Certification Association (EEPCA) in cooperation with Lighting Europe. It guarantees the correctness of performance parameters specified in data sheets, for example regarding the luminous flux, connected load, light output ratio and especially the service life of an LED. As such, the symbol creates more transparency and comparability in the market. To extend the level of trust of customers in LED technology, TRILUX will have the VDE inspection authority certify its products with the ENEC+ according to the new, international standards.

TRILUX-TIP
Industry-leading thermal and electric management



In order for LEDs to fully leverage on their advantages in terms of service life and luminous efficiency they must be operated at the ideal operating point. For this, excellent thermal and electrical management is mandatory. TRILUX optimises the thermal chain of its luminaires via detailed simulations and constructions on the real system. Factors considered include the total power consumption of the luminaire, the ambient temperature in the application, the air flow around the luminaire, the required luminous efficiency of the LED and the targeted service life.

Rated service life L_xB_y
Nominal rated service life L_x
Number of luminaires with increased luminous flux reduction B_y

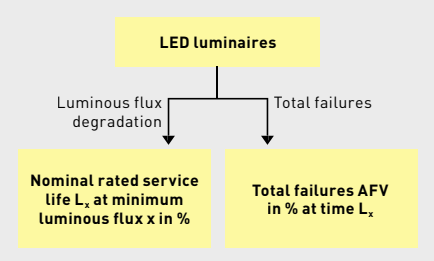
The parameter L_x in the specifications for rated service life specifies the service life with reference to the preservation of luminous flux of a quantity of identical luminaires. Here the luminous flux of each of these LED luminaires at the time of the specified rated service life relates to the component as listed in the index of x (in %) of rated luminous flux in new condition. For example, L_{80} or L_{70} specifies that the rated service life is based on an evaluation of 80 % or 70 % of the rated luminous flux in each case.

When comparing different LED luminaires, not only the actual service life in hours is of interest but in particular the specification of the value x from L_x that can differ between manufacturers and also between products. For various luminaires with identical rated service life (e.g. 50,000 hrs.), this means that luminaires with the higher x value (L_{80}) still emit 10 % more light after 50,000 hours than the luminaires specified with the lower x value (L_{70}). As a consequence, in a specified lighting system a larger quantity of luminaires with lower x values, or alternatively, luminaires with higher luminous flux levels must be installed, and this usually means higher connected loads in each case.

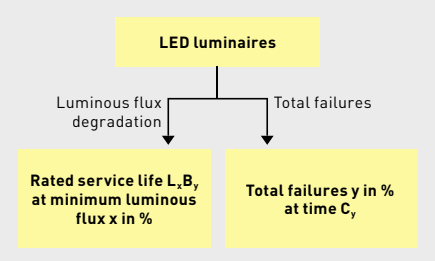
As already explained under the term "rated luminous flux", LED luminaires of identical type may have different luminous flux levels. With high quality products, these luminous flux levels are distributed in accordance with an identical curve within a narrow range of just a few percentage points. Such products are specified in particular by specifying the number of luminaires with increased luminous flux reduction B_y, which is also a part of the service life specifications. The value y (in %) specified in the index describes the number of LED luminaires that fall below the value of x (in % of L_x) of the rated luminous flux at the time of the specified rated service life, but that are, however, still functional. Thus B_y specifies a gradual but not total failure of an LED product.

B_{50} therefore means that the luminous flux levels of 50 % of luminaires from a larger quantity of the same luminaire type at the time of the specified rated service life are in each case below x % of the rated luminous flux. The luminous flux levels of the other 50 % of these luminaires are therefore above x % of rated luminous flux. Because of the same distribution of luminous flux of the individual luminaires, the value of x % of the rated luminous flux at this time can be practically assumed to be the nominal luminous flux of this larger quantity of luminaires. Because of the direct relation between luminous flux levels and service life specifications, the term used at this operating time is also the nominal rated service life L_x, although due to the direct connection to B_{50}, specifying the number of luminaires with increased luminous flux reduction B_y is not necessary.

If products reference other B_y values (e.g. B_{10}), then L_xB_y must be specified for these luminaire rated service life figures. These, however, are not directly comparable with the specification for nominal rated service life L_x. To aid easier understanding and for comparability of specifications for LED luminaires, the trade association "licht im ZVEI e. V. "recommends using specifications for nominal rated service life L_x on principle.



Service life criteria with LED luminaires for nominal rated service life



General service life criteria for LED luminaires

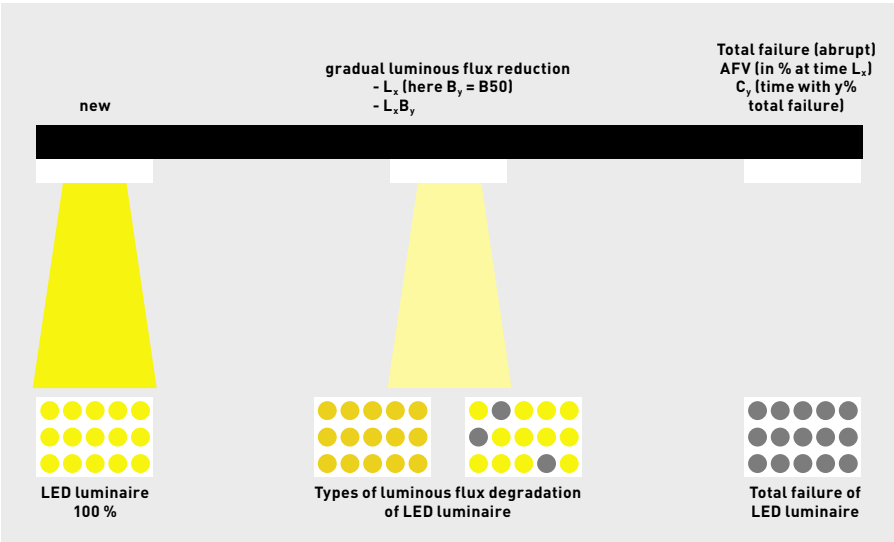
Failure rate AFV
Total failure time C_y

The AFV failure rate ('abrupt failure fraction') specifies the percentage quantity of LED luminaires that totally failed up to the time of nominal rated service life L_x (at B_{50}). If the failure rate of LED luminaires is practically non-existent up to the rated service life, it is usually not specified.

The total failure time C_y is specified as B_{50} for all other B_y values, and specifies the time after which y % of the LED luminaires have totally failed. The index value y in C_y in this case is not necessarily comparable with the index y in B_y.

If LED luminaires consist of several LEDs or LED modules, the total failure of LED luminaires does not relate to the failure of individual LEDs or LED modules.

Failures of further electronic components (e.g. electronic control units) can currently only be separately observed in practice. Manufacturers should specify the corresponding data. Internationally, it is currently being discussed how a consideration of all components used could be implemented and standardised.



Possible conditions or error situations for an LED luminaire
(new state, degradation and total failure; source: TRILUX Akademie)

Examples for representing specifications for service life and failure rates

L_{80} – 50,000 h: At the time of the "nominal rated service life L_{80}" of 50,000 hours, 50 % of the still functional LED luminaires fall below a value of 80 % of rated luminous flux. At that time, no appreciable quantity of LED luminaires has totally failed (AFV << 1 %).

L_{80} AFV= 2 – 50,000 h: At the time of the "nominal rated service life" of 50,000 hours, 50 % of the still functional LED luminaires fall below a value of 80 % of rated luminous flux. At that time, 2 % of LED luminaires has totally failed.

$L_{80}B_{10}$ – 50,000 h: At the time of the "rated service life $L_{80}B_{10}$" of 50,000 hours, 10 % of the still functional LED luminaires fall below a value of 80 % of rated luminous flux. At that time, no appreciable quantity of LED luminaires has totally failed (because C_y is not specified).

$L_{80}B_{10}$ – 50,000 h: C_5 – 65.000 h: At the time of the "rated service life $L_{80}B_{10}$" of 50,000 hours, 10 % of the still functional LED luminaires fall below a value of 80 % of rated luminous flux. 5 % of LED luminaires have totally failed after 65,000 h.

Because of the low range of distribution of luminous flux levels with the LED luminaires and easier documentation of the nominal luminous flux at the defined end of service life for a larger quantity of a luminaire type, specifying the nominal rated service life is recommended for an easier understanding.

Nominal rated life cycles in comparison

It is only possible to compare LED luminaires with regard to service life by specifying the nominal rated service life L_x and the total failure AFV. The quantity of total failures up until the nominal rated service life of quality-manufactured LED luminaires is usually very low. Attention should be paid to total failure when specifying the products, but this plays almost no role when observing luminaire classifications. Products become comparable with the categorising of LED luminaires into corresponding luminaire classifications (e.g. L_{80} – 50,000 hrs.).

Luminaire classification of LED luminaire	**Conversion into other luminaire classifications**		
	L_{85}	**L_{80}**	**L_{70}**
L_{85} – 50,000 h	50,000 h	67,500 h	100,000 h
L_{80} – 50,000 h	37,500 h	50,000 h	75,000 h
L_{70} – 50,000 h	25,000 h	33,500 h	50,000 h

Exemplary figure: The left column contains the luminaire classifications of the actual LED luminaires. The three columns on the right show the corresponding nominal rated service life with conversion into other luminaire classifications. The values in each case are valid with comparable ambient temperatures t_a.

3. CONSTRUCTION OF AN LED – THE COMPONENTS

Construction of an LED assembly

At first sight an LED assembly consists of a series of simple components. The central element is the actual LED (light emitting diode), a specially doped semiconductor that transforms the electrical energy into visible light. This process takes place in a very narrow area in the centre of the semiconductor, the so-called junction area or junction. The LED itself features two electrical connections and can be fixed onto a thermally conducting carrier material to dissipate the heat occurring during operation. These components are protected by a robust housing that is covered above, i.e. in the radiation direction, by a primary optical system (usually a small lens).

TRILUX TIP
LED ≠ LED – there are large differences in quality of the components

The service life of an LED, uniform and homogeneous brightness and colour values of the light and the safety of an LED luminaire all depend on the quality of the components used. This is why TRILUX only uses first-class components in its LED luminaires sourced from certified and quality-tested suppliers.

Simple LEDs to 1 watt

LED types of lower power ratings have in past years made a large quality leap and can thus be used very well for general lighting purposes. The largest progress with mid-power packages has been achieved with thermal resistance, and by introducing the so-called slug, as previously done with high-power packages. Here the thermal energy is not only dissipated via the electrical contacts (anode and cathode) but also via a direct thermal path (slug) on the PCB.

In this way, maximum efficiency levels in the luminaires can be achieved. This type of LED is particularly suitable for generating wide-area light, both for trans-illuminating optical systems as well as for edge light entry.

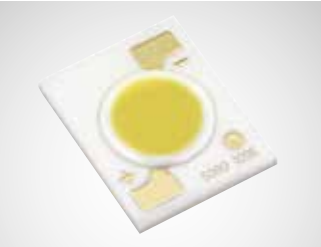
High performance LED – increasing output requires a heat sink

It is not only the luminous flux that increases with increasing wattage but also the temperature on the junction area. The LED heat sink by itself is not enough though, and the luminaire manufacturer has also to ensure that the heat is effectively dissipated.

SMD LED – wireless LED assembly

SMD LED (surface mounted devices) need no wires. Instead, the SMD LED has small bumps on the underside that fit precisely into the slightly recessed, laterally reversed connection contacts (footprints) on the PCB so that they can be directly mounted onto the circuit board without drilling. SMD LEDs are the industrial standard and the type of construction most often used in practice. They cover an extremely wide application spectrum ranging from low-power LEDs with a power consumption of a few milliwatts to high-power LEDs with a wattage of up to 20 watts.

