

licht.wissen 09

Refurbishment in Trade, Commerce and Administration



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Editorial



Modern lighting technology is an intrinsic element of the Energy Transition

There is a close connection between equipping contemporary buildings with innovative, sustainable and flexible building systems and meeting modern standards of design, comfort, safety and energy efficiency. It is a well-known fact that the technical standard of commercial buildings is one of the factors for business success. Workplaces need to meet numerous requirements to promote concentration, performance, productivity, safety, visual comfort, wellbeing and motivation. That is because employees who are content, appreciated and above all healthy are a key business asset that needs to be preserved – especially in the light of the current shortage of skilled labour. Last but not least, modern building systems are also a vital safeguard for the property investor.

Lighting is an important element of building services and the refurbishment of interior lighting solutions is an increasingly important topic.

Innovative lighting solutions and energy-efficient lighting systems are regulated by intelligent lighting management, which not only saves energy but also enhances comfort and flexibility. Through the use of intelligent lighting control, daylight sensors and control gear, modern lighting concepts take account of the particular environmental and usage situation, e.g. delivering more light for older employees or higher illuminance in the dark months of the year and during night shifts. Changes in lighting requirements can thus be more easily catered for.

LED technology has also long offered effective and efficient solutions for office and industrial buildings. The high-quality components are more expensive than classical lighting solutions but the energy cost savings they produce mean that the initial outlay is often recouped within a reasonable time frame. What is more, acquisition costs may be reduced by support funding and additional savings are made as a result of the longer maintenance intervals permitted by the longevity of LED lighting.

This booklet from licht.de contains impartial advice for consultations with commercial clients. It also flags up web tools for assessing lighting installations and making design recommendations. Practical relevance is assured by close cooperation between major lighting manufacturers and the electrical trades.

licht.wissen 09 helps develop a systematic approach to the planning of small and medium scale lighting refurbishment projects and provides concrete decision-making aids for crafting efficient solutions for the refurbishment of lighting installations.

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**Refurbishment:
better light,
lower costs**
Page 6



**Innovative
technology for
human needs**
Page 8



**Lighting solutions
for optimal
efficiency**
Page 10



**Refurbishment
options**
Page 12



**Systematic
refurbishment**
Page 16



Office lighting
Page 18



**Corridor and
staircase lighting**
Page 20



**Production plant
lighting**
Page 22





Warehouse lighting
Page 24



Classroom lighting
Page 26



Shop and salesroom lighting
Page 28



Doctor's surgery lighting
Page 30



Sports and leisure facility lighting
Page 32



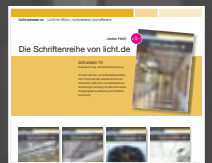
Enclosed parking facility lighting
Page 34



Support funding
Page 36



Planning aids
Page 37



licht.de publications, imprint
Page 38

Refurbishment: better light, lower costs

An extensive survey of offices, workshops and school classrooms shows that lots of lighting installations are obsolete. Inform your customers that refurbishment sustainably lowers energy consumption, saves costs and makes for a significant improvement in lighting quality.

More than three-quarters of all buildings are more than 30 years old. And installers know from experience that the lighting installations in them are also well advanced in years. The German electrical and electronic manufacturers' association ZVEI estimates that 75 percent of the office lighting in Germany alone is in need of refurbishment.

Shortcomings of old lighting systems

It is easier than ever today to save a great deal of energy with modern lighting technology while at the same time ensuring a better quality of light. If a lighting installation is clearly ripe for refurbishment, inform the customer of the fact. Old installations

- consume too much energy,
- drive up electricity costs,
- require a lot of cleaning and maintenance,
- are often no longer compliant with current standards
- and frequently provide poor lighting levels, e.g. due to soiled luminaires or inadequate glare suppression.

Over the years, the light output ratio of an installation and its components – luminaires, lamps and operating devices – can be halved by dirt and material ageing. That means poor quality of light and high power costs. Attention should also be paid to inefficient old magnetic ballasts. Conventional ballasts (CBs) and low-loss ballasts (LLBs) consume a great deal more energy than modern electronic ballasts (EBs).