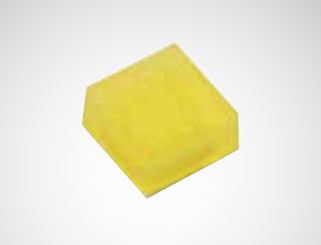
COB LED – the "naked" Chip on Board



Source: Lumileds

With the SMD LED the chip is installed into a so-called package, but with COB LEDs the naked LED chip is assembled directly onto the circuit board (Chip on Board). Subsequently the chip gets an epoxy lens with defined beam angle. COB LEDs may consist of very tightly equipped LED chips that emit high quantities of light from a compact surface. Typical applications are downlights and floodlights.

Flip chips without a package



Source: Lumileds

Flip chips are already known from the high-power LED sector. Progress in the areas of efficiency and continuous cost pressure now cause leading manufacturers to offer these flip chips without a package. With corresponding assembly systems, these chips can be attached to the PCB exactly as LED packages are. The advantage compared to chip-on-board technology is that the failure-sensitive wire bond is not required.

OLED – ultra-thin, flexible LED film

The semiconductor in an OLED – an organic LED – when compared to a normal LED does not consist of inorganic crystal but an ultra-thin, organic layer with semiconductor properties. Analogue to inorganic LEDs, the light in OLEDs is created via the recombination of electrons and holes. In the junction they form an excitron, a quasiparticle, that when returning to a lower energy state either emits light itself or excites a pigment in the junction to light emission.

One of the most important benefits of OLED is its low thickness: this can be less than 2 mm on a glass substrate. Although OLEDs are already used commercially, in terms of service life they do not yet meet the TRILUX quality criteria. With white light OLEDs the service life (L_{70}) is currently at 10,000 - 40,000 hrs. (at 3,000 K). For further information about OLED, see from page 218.

LED module – a unit ready for use

One or several LED chips are fixed to a PCB and are assembled to a unit ready for use with all required optical, electrical and thermal elements. The module can be controlled via standardised connections, and according to construction can be operated directly or can be used to design a luminaire. Fundamentally a differentiation is made between linear, flexible and flat LED modules, LED chains and LEDs with sockets (e.g. retrofit lamps).

LED light engine

In addition, a light engine also contains the control gear.

TRILUX TIP
TRILUX – from module to luminaire

The construction of our LED luminaires is a highly complex and individual adaptation process. Which LED chips and LEDs are assembled onto which PCBs with which optics? How can thermal management, operating and control units as well as luminous intensity and light colour be adapted to individual application conditions? Which light distribution is ideal? And of course: How can all of these requirements be combined to become an attractive, durable and efficient lighting solution with a future-fit design? Our answers to these questions are found on the product pages of this LED Guide.

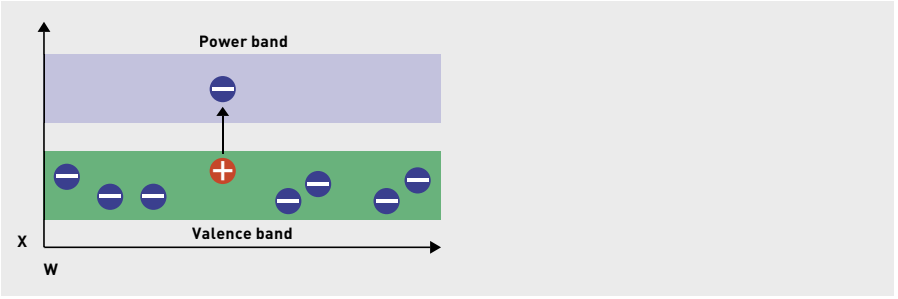
Semiconductors

Semiconductors are crystalline solids with a strongly temperature-dependent conductivity. At absolute zero (-273,15 °C) they function as an isolator, but at room temperature they have a measurable conductivity that rises with increasing temperature.

The band model

This phenomenon can be explained with the quantum band model. This states that the electrons in a semiconductor can move only on specific energy bands with a specific energy level. At absolute zero the highest occupied energy band, the valence band, is completely filled with electrons and is separated from the next higher empty energy band, the conduction band, by a band gap. If temperature increases then single electrons can overcome the band gap and move freely on the conduction band so that conductivity increases. This leaves a positively charged gap on the valence band, a so-called defect electron or "hole".

Semiconductors



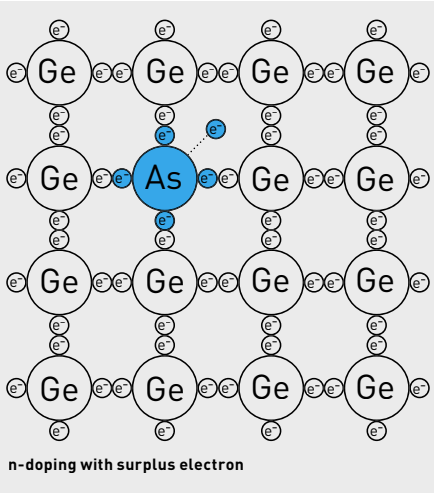
Recombination and light emission

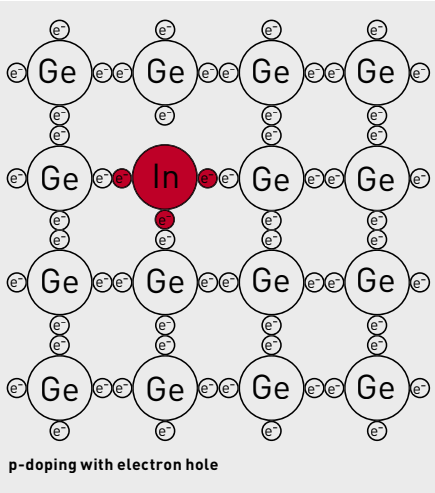
If a freely movable electron on the conduction band meets a defect electron in the valence band then the electron and hole can recombine. The energy thus released can be emitted as light, as is the case with LEDs. The wavelength of the emitted light depends on the size of the band gap and can be influenced by the selection of semiconductor materials.

Doping, P-doping, N-doping

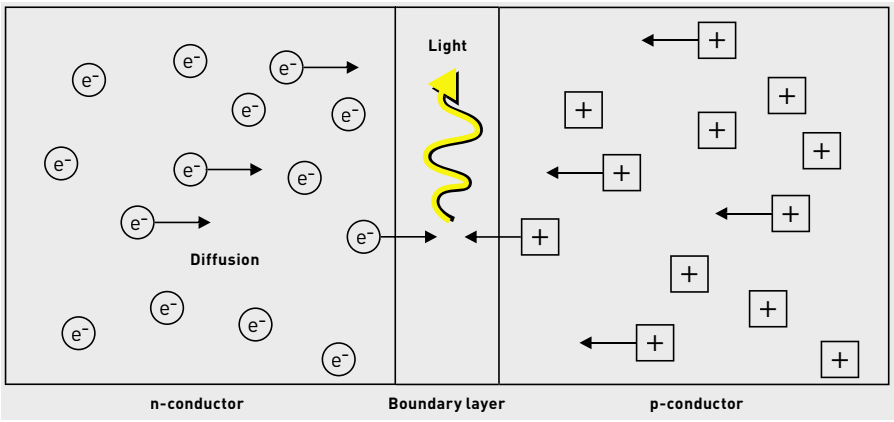
Doping specifically increases the conductivity of a semiconductor. Discontinuities in the crystal lattice are integrated by atoms with a lower or higher quantity of valence electrons. If a series of arsenic atoms with five valence electrons for example is integrated into a crystal lattice of germanium atoms (four valence electrons), then the fifth atom is not required for combination. It flows freely through the lattice and is available for conduction of the electrical current. A semiconductor doped with foreign atoms of a higher value is called an n-conductor. If an atom is integrated into the germanium lattice with only three valence electrons, e.g. indium, then a freely wandering electron hole is generated in the lattice. A semiconductor doped in this way is a p-conductor.

Doping, p-doping, n-doping
Continuation





The pn junction

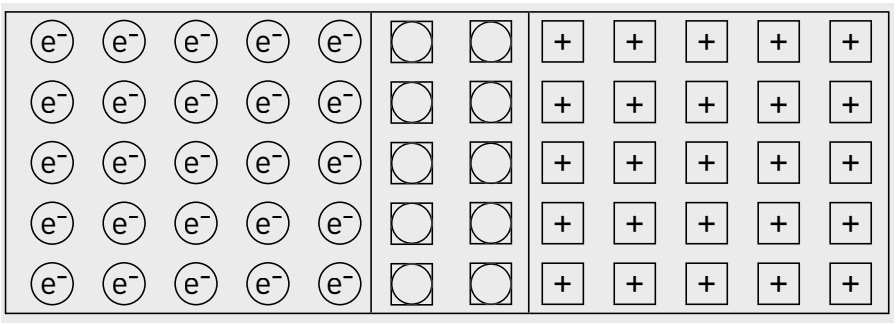


If an n- and a p-conductor are combined, electrons diffuse on the boundary layer from the n-conductor into the p-conductor and holes from the p-conductor into the n-conductor. Here the pn semiconductor remains electrically neutral but tension is generated by the disappearing of an electron from the n-conductor and a hole from the p-conductor. The n-conductor becomes increasingly positively charged in the boundary layer and the p-conductor negatively charged. The surplus electrons in the n-conductor are still attracted by the holes in the p-conductor, but are simultaneously repulsed by the increasing negative charge in the p-conductor, until a state of equilibrium is attained and electron migration stops.

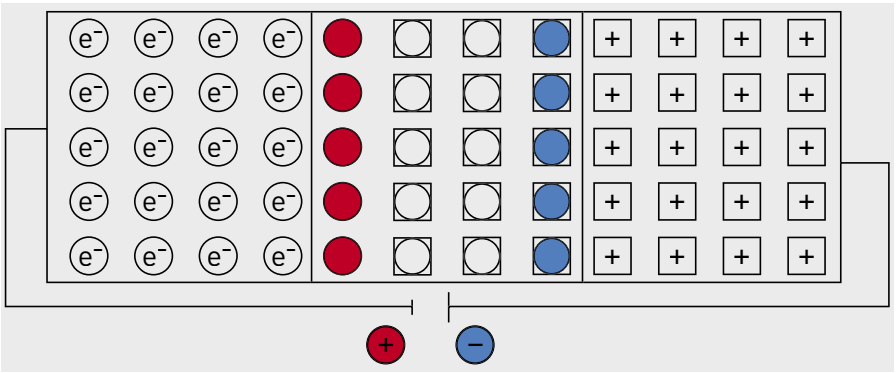
Forward direction and reverse direction

With application of voltage to the pn junction, the size of the junction area can be influenced. Here polarity is decisive. If the n-conductor (electron donor) is combined with the negatively charged cathode, then electrons push in from the n side in the direction of the junction area to the anode. At the same time holes migrate from the p side (connected with the positively charged anode) towards the junction area or cathode. The junction area becomes smaller with increasing voltage until the forward voltage is achieved and the diode conducts current. If though the n-conductor is combined with the positively charged anode, electrons are attracted by the anode so that the junction area increases and no current can flow.

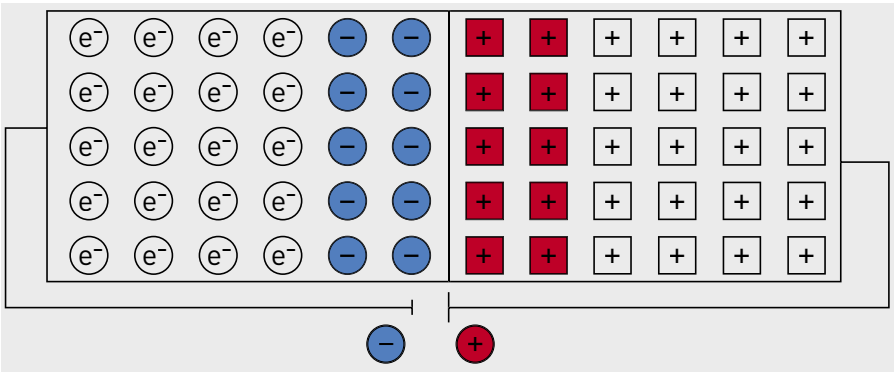
Currentless situation



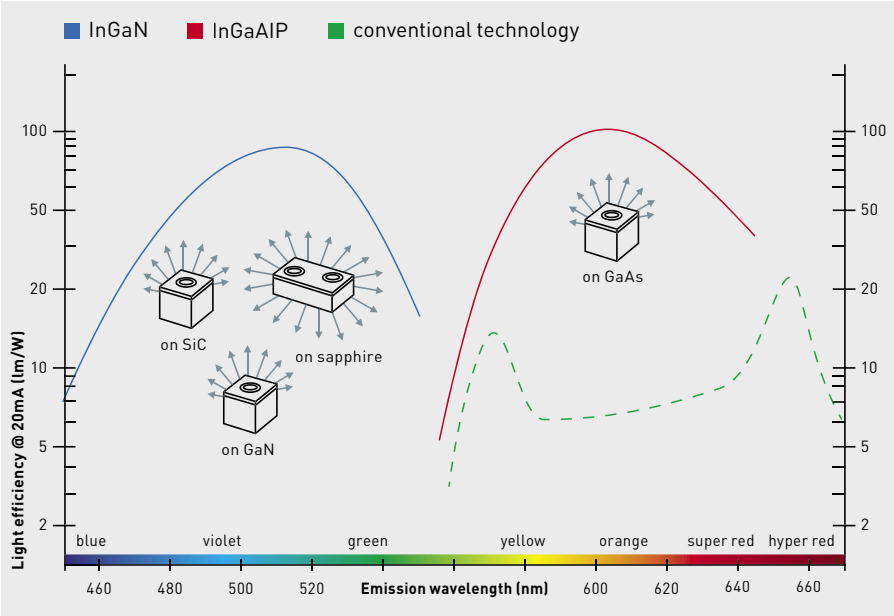
Diode in reverse direction



Diode in forward direction



Monochromatic light with recombination at the junction area

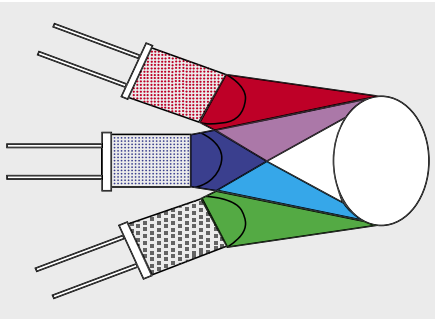


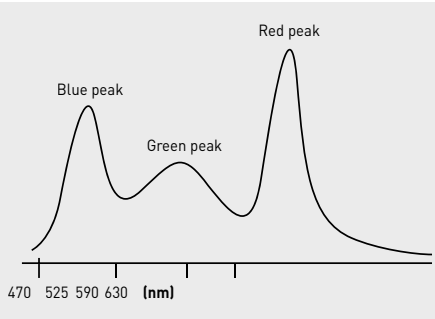
If an electron and a hole recombine, light emission is generated. Because with the return of the electron from the conduction to the valence band the same quantity of energy is always released, the emitted light is monochromatic. By selection of suitable semiconductor materials, the size of the band gap can be specified to generate all spectral colours, i.e. red, orange, yellow, green, blue and violet. Because efficiency of the green LED is significantly lower than the other spectral colours, further research is being carried out here for suitable semiconductor materials.

White light – trichromatic via RGB LED

White light is generated with the additive colour mixing of the spectral colours red, green and blue. This fact is utilised by RGB LEDs: a red, green and blue LED chip are combined to an LED unit. With specific control of the single LED chips the mixing ratio of the primary colours and thus the colour of the emitted light can be dynamically and infinitely modified. But because red, green and blue LEDs differ in terms of brightness, service life and operating conditions, RGB LED has high demands with construction and control technology. The LED industry has now worked out solutions to reduce these disadvantages though. As a consequence, green and other coloured LEDs are now available that do not directly emit the specific wavelength but use a blue LED chip as the basis. The corresponding colours are generated using phosphor, as with white light. Another advantage for general lighting is that these coloured LEDs generate more broadband light compared to monochrome LEDs.

RGB-LED

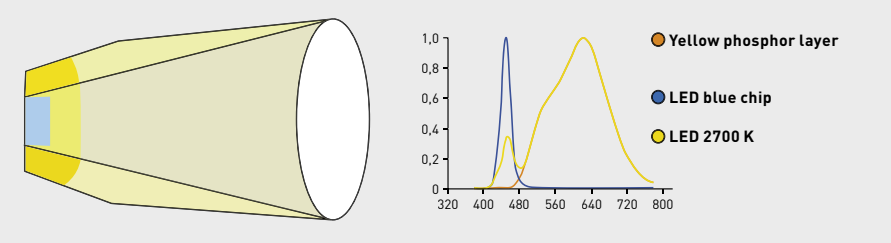




White light – bichromatic via blue LED and yellow phosphor

If a blue LED is combined with a luminescence colorant, e.g. yellow phosphor, then the energy-rich blue light is partly absorbed by the yellow phosphor and is emitted as longer wavelength yellow light. With additive mixing of the non-absorbed blue light component with the yellow light, white light is generated. The colour tone of the white light LED can be influenced here by type and concentration of the luminescence colorant. Compared to RGB LED, the light emitted by such luminescence conversion LEDs has a relatively wide and uniform spectral distribution and thus better colour rendering.

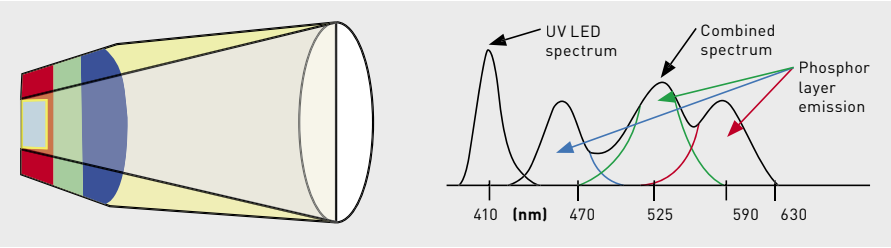
Blue LED + yellow phosphor layers



White light – via UV LED and RGB phosphor layers

White light can also be generated via a combination of UV LED and RGB phosphor layers. The UV LED emits highly energetic, invisible radiation that is absorbed by several luminescence colorants and is transformed to lower energy wavelengths that can be perceived by the human eye. In total, white light is generated.

UV LED + RGB phosphor layers



TRILUX-TIP

White light – which LED technology is the best?

Depending on the application area and demands, various LED technologies are suitable for generating white light. RGB LEDs are most often used for accent lighting. Their strengths are with the flexible, dynamic controllability of the light colour. Compared to bichromatic luminescence conversion LEDs though they are more expensive and less efficient in terms of colour rendering. Both technologies are part of the TRILUX LED program and are used in many different lighting solutions and luminaires. UV LED with RGB phosphor have a high potential for the future, but are technologically not yet mature enough to satisfy TRILUX quality standards.

White light, warm light, cool light?

If the spectral composition of the light from various light sources is compared then major differences are seen. Candlelight for example contains an above average red component and is perceived as warm light, whereas the light from a fluorescent lamp has a higher blue component and appears cooler. As most natural light sources emit a wide spectrum of various wavelengths, specification of a single wavelength is not suitable for characterising white light. More decisive is the ratio of the various spectral components. These specify the colour temperature with white light or the colour of coloured light.

Colour temperature – black body

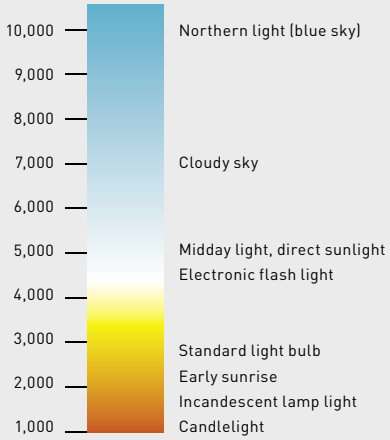
If a black metal body is heated (a so-called black body) it begins to emit electromagnetic rays. These are initially heat radiations in the infrared range, but then with increasing heat they achieve the spectrum of visible light. At a specific temperature the metal begins to glow red, then yellow, then white and finally blue. Here the ratio of the various wavelengths changes: the hotter the metal becomes, the less red components and the more blue components the emitted light has.

Colour temperature – light in accordance with the black body

If the spectrum emitted from the metal is compared to a natural light source it can be seen that: Each light source can be specified by the light of the glowing metal at a specific temperature. With a temperature of 1,500 Kelvin (approx. 1,773 °C) the metal emits the same light spectrum as candlelight. At 4,000 K (approx. 4,273 °C) the light corresponds to a neutral white (nw) fluorescent lamp usually used in Germany, and at around 6,500 K (approx. 6,773 °C) the colour temperature is that of daylight.

Colour temperature specification

Excerpt from DIN-EN 12464-1
The "light colour" of a lamp refers to the colour appearance (colour type) of the radiated light. This is quantified by its most similar colour temperature (T_{CP}). The light colour of daylight changes through the day. The light colour of artificial light can also be specified as in the table.

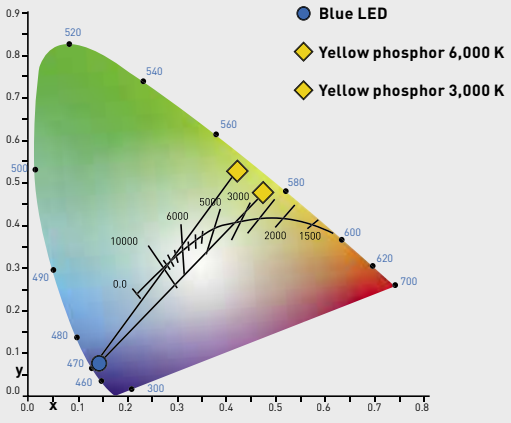


Light colour groups of lamps:

Light colour	Most similar colour temperature TCP
Warm white	below 3,300 K
Neutral white	3,300 K to 5,300 K
Daylight white	over 5,300 K

Light colour and most similar colour temperature of lamps according to EN 12464-1

Generation of white light with phosphor



CRI – the colour rendering index

In practice the question is often asked how "natural" light is, meaning how natural colours appear with this light. This value is measured with the aid of the colour rendering index. This specifies how natural the light from a source is perceived or how natural the colours of an object are rendered in this light. Sunlight has a colour rendering index (Ra value) of 100, and the higher the Ra value of a light source, the more natural is its colour rendering.

Colour rendering of specific lamps

Lamp	Index R
Quality of colour homogeneity in the ellipse	up to 100
Fluorescent lamp, white de Luxe	85···100
Fluorescent lamp, white	70···84
LED, white	65···97
Fluorescent lamp	50···90
Metal halide lamp	60···95
High pressure sodium vapour lamp, warm white	80···85
High pressure mercury vapour lamp	45
High pressure sodium vapour lamp, standard	18···30
High pressure sodium vapour lamp, colour- improving	60

Binning – sorting for consistent light quality

With the production of LEDs, deviations of colour and intensity of the light as well as forward voltage may occur due to the production process. To ensure uniform configuration of the luminaire, binning is carried out, meaning the LEDs are inspected after production and grouped into various classes or groups. Binning is realised according to the following criteria:

Colour binning

LEDs are sorted according to their colour coordinates in the CIE standard colorimetric system. Here white LEDs are differentiated according to colour temperature and colour locus. For coloured LEDs, binning is implemented with the aid of the colour locus and the peak or dominant wavelength. With the help of the MacAdam ellipses it can be demonstrated how fine the bin has been set by the manufacturer. The following applies: The smaller the bin, the less colour differences are visible. If a bin is as large or smaller than the MacAdam ellipse at the corresponding colour locus, then the human eye can no longer recognise colour differences.