The operational reliability of a lighting installation also decreases with age: lampholders become brittle in the course of time and need to be replaced; cables and leads become porous and can break. And if it is many years since the luminaire model in question was on the market, replacement parts may no longer be available.

Optimal refurbishment: “new” for “old”

The best refurbishment solution is generally to swap “new” for “old”. If building owners and investors wish to minimise costs by replacing only individual components, your advice is definitely required. Retrofit kits – different operating devices or new light sources for which the luminaires were not originally intended – rarely deliver what they promise.

Occasionally, a lighting system is no longer standard-compliant after a retrofit. What is more, there may well be safety issues. Unauthorised retrofitting always constitutes a structural modification of the original and can thus void the luminaire's test certificate. In that case, the operator of the installation is responsible for its safety. The only exception is where the retrofitting materials used have been categorically approved by the luminaire manufacturer.

Useful to know when advising a customer

The German government and the European Union actively promote energy efficiency and sustainability. Government grants, favourable loans and numerous incentive schemes help small and medium-sized enterprises, in particular, to refurbish their lighting installations (see page 36). Explain to your customers the advantages of switching to sustainably efficient lighting.

Advantage 1: High energy efficiency

Efficient light sources, optimised control gear and quality luminaires with high light output ratios alone save a great deal of electricity. Maximum efficiency and high comfort are offered by modern lighting control systems with presence detectors and intelligent utilisation of daylight. An optimised lighting installation saves a lot of energy, helps the environment and lowers operating costs.

Advantage 2: Lower costs

Operating costs (electricity consumed and maintenance) account for 90 percent of the total cost of a lighting installation today. Replacing an old installation with a new one saves a considerable amount of money over the life of the system – even if the initial investment is expensive. As a general rule: the older the installation that is replaced and the longer it is in use each day, the greater the savings.

Advantage 3: Better quality of light

A crucial argument in favour of refurbishment is that it makes for a significantly better quality of light. Distinguishing features are optimal visual conditions (= visual quality), an agreeable lighting atmosphere (= emotional quality) and a beneficial effect on the human body (=biological quality). Last but not least, it also enhances the visual impact of the room.

[02 + 03] Top marks for intelligent school lighting: planar LED luminaires replace old louver luminaires, creating the impression of natural skylights. Integrated lighting control regulates the lighting according to the level of incident daylight and whether persons are present or not.

[04 + 05] Better quality of light, greater efficiency: a modern lighting system with lighting control also makes for an agreeable atmosphere and comfortable working conditions in a factory.



02



03



04



05



LED feature	Advantage & benefit	Lighting application examples
high efficiency	low operating costs	multi-shift factory halls
long life	low maintenance costs, especially where luminaires are difficult to reach	multi-shift production halls, tennis halls
good to very good colour rendering	natural-looking colours	dental surgeries, skin care clinics
broad spectrum of white light colours	required for circadian lighting	communal rooms in homes for the elderly
robust construction	usable even under demanding mechanical conditions	machine lights
no beam heat	also suitable for illuminating heat-sensitive objects	food lighting
no UV radiation	also suitable for illuminating UV-sensitive objects	shop windows
instant starting	100% light immediately on activation	stairwells, control centres or building service rooms
low temperature reliability	instant starting even at low temperatures	cold storage facilities
high switching resistance	longevity not affected by frequent switching	applications with motion detectors (e.g. corridors or stairwells)

Innovative technology for human needs

Within a decade, the lighting industry has developed new technologies that are highly energy efficient and help deliver a better quality of light. Among the most important trends in lighting are LEDs and biologically effective light, which provides important stimuli for the human body's internal clock and helps make for a greater sense of wellbeing.

Indoors and out, LEDs have conquered the realm of general lighting. No other light source has ever worked so reliably for so many years and at the same time required so little electricity.

Efficient LEDs play out their advantages mainly in complete LED luminaires and LED modules. They have an operating life of up to 50,000 hours or more. LEDs have an impressive luminous efficacy and can be precisely controlled and steplessly dimmed. They are thus perfect for use with intelligent lighting management systems.