Flux binning

Sorting is carried out according to the luminous flux of the LEDs, measured in lumens. This ensures a uniform luminous flux. For LEDs with integral optics, instead of luminous flux a specification of luminous intensity in candelas can be made.

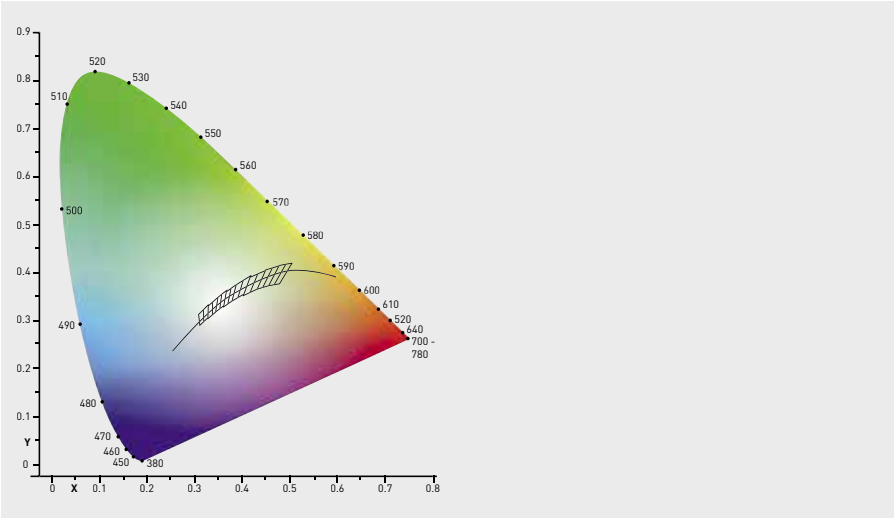
Voltage binning

LEDs are sorted according to forward voltage.

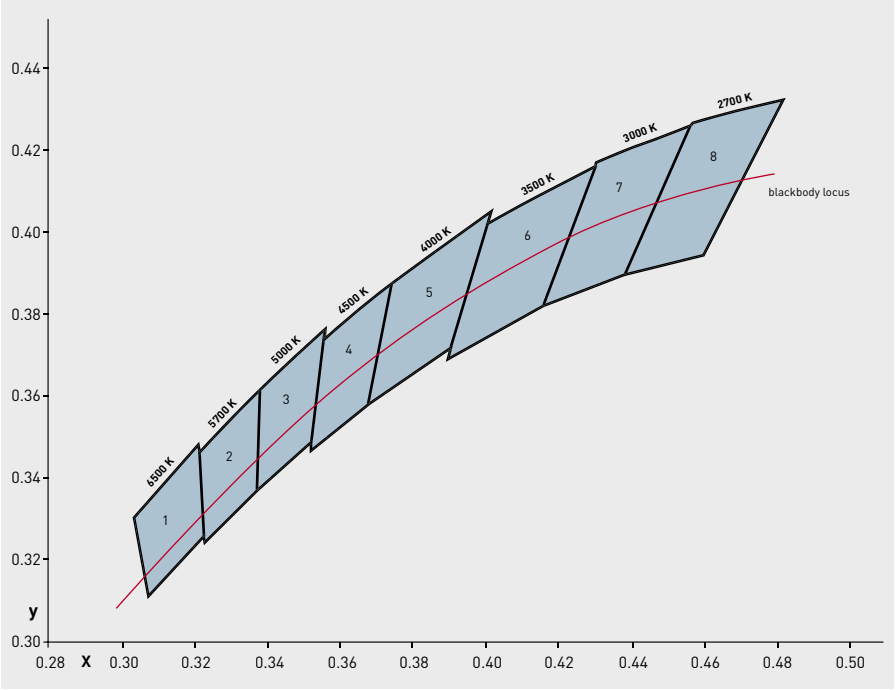
The CIE standard colorimetric system

A colour can be objectively described with the CIE standard colorimetric system, and this is a fundamental requirement for useful clustering and binning. With specification of a colour with the CIE standard colorimetric system, the RGB colour values are transferred via mathematical conversion to an XY coordinate system. The result is a horseshoe-shaped spectral locus. On the outside are the colour tones with the highest saturation level and towards the centre the secondary colours increase. In the achromatic or white point, red, green and blue are mixed to equal ratios so that the light is white.

CIE standard colorimetric system

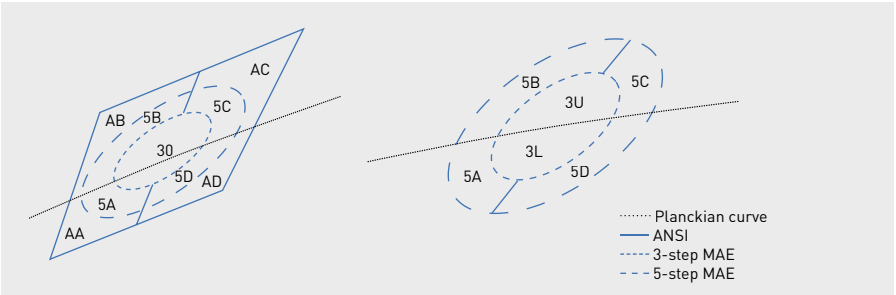


Binning of white LEDs (ANSI bins)



The colour space shown as white in the CIE system contains a wide spectrum of colour temperatures. Warm white for example is at 2,670 K and daylight white is at 6,500 K. In addition to colour temperature, binning considers the "colour tone", i.e. the colour component with which the LED deviates from the ideal spectrum of a black body.

Binning of white LEDs (MacAdam ellipses)



Several LED producers are now binning LEDs according to the colour temperatures of the ANSI bins in MacAdam ellipses. The figure shows the proportions between the ANSI bin at 4,000 K for the associated 5-step und 3-step MacAdam ellipses. See page 205 for more detailed explanations.

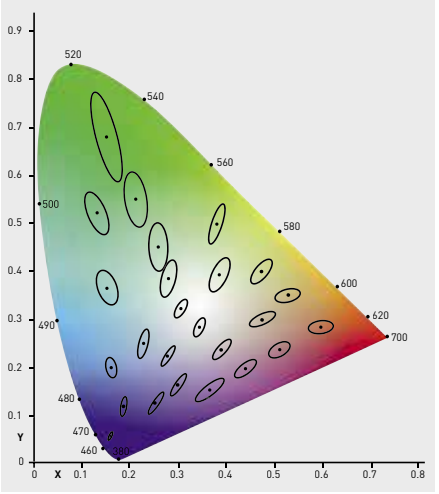
White LEDs in full distribution

With a full distribution solution, the LEDs jointly integrated into a luminaire are not binned and the emitted light has visible colour differences.

Binning of LEDs – what the eye sees...

To sort LEDs it would theoretically be a good idea to define a desired colour value in the CIE system and to assign this a circular tolerance radius. Testing in practice though shows that the human eye perceives different colour deviations to different extents. While it perceives relatively small differences in the blue-violet range, perception in the green range for example is poorer.

Note:
The figure shows no 1-SDCM MacAdam ellipses but enlargements to more clearly explain the principle.



LED binning – MacAdam ellipses

This phenomenon is taken into account by MacAdam ellipses. According to the definition, a MacAdam ellipse is the extent around a colour tone in which the observer has the impression that all comparative colours have the same distance from the reference colour tone. The dimensions in which the MacAdam ellipses are specified are SDCM (Standard Deviation of Color Matching) or threshold value units. If the ellipse is small enough, e.g. SDCM = 1, the colours within the ellipse are perceived to be equal.

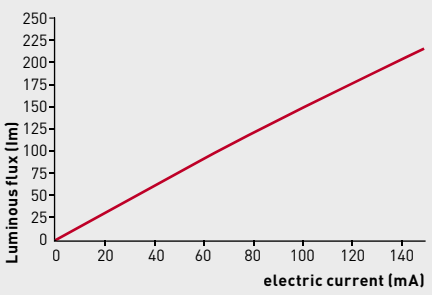
Dimensions of the MacAdam ellipses in SDCM

Size of MacAdam ellipse	**1 SDCM / Single distance**	**2-3 SDCM / 2-3 fold distance**	**> 4 SDCM / > 4-fold distance**
Quality of colour homogeneity in the ellipse	No visible colour deviation	Hardly any visible colour deviation	Visible colour deviation

The brightness and colour of an LED system can be dynamically controlled to the finest levels with intelligent control and operating devices. Standardised digital interfaces such as DALI or DMX can be used as well as the analogue 1-10 V process. One of the strengths of LED systems is the high bandwidth of dimming. While fluorescent tubes can only be dimmed to around 3 % of their total output, LEDs can be infinitely dimmed down to 0.1 %.

Dimming via current intensity

One of the possibilities of dimming LEDs is controlling the current intensity, because in a particular range the quantity of light from an LED depends linearly on the level of electrical current flow. A major benefit with current dimming is the fact that LEDs become more efficient with low current feed. Problematic though here is the lightly varying voltage curves of the individual LEDs. If the LED is dimmed to below 10 % it can happen that individual LEDs still illuminate while others are already inactive. In addition, with current dimming it has to be considered that the colour locus of the LED shifts slightly so that colour differences may become visible. Continuously improving LED production processes and new LED technology significantly reduces this disadvantage so that current dimming is increasingly used.



Luminous flux subject to electric current of a typical mid-power LED.

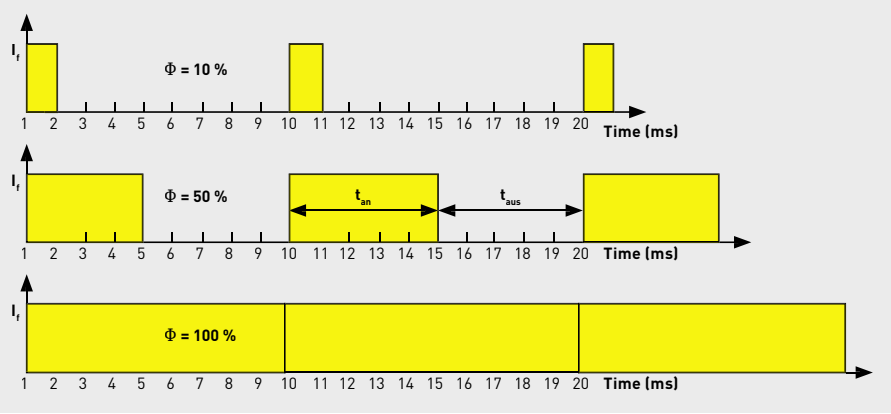
Dimming with pulse width modulation

If an LED module is operated with constant extra low voltage, e.g. 10, 12 or 24 V, then dimming must be implemented via pulse width modulation. But PWM can also be used for dimming in other conditions. LEDs here are always operated with nominal current. Dimming is by switching the LED on or off for only a specific percentage of time. The human eye cannot resolve the single pulses occurring at high switching frequency in the millisecond range. It only perceives that the time-averaged luminous intensity decreases.

TRILUX-TIP
The body sees more than the eye

If LEDs are dimmed via pulse width modulation, the frequency must not fall below a certain value, because even when the eye only sees reduced luminous flux, the human body responds to the hardly perceivable flickering caused by the high frequency on and off switching. To examine these conditions, TRILUX cooperates with the Bartenbach light laboratory. It was determined among other facts that insufficient switching frequency may lead to tiring.

A tip: High-quality luminaires should have a minimum PWM frequency of 500 Hz.

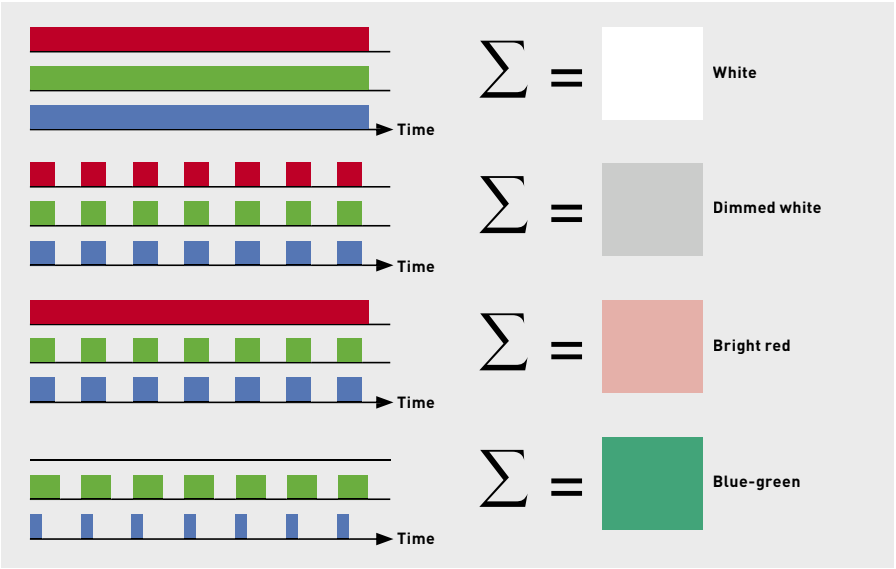


LEDs are always operated with nominal current with pulse width modulation – or not at all.

Colour transitions with pulse width modulation

Not only the brightness but also the colour can be varied with pulse width modulation. Up to 16.7 million different colours can be generated by the selective control of the RGB chips within an RGB LED, ranging from blue, cyan, green, yellow, orange to deep red. Depending on the control method, variation can also be made between saturated and weakly saturated colours up to white.

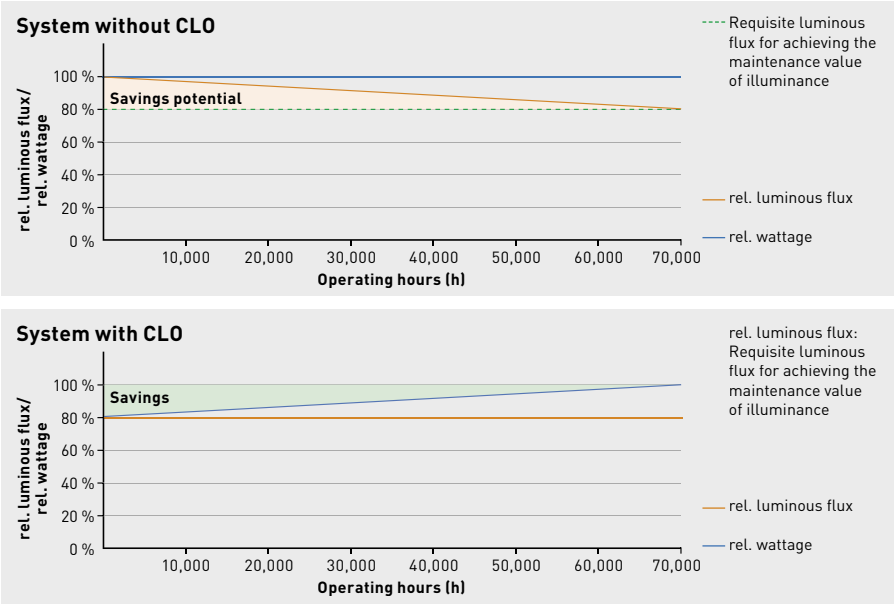
Dimming and colouring with pulse width modulation



TRILUX uses CLO technology. Where is the advantage?

With increasing operating periods, luminaire luminous flux decreases even with LED luminaires. If this operationally-dependent degradation is not taken into account during planning, the level of illuminance falls below specified reference values after a certain duration. To ensure lighting that complies to standards over a specific time period, the lighting system is initially set to higher illuminance. TRILUX uses an intelligent alternative – CLO. Constant Light Output technology counteracts the degradation-related loss of luminous flux. As part of this, the luminous flux of luminaires is kept constant over the complete service life due to successive increases in current value. This renders higher system configuration due to degradation unnecessary and reduces operating costs. Compared to switchable luminaire types, service life also increases because total load on the LEDs is reduced. Defective LED luminaires can also be replaced without noticeable divergences as no differences in brightness occur between old and new luminaires.

What is CLO?



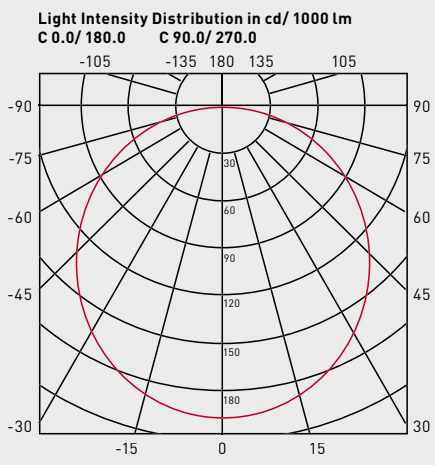
Examples with L80 70,000 hr. LED luminaire with and without CLO.

7. LIGHT DISTRIBUTION

An LED is a point-shaped light source that emits light at a narrow angle of 0° to 150° (Full Width Half Maximum). With use of various primary, secondary or tertiary optics (e.g. lenses, diffusers or reflectors) the light distribution can be specifically adapted to the application to construct narrow- or wide-angle, asymmetric or symmetric light solutions.

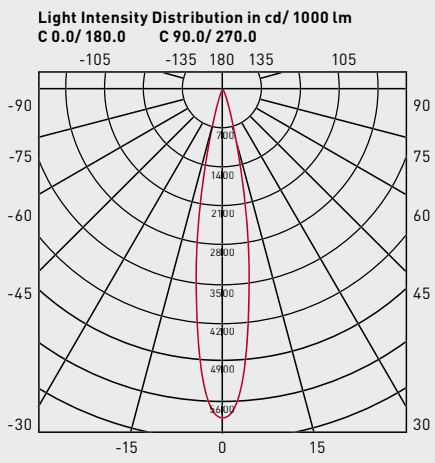
Luminous intensity distribution curve (without secondary optic)

The luminous intensity distribution curve of an LED "without secondary optic" corresponds in many cases to that of a Lambertian source.



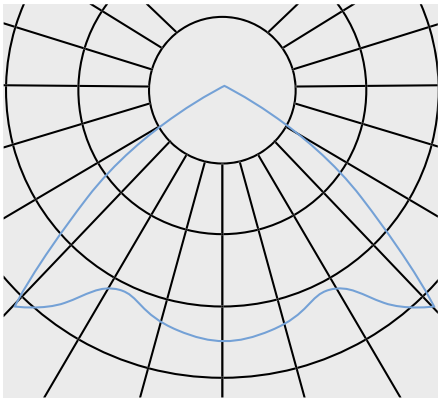
Luminous intensity distribution curve (with secondary optic)

A supplementary optic focuses the LED light "with secondary optic". The result is a narrow-angle light spot.



Luminous intensity distribution curve (LDC)

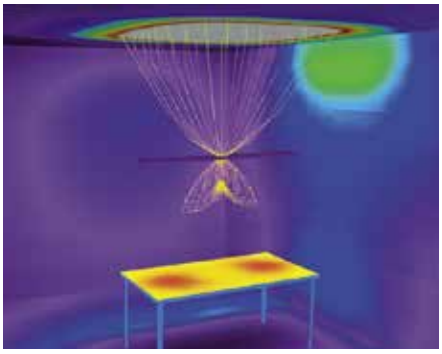
The luminous intensity distribution body specifies precisely how the light of an LED is distributed. Here luminous intensities in the room are displayed as polar coordinates and combined to form a curve. The figure on the right shows a luminous intensity distribution curve that represents excerpts from individual levels of the luminous intensity distribution body.



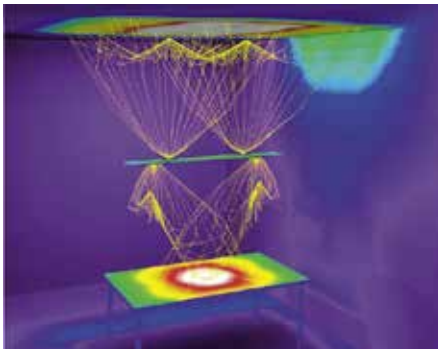
Complex light distributions calculated with ULD

If several LEDs are installed in a luminaire then a central LDC does not give reliable results as the calculations assume that light was emitted from a point-shaped light source in the luminaire centre or uniformly over the complete luminaire surface. Here though the situation in some cases does not reflect the practice. A correct representation is achieved when the luminous intensities of the individual LEDs are integrated into the calculation as ULD data (Unified Luminaire Data) where several LDCs serve as the basis for correct calculation.

Complex light distribution



Lighting planning with a total light distribution leads to erroneous illuminances.



Correct is the use of four individual luminous intensity distribution characteristics in so-called ULD data (Unified Luminaire Data).

8. FOUR CRITERIA FOR A GOOD LED LUMINAIRE

Premium components

The source of LEDs is particularly decisive for quality and service life of the light.

Perfect light control

Only with precise light control the advantage of LEDs can be fully used.

Ideal use of energy

LEDs have low-cost power consumption, but they do not operate efficiently in terms of energy in all cases. The luminous efficiency of the complete system is decisive.

Light stability and light colour

During planning, light colour and light stability over the service life should definitely be taken into account.

TRILUX TIP
LED and design – complete flexibility with form and colour

LEDs with a diameter of 0.5 mm, flexible LED modules that can be integrated as bands, chains or surfaces into luminaires and 16.7 million colours – never before have luminaire designers had such flexibility with forms and colour design. TRILUX uses this creative freedom mainly for one thing: to construct luminaires that are both so innovative and attractive that they deserve design awards and so powerful and energy-efficient that they inspire in practice.