LEDs: Quality pays off

The market for LED solutions is still growing rapidly. But some products on the market do not deliver what they promise. With LED applications in particular, make sure that the manufacturer offers uniform high quality. Cut-price articles often fail to match the performance ratings displayed on the packaging. If lighting quality, colour temperature, colour rendering and homogeneous light colour are not as disclosed, the user can be in for an unpleasant surprise when the installation goes into operation. Explain to your customers that although the capital cost of a high-quality product may be higher, it is often quickly recouped due to far superior efficiency and longevity.

Headway is also being made in the development of organic light-emitting diodes (OLEDs). OLEDs are the first truly planar light source and produce an agreeably uniform, glare-free light. The first models are already on the market.

Biologically effective light

The switch to energy-efficient LED lighting and the development of intelligent lighting control systems are not just the key to energy-saving lighting solutions. They also permit lighting that has more than just


visual effects and can crucially improve quality of life.

Current studies show that light and the natural sequence of daylight and darkness are triggers for many biological processes in the human body. These non-visual effects of light are mediated by special photoreceptors containing the photosensitive molecule melanopsin. Experts thus speak of melanopic lighting.

Artificial lighting that has non-visual effects takes its cue from daylight, supporting the human day/night rhythm with different illuminance levels and dynamically changing light colours: cool white light with a high blue content and at least 5,300 kelvin colour temperature help sharpen our focus in the morning, dimmed warm white light with no more than 3,000 kelvin prepares our body for sleep in the evening. A second variant takes the form of "light showers", which briefly energise and promote concentration. This activating light has been found to produce positive results, for example, in schools.

Generally speaking, the larger the visible surface of the light source, the greater the biological effect of its light. Lighting concepts that extend over walls or ceilings are thus particularly efficient. Large-format luminaires and illuminated ceilings or pendant luminaires that bounce some of their light off the ceiling and upper third of the walls are recommended options.

In schools, offices and industry, biologically effective lighting can significantly help boost wellbeing and motivation.

 Detailed information about the LED is found in the booklet licht.wissen 17 "LED – The Light of the Future"; circadian lighting is covered in licht.wissen 19 "Impact of Light on Human Beings".

[06 + 07] Biologically effective (circadian) lighting can provide effective support for the human body's internal clock. It does this by taking a leaf from daylight and dynamically varying light colours and brightness levels: cool light colours and high illuminance have an activating effect; warm light colours and low illuminance help us relax.

Lighting solutions for optimal efficiency

Low energy consumption is one of a lighting installation's quality features. Efficient lighting technology and intelligent utilisation of daylight are good for the environment, lower operating costs and help make for business success.

Climate change and scarce resources are forcing us to re-think the way we live. And action is being taken at political level: targets and the line of approach are set out in the German Energy Saving Ordinance (EnEV) and the EU Ecodesign Directive for energy-related products, which is transposed into German law as the Energy-Using Products Act (EBPG).

Another force for change is the relentless rise of energy prices. Inefficient products are thus gradually disappearing from the market.

EnEV 2014: Even more efficient buildings

Low and ultra-low energy buildings will soon be the norm. In 2009, the EU tightened up the building directive approved in 2007; the next stage followed in 2014. Member states are now required to trans-

pose the latest update into national law. In Germany, that step was taken in May 2014, when a new Energy Saving Ordinance (EnEV) came into force.

From now on, the overall energy performance of buildings needs to meet even more exacting standards. And energy certificates are required for more than just non-residential buildings with a floor area in excess of 1,000 square metres. The size threshold is lowered to 500 square metres and buildings with a high volume of public traffic are included. Hotels, cinemas and small company premises thus also require an energy certificate. So lighting is under scrutiny.

EnEV requires the owner of a building to establish the building's total energy consumption: before a building is refurbished or constructed, the primary energy demand for lighting needs to be calculated in accor-