Design-awarded LED luminaires

DESIGN AWARD 2016

GOLD AWARD 2016

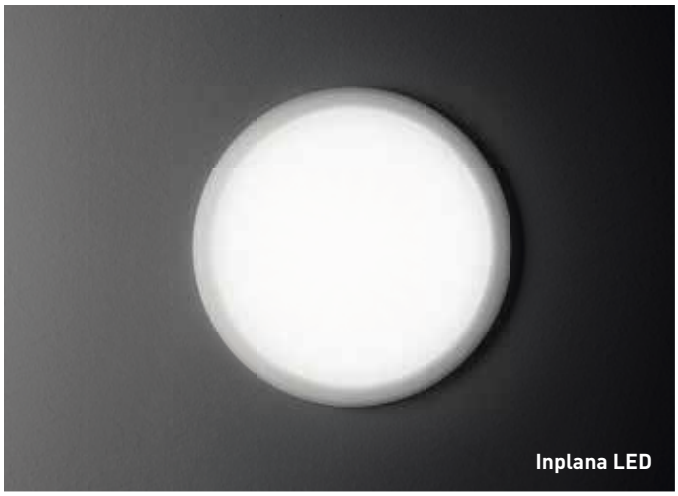
DESIGN PLUS
powered by: light+building

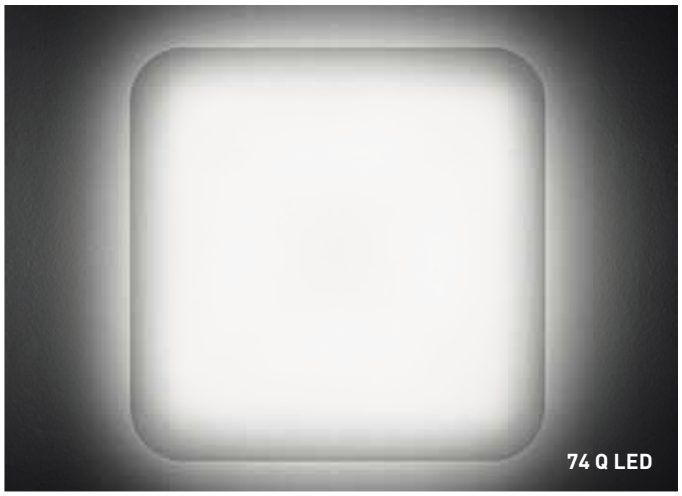
Lunexo LED

Solvan Flow LED

Less G2 LED

Design-awarded LED luminaires


Inplana LED


74 Q LED


74 R LED


Onplana LED

9. OPTICAL SYSTEMS

LED technology has become the standard and we have now already converted the major part of the TRILUX portfolio to LED. The luminous efficiency of today's LEDs has left all traditional lamps far behind. However, the combination of LEDs and their optical systems is decisive for luminous efficiency. For us, a further essential evaluation factor is light comfort, also referred to as light quality. Therefore, TRILUX began to develop optical systems specifically for LED luminaires more than 10 years ago.

We have continued to optimise these until this day to develop innovative solution concepts for highly diverse applications and needs. We offer innovative standards where the blending of optics and LED technology can be experienced more intensively than ever before. Previously it was the classic louvre systems, today it's miniaturised lenses and reflectors for directed light as well as backlit prismatic structures and light emission panels for the uniform emission of light. The results though always target best possible efficiency (costs) as well as maximum light comfort (visual comfort), with a significant increase of options due to LED technology. The smallest details are often decisive in such cases to guarantee premium levels of quality.

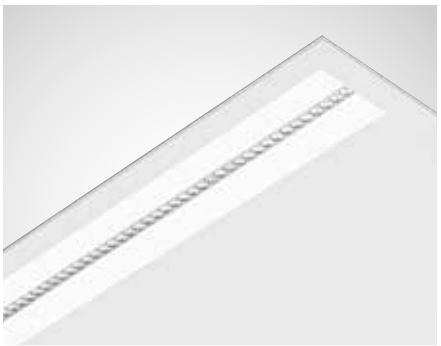
DIRECT DISTRIBUTION, SECTIONAL

MRX (Micro Reflector Technology)
Reflector chamber, aluminium-vaporised

For VDU-compliant visual tasks with maximum efficiency

Micro Reflector Technology (MRX) specifically developed by TRILUX is specially designed for direct distribution optics in offices. The single highly-efficient reflector chambers made of plastic (aluminium-vaporised) ensure maximum glare reduction, and with a highly-reflective surface guarantee maximum efficiency and energy savings (<1,500 or 3,000 cd/m²; UGR19).

Product examples: Solvan Flow MRX, Coriflex MRX, Arimo Slim MRX



MRW (Micro Reflector Technology)
Reflector chamber, plastic, white with cover

For flexible lighting concepts and increased visual comfort

Micro Reflector Technology specifically developed by TRILUX is specially designed for direct distribution optics. The single highly-efficient reflector chambers of polished white plastic provide increased light comfort and maximum energy savings (< 3,000 cd/m²; UGR22 or < 5,000 cd/m²; UGR19). The additionally integrated cover achieves a flush fit on the room side and protects the LEDs.

Product example: Solvan Flow MRW

DIRECT DISTRIBUTION, SECTIONAL

MRW-D (Micro Reflector Technology)
Reflector chamber, plastic, white, with diffuse cover

For flexible lighting concepts and increased visual comfort

Micro Reflector Technology specifically developed by TRILUX is designed for direct distribution optics. The single highly-efficient reflector chambers of polished white plastic with diffuse cover create a homogeneous light effect and maximum visual comfort (< 3,000 cd/m² UGR22). In addition, the diffuse cover achieves a flush fit on the room side and protects the LEDs, while simultaneously minimising point luminance levels.

Product example: Solvan Flow MRW-D

MLA (Micro Linear Technology)
Light-guiding linear reflector, plastic, asymmetric

For special wall and board lighting

Micro Linear Technology specifically developed by TRILUX is designed for specific optics. The highly-efficient reflector comb of profiled plastic with diffuser cover provides a highly asymmetric light effect. The flush fit on the room side protects the LEDs while simultaneously minimising point luminance levels.

Product example: Solvan Flow MLA

DIRECT DISTRIBUTION, OUTDOOR

MLT^{IQ} (Multi Lens Technology)

More intelligent outdoor illumination

Special requirements demand special lighting solutions. MLT (Multi Lens Technology) lenses specifically developed by TRILUX enable luminaires to be individually modified to customer-specific lighting tasks, thus covering all P and M lighting classes via differing light distribution characteristics. This allows to optimise lighting solutions in terms of the ratio of road width to mounting height. The new, modular and intelligent MLT^{IQ} lens system is also ideal for floodlighting tasks and the illumination of industrial yards and zones. For optimum customer solutions, in addition to four different PCB sizes, a diversity of MLT lenses is also available for all MLT^{IQ}-compatible luminaires.

Product examples: Lumega IQ, ConStela, Publisca, Lumena 40

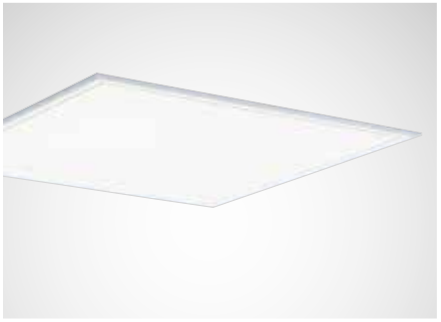
DIRECT DISTRIBUTION, HOMOGENEOUS

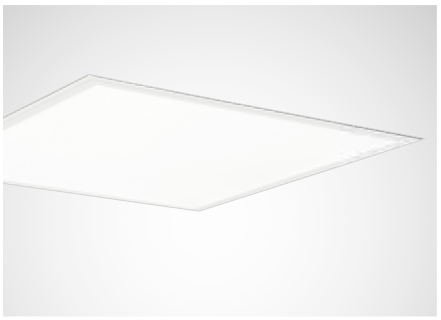
CDP prismatics (Conical Deglaring Prism)

For VDU-compliant, flexible lighting concepts with visible light

The innovative CDP (Conical Deglaring Prism) optic with fine prismatic structure achieves highly homogeneous light distribution and uniformity especially with LEDs, with maximum glare reduction (< 3,000 cd/m^2; UGR19). Maximum light comfort predestines this optical system for a wide application spectrum, far exceeding actual office applications.

Product examples: Belviso CDP, Arimo CDP, Inplana/Onplana CDP



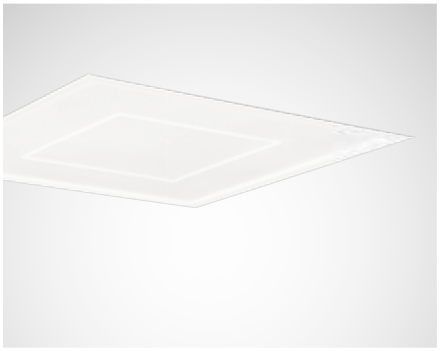


CDP-X prismatics (Conical Deglaring Prism)
with very fine-lined structure

For VDU-compliant, flexible lighting concepts with visible light

The innovative CDP (Conical Deglaring Prism) optics with fine prismatic structure achieves highly homogeneous light distribution and uniformity especially with LEDs, with maximum glare reduction (< 3,000 cd/m^2; UGR19). Maximum light comfort and a unique appearance thanks to a very finely designed light gap ensure a wide application spectrum, far exceeding actual office applications.

Product example: Arimo CDP-X



CDP-I prismatics (Conical Deglaring Prism)
Internal

For VDU-compliant, flexible lighting concepts with visible light

The innovative CDP (Conical Deglaring Prism) optics with fine prismatic structure achieves highly homogeneous light distribution and uniformity especially with LEDs, with maximum glare reduction (< 3,000 cd/m^2; UGR19). The inner prismatic structure and smooth exterior surface guarantee maximum visual and light comfort.

Product example: Lunexo CDP-I

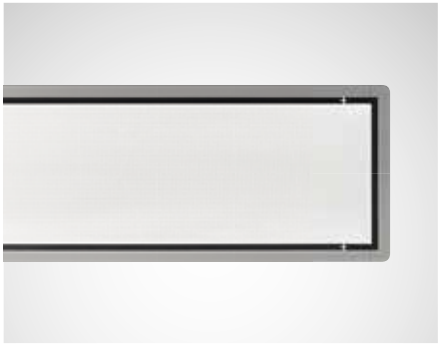
DIRECT-INDIRECT DISTRIBUTION, HOMOGENEOUS

BLGS (Binary Light Guide System)

For VDU-compliant, flexible lighting concepts with perceivable light and maximum visual comfort

The innovative planar optic (Binary Light Guide System) specifically developed for direct/indirect LED luminaires intelligently combines very wide-angle direct and indirect light components. The light is laterally fed into a dual panel system and a specific prism structure emits the light almost three-dimensionally. This guarantees maximum visual comfort on the one hand, and makes the light perceivable in a new strength, virtually free of shadows and glare. The concept also offers new benefits for planning and upgrading obsolete concepts. Because of the extremely wide distribution, using low-suspended luminaires is also possible with low ceiling heights, and a high lighting quality is ensured (< 3,000 cd/m^2; UGR19).

Product examples: Lateralo Plus, Lateralo Ring



When planning an energy-efficient lighting system, determining the maintenance factor is the essential driver because levels of illuminance or luminance of lighting systems decrease during the course of the service life. The reasons for this are ageing and failure of the light sources, soiling of the luminaires, and with indoor lighting a reduction in the reflectance value of the ceilings and walls (room soiling). The soiling of illuminated surfaces should also be taken into account with outdoor lighting.

The higher the maintenance factor for a lighting system can be set, the lower is its energy consumption. Despite this, a cost/effort analysis should be carried out to achieve practical maintenance cycles. The previously specified definitions with regard to service life criteria here play an important role. Planners must be able to determine and document the maintenance factor and recommend suitable maintenance activities.

The maintenance factor is dependent on the type of lamps and luminaires and the sensitivity of the room to dust and soiling, as well as the maintenance method and maintenance interval. Because with LED applications the actual LED and the luminaire are increasingly becoming one unit, observance of luminous flux reduction and the survival factor of the LEDs as the light source (lamps) is applied to LED luminaires in order to still be able to use the maintenance factor process for conventional lamps.