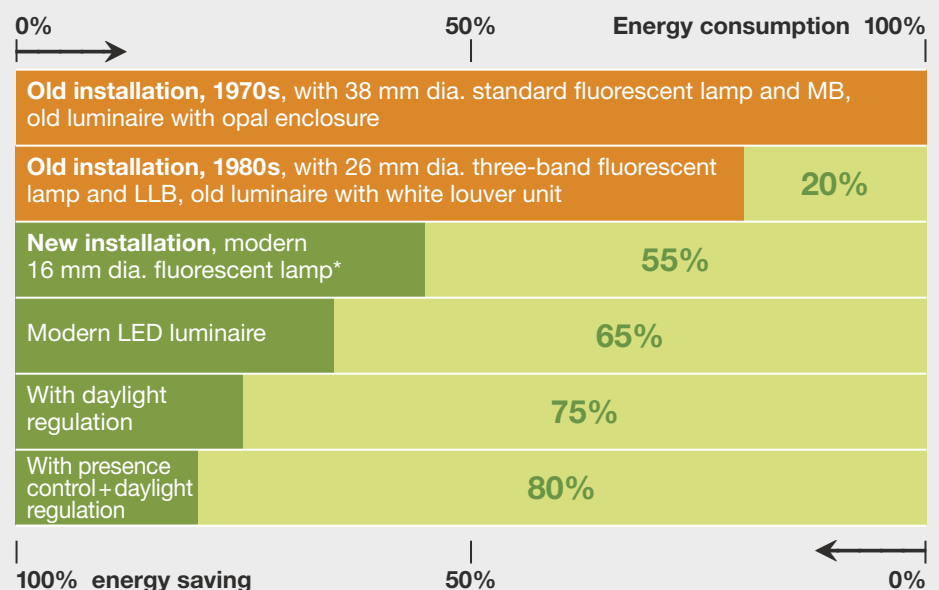
[08] The refurbishment of an old lighting installation makes for significantly more lighting comfort and saves a great deal of energy. The greatest efficiency is guaranteed by lighting management systems with presence control and daylight regulation.

[09] Daylight-dependent lighting control saves energy: the artificial lighting is automatically switched and dimmed as required. Sensors at windows and in the room ascertain the current lighting level and send signals to regulate the artificial lighting as required.

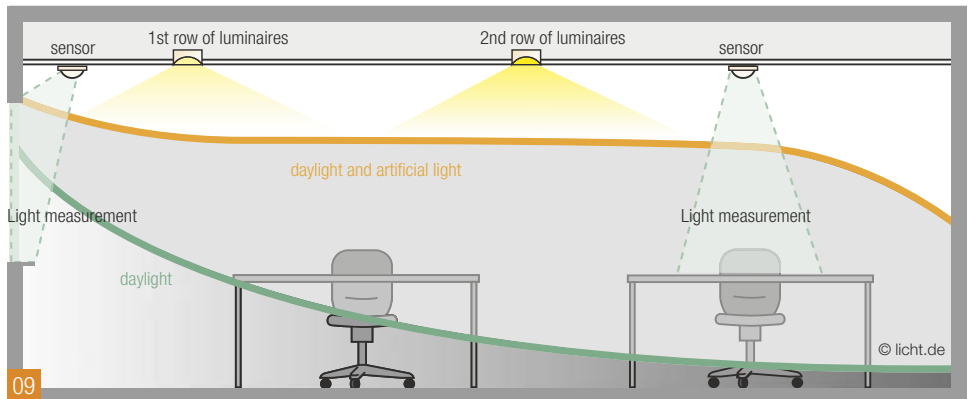
[10] Different lighting scenes can be easily accessed from a display panel.

[11] Energy-saving room lighting: Sensors measure the available daylight and regulate the light required in the room. Because the room in this example is sufficiently flooded with daylight, the luminaires at the window are deactivated and those in the middle of the room dimmed. Only the luminaires in the deeper part of the room are operating at full capacity.

Savings potential of interior lighting



* Fluorescent lamp operated by EB with very low power loss, energy-efficient direct or direct/indirect luminaires with modern optical control technology



dance with DIN V 18599, Part 4 and approved before any construction work commences.

Lighting management is the key to greater efficiency

Many old lighting installations will no longer satisfy the new requirements. This is a major source of potential savings: the older an installation is, the greater the savings possible (see chart on page 10).

Intelligently designed lighting concepts enhance both lighting quality and energy efficiency. The following are factors for success:

- Quality luminaires with high light output ratios and optimised optical control,
- efficient light sources with high luminous efficacy ratings, such as LEDs,
- modern electronic operating devices and control gear,

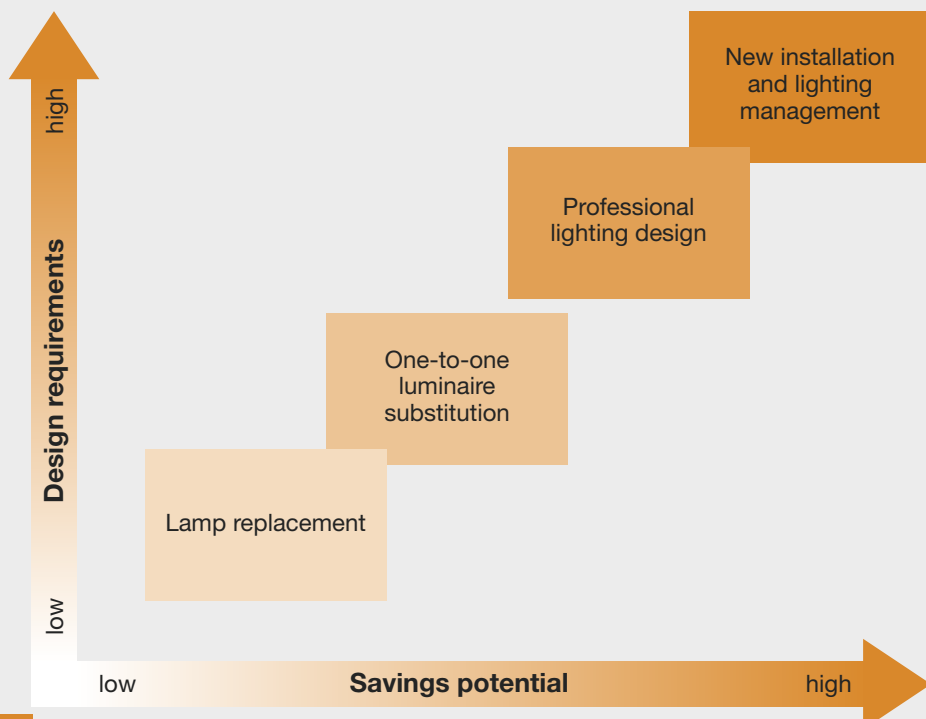
- lighting concepts with different switching groups that can be individually and separately dimmed and controlled,
- lighting management systems that take account of daylight and whether rooms are occupied.

The only way an operator can harness all the advantages offered by modern light sources, luminaires and operating devices is with electronic control. Presence detectors, for instance, ensure that luminaires are automatically deactivated as long as no light is needed. Even greater efficiency is achieved by utilising natural daylight: a new lighting system with daylight and presence control saves as much as 80 percent of the energy and electricity costs generated by an old installation.





Refurbishment options and savings potential





Refurbishment options

The lighting in many companies is more than ten years old. But yesterday's technology no longer delivers the quality of light and energy efficiency that are required today. Where refurbishment is considered, there are various options. .

Soiled luminaires, a monotonous lighting atmosphere at the workplace – old lighting installations consume too much electricity and energy, and the poor lighting conditions they create make task performance more difficult, lead to high error rates and undermine productivity.

The light output ratio of an old installation and the components in it – lamps, luminaires and operating devices – can be halved by dirt and material ageing. Investment in new, efficient lighting substantially reduces annual operating costs and also lowers the cost of routine maintenance. In many cases, even simple refurbishment measures can bring about an improvement. Talk to your customers about the various refurbishment options available and explain the differences between them.

As a general rule, four levels of refurbishment are possible – each one making for more comfort and convenience and greater scope for energy savings.

The options are:

- Replacement of lamps
- One-to-one substitution of luminaires
- Design of a new installation
- Incorporation of lighting management systems

Solution 1:

Lamp replacement

The simplest form of refurbishment consists of fitting existing luminaires with new, more efficient light sources. Lamps must always be replaced if lamps flicker or fail to start properly. Other reasons for lamp replacement are poor quality of light and fire risk, e.g. due to old ballasts overheating in operation.

It can also make sense to replace lamps regularly in groups before they reach the end of their life. Group replacement is particularly recommended in interiors where



[12] A cost-cutting duo: Pendant luminaires and recessed louver luminaires flush with the ceiling make for agreeable glare-free lighting in the conference room; a lighting management system switches and dims the luminaires according to the time of day and whether persons are present.