The maintenance factor MF is determined by:

LLMF: Lamp lumen maintenance factor – specifies the reduction of LED luminaire luminous flux during the service life
LSF: Lamp survival factor – specifies LED luminaire failure during the service life
LMF: Luminaire maintenance factor – specifies the influence of soiling of the optical system of luminaires between two cleaning operations
RMF: Room maintenance factor – specifies deterioration of the system light output ratio due to deterioration of the reflectance values of the ceiling, walls and floor for indoor lighting
SMF: Surface maintenance factor – specifies deterioration of the system light output ratio due to deterioration of the reflectance values of the illuminated surface in outdoor applications. Only used where practical

The maintenance factor MF is the product of the single sub-maintenance factors of the lighting system:

Indoor lighting: **MF = (LLMF x LSF) x LMF x RMF**
Outdoor lighting: **MF = (LLMF x LSF) x LMF x (SMF)**

For conventional lamps, corresponding information about the lamp lumen maintenance factor (LLMF) and the lamp survival factor (LSF) exists in the relevant documentation, but until now this was not the case for LED light sources. For this reason, a handy maintenance factor table for LED luminaires has been drawn up. The specific luminaire classification of an LED luminaire is via the average rated service life L_x, specified in hours. The value for the lamp survival factor (LSF) is determined directly from the value of total failure AFV. Typical values are seen in the maintenance factor table.

$$\textbf{LSF} = 1 - \frac{AFV}{100}$$

Measurement parameters			Service life in 1000 h																				
L_x (B_{50})			1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
L85	25,000 h	LLMF	0.99	0.97	0.94	0.91	0.88	0.85	0.82	0.79													
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96													
L85	35,000 h	LLMF	1.00	0.98	0.96	0.94	0.91	0.89	0.87	0.85	0.83	0.81	0.79										
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.97	0.94										
L85	50,000 h	LLMF	1.00	0.99	0.97	0.96	0.94	0.93	0.91	0.90	0.88	0.87	0.85	0.84	0.82	0.81	0.79	0.78					
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.97	0.95	0.93	0.91					
L85	70,000 h	LLMF	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.97	0.95	0.93	0.91	0.88
L85	85,000 h	LLMF	1.00	0.99	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.96
L85	100,000 h	LLMF	1.00	0.99	0.99	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.93	0.92	0.91	0.90	0.90	0.89	0.88	0.87	0.87	0.86	0.85
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L80	25,000 h	LLMF	0.99	0.96	0.92	0.88	0.84	0.80	0.76	0.72													
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96													
L80	35,000 h	LLMF	0.99	0.97	0.94	0.91	0.89	0.86	0.83	0.80	0.77	0.74	0.71										
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.96	0.93										
L80	50,000 h	LLMF	1.00	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.80	0.78	0.76	0.74	0.72	0.70					
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.96	0.94	0.92	0.90					
L80	70,000 h	LLMF	1.00	0.99	0.97	0.96	0.94	0.93	0.91	0.90	0.89	0.87	0.86	0.84	0.83	0.81	0.80	0.79	0.77	0.76	0.74	0.73	0.71
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.96	0.94	0.92	0.90	0.87
L80	85,000 h	LLMF	1.00	0.99	0.98	0.96	0.95	0.94	0.93	0.92	0.91	0.89	0.88	0.87	0.86	0.85	0.84	0.82	0.81	0.80	0.79	0.78	0.76
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.96	0.94
L80	100,000 h	LLMF	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L70	25,000 h	LLMF	0.99	0.94	0.88	0.82	0.76	0.70	0.64	0.58													
		LSF	1.00	1.00	1.00	0.99	0.98	0.96	0.94	0.92													
L70	35,000 h	LLMF	0.99	0.96	0.91	0.87	0.83	0.79	0.74	0.70	0.66	0.61	0.57										
		LSF	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.96	0.95	0.93	0.90										
L70	50,000 h	LLMF	0.99	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.70	0.67	0.64	0.61	0.58	0.55					
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.96	0.95	0.93	0.90	0.87	0.84					
L70	70,000 h	LLMF	1.00	0.98	0.96	0.94	0.91	0.89	0.87	0.85	0.83	0.81	0.79	0.76	0.74	0.72	0.70	0.68	0.66	0.64	0.61	0.59	0.57
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.96	0.95	0.93	0.90	0.87	0.84	0.81
L70	85,000 h	LLMF	1.00	0.98	0.96	0.95	0.93	0.91	0.89	0.88	0.86	0.84	0.82	0.81	0.79	0.77	0.75	0.74	0.72	0.70	0.68	0.66	0.65
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.96	0.95	0.93	0.90
L70	100,000 h	LLMF	1.00	0.99	0.97	0.96	0.94	0.93	0.91	0.90	0.88	0.87	0.85	0.84	0.82	0.81	0.79	0.78	0.76	0.75	0.73	0.72	0.70
		LSF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.96

Table: Maintenance factor table for LED luminaires with selected $L_x(B_{50})$ classifications (source: TRILUX Akademie). The reduction in luminous flux (LLMF) and survival factor (LSF) of LED luminaires are shown. These specifications help with the photometric planning of lighting installations. The maintenance factor table is also available online: www.trilux.com/maintenance_factor_table

Example of luminaire classification and maintenance factor:
If the luminaire classification L_{85} = 50,000 h has been specified for an LED luminaire, then the maintenance factor value for luminous flux reduction (LLMF) after 50,000 hours is 0.85. The survival factor (LSF) value is 1, because up to this time no LED luminaire completely failed. In comparison, LED luminaires with the evaluation class L_{70} = 50,000 h, AFV = 4 achieve values of 0.7 for LLMF and 0.96 for LSF. This clarifies the potential for energy saving by selecting a product with a higher luminaire classification.

If on the other hand an LED luminaire with luminaire classification L_{85} = 50,000 h is designed for an operating period of only 25,000 h, then a value of 0.93 can be used as maintenance factor for luminous flux reduction LLMF. Accordingly, an evaluation class of L_{93} = 25,000 h could also be specified for such a luminaire. If on the other hand longer use of e.g. 70,000 h is intended, then the value 0.79 should be used for LLMF in planning. If changing a group is intended as the form of maintenance, an LSF of 0.93 should also be observed in planning.

To show the potential with investment costs and energy saving, the table directly compares luminaires with different luminaire classifications available on the market.

Luminaire classification of LED luminaire	Lamp lumen maintenance factor LLMF	Initial value factor (planning factor)	Percentage-based comparison
L_{85} – 50,000 h	0.85	1.18	100 %
L_{80} – 50,000 h	0.80	1.25	106 %
L_{70} – 50,000 h	0.70	1.43	121 %

Table: Display of lamp lumen maintenance factors and the corresponding initial value factor (1/LLMF) for differing luminaire classifications. With the assumption of comparable rated input power values and rated luminous flux of the luminaires, it becomes clear that when using luminaires from lower luminaire classifications a higher quantity and a higher connected load is needed.

In addition, photometric planning must also take into account the time-related soiling of luminaires and rooms. For these factors, characteristic values apply with regard to different types of luminaires and, with indoor lighting, different room sizes.

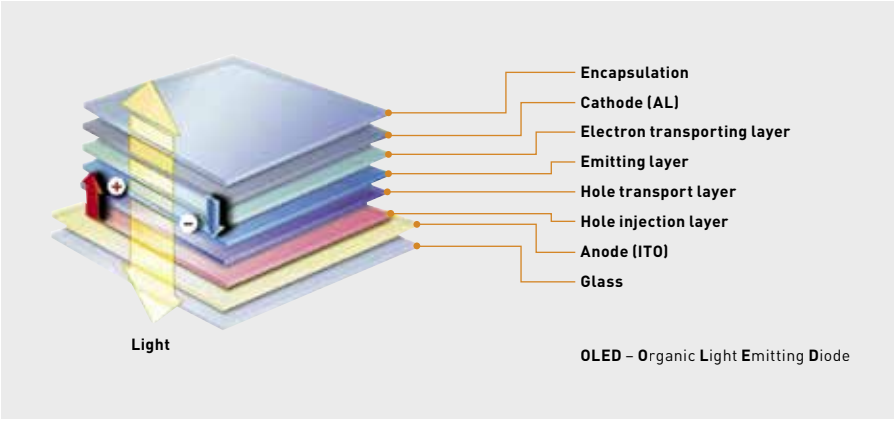
11. WHAT IS AN OLED?

The history of the organic light emitting diode is comparatively short compared to its inorganic cousin. Light emission from an organic (anthracene) crystal was discovered for the first time in 1967 via current input, but it took until 1987 until the first thin-layer OLED based on small molecules from the Tang and van Slyke research community was presented. This was the go-ahead signal for the rapid further development of complete components and the dawn of a new area in physics. The first functional, liquid-processed OLEDs were developed just three years later with the use of polymers.

The efficiency and stability of OLEDs could only be slowly improved in the following years until a major jump in efficiency was achieved with the development of so-called phosphorescent emitters. From that time it became possible to continuously improve OLEDs, until they were able to surpass the efficiency of modern fluorescent lamps (80-100 lm/W) in laboratory conditions in 2010.

OLED is short for organic light emitting diode. OLEDs consist of several different material layers, and each of these layers has a specific task. Beginning with the carrier material, today usually glass but in some cases metal, and finishing with the encapsulating cover glass, 10 different layers are not unusual. Among these are in some cases transparent electrode materials, electron transporting materials and the actual organic emitter materials. Light generation takes place within these organic emitter materials. The materials are applied in very thin layers (sometimes consisting of just a few nanometres) in planar fashion onto the carrier materials to create a homogeneous, luminous sequence of layers.

General construction of an OLED



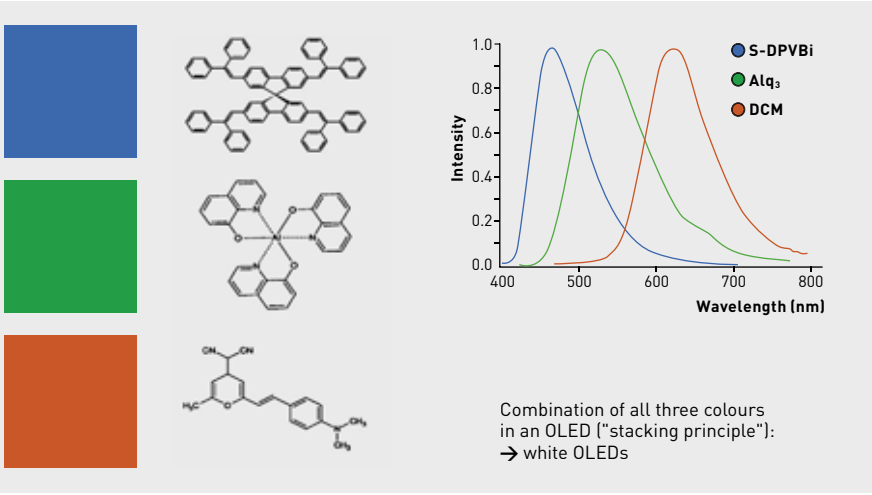
OLED construction LG Chemical

OLEDs emit light only in the visible range. Depending on the specific combination of individual layers, they emit monochromatic (single-colour) light or white light. Warm white and cool white colour tones are possible. The light is emitted diffusely, homogeneously and almost Lambertian, in one direction (with non-transparent OLEDs) or two directions (with transparent OLEDs). The organic solids contained in OLEDs are "soft solids" that enable flexible light sources. A flexible OLED is not destroyed even when frequently deformed in switched-on state.

Because of the construction and properties of OLEDs, almost any luminous forms, both with flexible and with rigid OLEDs, can be designed.

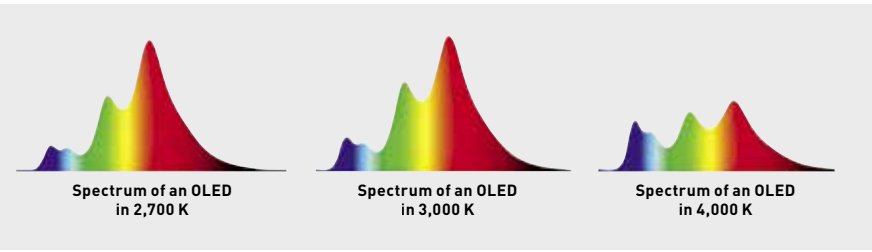
The spectrum of OLEDs differs significantly to that of LEDs. The LED spectrum is narrowband (e.g. white RGB LEDs) or is a narrow peak in the blue spectral range with a wide spectrum of one or several phosphors in the green-yellow-red spectral range (white luminescence conversion LEDs), whereas the OLED spectrum is a much more continuous, broadband spectrum (see figure of the OLED spectrum). This spectrum is comparable to the spectrum of daylight and creates a very pleasant visual perception of light. A peak in the blue spectral range combined with one or several phosphors is currently not being focused on with OLED development. Mitsubishi and Pioneer are currently developing an OLED that 'almost' does without blue components in the spectrum.

General construction of an OLED
Continuation



Combination of all three colours in an OLED ("stacking principle"):
→ white OLEDs

Emission spectrum of three different organic molecules. The complete visible spectrum can be covered by combining these molecules in an OLED.
Source: J. Frischeisen, "Light extraction in organic light-emitting diodes," dissertation, University of Augsburg, 2011.



OLED spectrum – Neumüller Electronic

The functional principle is similar to that of LEDs. Electrons and holes recombine with each other with OLEDs as well to generate energy in the form of light. As with LEDs, band structures exist in whose transition areas the recombination processes take place.

The production of OLEDs is under cleanroom conditions and is implemented by vaporization under high vacuum. This is a very elaborate and expensive complex process, and even the smallest of impurities can damage the organic materials. The layer construction must therefore be ideally protected from external influences such as oxygen, water vapour and other particles by very good encapsulation with a cover glass.

Thermics

Heat is inevitably generated with the conversion of electrical energy into light. The major advantage of OLEDs in this area is their large light emission surface. This enables the heat to be much more uniformly generated and efficiently dissipated, and can therefore be more easily controlled. OLEDs usually only become lukewarm due to the relatively low output density of the current models and their already very good efficiency. Research tests have shown that just a small air gap between an OLED and the luminaire chassis is enough for sufficient cooling. This, however, can be improved by completely surface-attaching the OLEDs on aluminium sheet for example. Many of today's OLEDs are already factory-equipped with such heat spreaders. This can be for example thin copper plate, graphite foils or thin aluminium sheet.

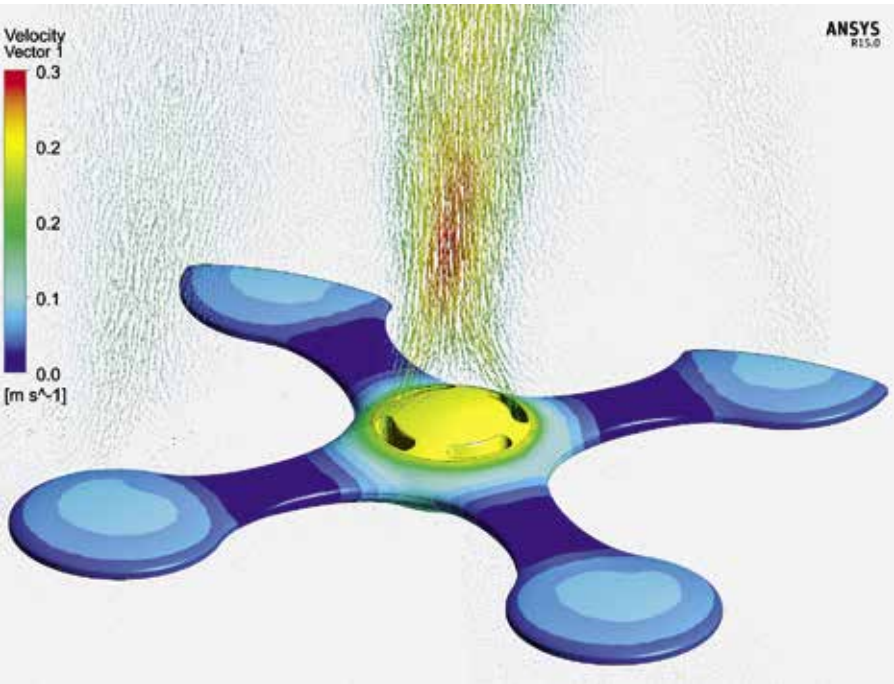
Thermics
Continuation

A positive side-effect of such heat spreaders is on the one hand an improvement in service life due to better thermal management, and on the other a more uniform distribution of luminance in the light emission direction. Because of contacting or power feed at the periphery with OLEDs, higher output densities usually occur in these areas. Higher current at these locations also usually has higher luminance, which in turn causes unevenness in the luminous surface. The more uniform distribution of heat and therefore an adaptation of the output density on the OLED surface is an advantage in this respect.

In luminaire development, much importance is placed on suitable thermal management. Developers are increasingly working with simulations to predict the distribution of heat and the effect of heat sinks. Current simulation tools can also be used with OLEDs. The figure shows this with the example of a hybrid luminaire where in addition to self-heating of the OLEDs the influence of supplementary heat development from the LEDs must be taken into account.

Service life

Excessively high temperatures directly affect the lifespans of OLEDs. If the optimum power density in the assembly is exceeded the materials suffer more than average. Further parameters limiting the service life are burdens from external UV radiation, high ambient temperatures and humidity. Under consideration of the specified standard values of manufacturers, 10,000 - 40,000 hours are specified as the service life of OLEDs, varying according to size and colour temperature (at 3,000 K the lifespan is typically longer than at 4,000 K). These values relate to a reduction in luminous flux of 70 % (L_{70}) with achievement of this service life. A C-factor is not applicable with OLEDs because total failures are not possible. These lifespans already significantly exceed those of conventional lamps. LED lifespans are also higher but require significantly more complex thermal management.



Simulation of heat development and flow speeds of an OLED in a luminaire housing. The yellow, warmer area shows the LED and the outer area depicts the uniformly cool, round OLED. Significantly higher flow speeds occur above the LED heat sink (in yellow).

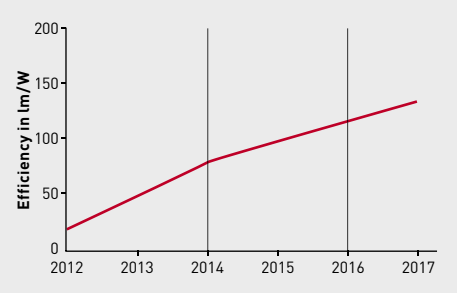
The current state of development and future outlook

With regard to technical characteristics, the development of OLEDs is highly positive. The last years have seen enormous improvements in efficiency. While efficiencies of around 20 lm/W where possible until 2012, 2015 has partly seen efficiency levels of 60 - 80 lm/W and in individual cases even 100 lm/W. The incline of the efficiency curve can clearly be considered very steep. It is currently difficult to predict where developments will take us to, and a milestone is definitely 100 lm/W. Once achieved, 2017/2018 will surely see 100 lm/W to 150 lm/W. This means that OLEDs as a semiconductor light source must be taken seriously. If in this regard a luminaire is seen as a total system and an OLED application is compared to an LED application, both may soon be almost equal in the sector of planar lighting. An OLED system has no losses with the mixing of light required for uniformly luminous surfaces. The generated light is already planar and homogeneous. Losses in efficiency caused by optical systems are saved because OLEDs need no such optics.

If on this basis the price range of both obviously competing LED and OLED light sources are more closely looked at, the admittedly higher prices for OLED luminaires can be more easily justified. The single component OLED will always have a significant disadvantage in terms of price compared to the single component LED. Based on a luminaire though, this difference is put into perspective. The prices for OLED tiles in 2015 were less than one euro per lumen. According to tile size and substrate material used (ranging from rigid glass to flexible plastic), tiles cost between approximately 50 and 3,000 euros. Scaling effects are of course created here for luminaire producers or large-scale consumers, and OLED manufacturers usually show themselves to be flexible in terms of prices to further drive forward the technology.

The sizes of tiles have now become diverse. OLEDs are now available with 2 cm - 5 cm edge lengths, round OLEDs with diameters of approx. 10 cm, square tiles are also available with edge lengths of 10 cm - 15 cm and rectangular tiles with dimensions of 5 cm x 20 cm up to 10 cm x 32 cm. Producers have managed to significantly increase the size, and thanks to busbar structures (conducting structures within the OLEDs, visible as grids) uniformity has been maintained. The currently largest tile has a square format with edge length of 32 cm. The size of OLEDs could easily be increased with the aid of larger substrates. At the moment, the substrate surface area in most systems is limited to 370 mm x 470 mm (GEN 2). Systems that could process larger substrates will also be capable of manufacturing larger OLEDs in the future. Any shape of OLED is ultimately feasible. These shapes will be cheaper or more expensive during production according to the load burden of the substrate, OLED/surface.

Development of efficiency



What's happening in the organic LED sector

The current positioning of the TRILUX Group with regard to OLED already today covers possible focus areas of future developments. The technology is being actively pushed by the manufacturers. However, without the support, the pull of the lighting industry, a "chicken and egg problem" will remain. With increasing demand the producers could reduce the prices, and luminaire manufacturers could integrate more OLEDs should the price be low enough.

Arguments concerning added value and customer benefits must be continuously updated and rethought due to LED developments. Because LED technology will continue to be dynamically developed though, OLED will find it hard to make their way in most application sectors.
For luminaire manufacturers it is enormously important to precisely observe possible changes in value creation components in connection with OLED, to be able to respond as early as possible. As such, the potential of OLED has hardly been exploited because the theoretical maximum luminous efficiency is specified at 249 lm/W. (Source: Y.-S. Tyan, Journal of Photonics for Energy, pp. 011009-1, 2011). Participating in research projects helps in this regard, and for this reason TRILUX is contributing to the cooperative OLYMP research project.

TRILUX ONLINE

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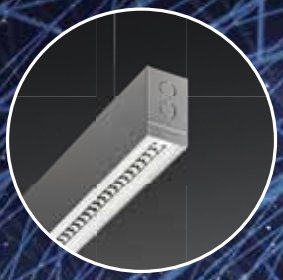
TRILUX XPERIENCE

DIVING INTO THE WORLD
OF LIGHT



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ICON EXPLANATION

Mounting method

- Recessed
- Surface-mounted
- Semi-recessed
- Wall
- Free-standing
- Suspended
- Voltage track
- Bracket-mounting
- Post-top
- Ground recessed
- Wire suspended
- Floor-standing
- Ground surface-mounted

Ceiling type

- Plasterboard ceilings
- Exposed grids
- Concealed grids
- Panel ceilings
- Concrete ceilings

Construction form

- round
- rectangular
- square

Light distribution

- extremely narrow
- narrow
- narrow-wide
- spot
- medium spot
- medium
- medium flood
- flood
- wide flood
- wide
- very wide-angle
- wallwasher
- double asymmetric
- asymmetric
- Lambertian

Light colour

- 2700 K — Warm white, 2700 K
- 3000 K — Warm white, 3000 K
- 3100 K EC — Efficient colour, 3100 K
- 3100 K BC — Best colour, 3100 K
- 3500 K — Neutral white, 3500 K
- 4000 K — Neutral white, 4000 K
- ≥ 5000 K — Daylight white, ≥ 5000 K
- Food — Foodlight
- variable

Colour

- red
- green
- blue
- amber
- RGB

Connectivity

- LiveLink integrated
- LiveLink capable
- Monitoring
- Constant Light Output (CLO)
- Light management integrable

Luminaire luminous flux

Mounting height

VDU screen suitability

Service life

Operating mode

Supplementary equipment

HACCP, IFS and BRC conformity for food industry

For detailed product descriptions see **www.trilux.com**

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