[13] The energy savings that are possible increase with each level of refurbishment. The greatest savings potential is offered by a well-designed new installation with efficient components.

[14] When lamps are replaced in an existing system, care needs to be taken to ensure that the lamps selected meet the specifications on the luminaire plate. The light colour of all light sources should be identical and appropriate for the application.



15

maintenance is difficult, e.g. in halls with high ceilings, in stairwells or at workplaces used in multiple shift operations.

Points to remember when replacing lamps:

- The lamps selected need to meet the specifications on the luminaire plate.
- They need to deliver at least the same luminous flux as the old lamps when new. If luminous flux is higher, glare limitation needs to be ensured.
- Their light colour should be appropriate for the application.
- Their colour rendering index needs to match that required for the application.

If only individual lamps are replaced, care must be taken to ensure that the light colour corresponds to that of the other lamps.

Retrofits and their drawbacks

Where retrofitting is performed, 35 Watt T16 lamps with 3,300 lumen (lm) are generally used to replace 58 Watt T26 lamps with 5,200 lm. The adapter is mounted on the T16 lamp and in the old luminaire. It also contains the EB required to operate the lamp. The idea is to lower the power input of the installation and thus reduce the power it consumes.

The problem is that the T16 and T26 power ranges do not permit one-to-one replacement. The luminous flux of a 35 Watt T16 lamp is around a third lower than that of a 58 Watt T26 lamp, so illuminance is significantly lower. If the required illuminance is maintained, energy savings are

not always achieved. It should also be pointed out that to make an illuminance comparison possible, the reflector of the old installation needs to be cleaned and the lamp renewed.

Another retrofit variant is the tubular LED lamp, designed to replace existing fluorescent lamps. With LED retrofit lamps, it is also necessary to ensure that the lighting quality requirements set out in standards – especially in terms of illuminance – are met. What is more, it should be noted that intensity distribution curves are different after lamps are replaced.

With all retrofit solutions, care must be taken to ensure that safety and electromagnetic compatibility standards are observed.

Solution 2:

One-to-one luminaire replacement

One-to-one replacement of luminaires makes sense where budgets are limited and energy needs to be saved without major construction work. Such measures can be implemented without making alterations to the ceiling (e.g. installation openings).

Requirements for successful luminaire replacement:

- The light distribution curves of the new luminaires should be identical to those of the ones replaced.
- The illuminance must at least meet standard requirements and the net luminous flux should be the same as that of the old luminaires. (In the case of fluorescent



16



17

lamp luminaires, the net luminous flux is the aggregate luminous flux of the lamps used multiplied by the light output ratio of the luminaire. With LED luminaires, it is the available luminous flux stated by the manufacturer).

- New recessed luminaires need to have the same physical dimensions as the luminaires they replace.
- The luminaires need to be electrically compatible or appropriately upgraded
- The lamps involved in a one-to-one luminaire replacement are subject to the requirements listed under “Lamp replacement” (page 13).

The replacement of old luminaires and lamps in combination with a switch to new electronic ballasts can reduce energy requirements by over 50 percent. This is due partly to the greater luminous efficacy of modern light sources, partly to the high light output ratio of the latest luminaires as a result of optimised reflectors and optics. On top of that, electronic ballasts (EBs) reduce power loss and offer flicker-free light with no start-up delays.

Important note: Installing retrofit lamps or other electrical components that are not expressly recommended by the lighting system manufacturer constitutes a structural modification, which voids the original type approval. In the event of damage or loss, this could give rise to legal problems. So when performing a retrofit, make sure that all the components installed have the manufacturer's approval for use in the installation in question. If in doubt, check with the manufacturer.

Solution 3: Professional design

The greatest energy savings are made when a new installation is professionally designed using special lighting design software. This is the only way to harness the technical advantages of new luminaires for maximum energy efficiency.

Computer-designed lighting for corridors, for example, can feature greater spacing between light points, so fewer luminaires are needed than with the installation that is replaced. This option should always be selected if the ceiling in the room is renovated.

Solution 4: New installation with lighting management system

If the aim is not only to save costs but also to enhance the convenience of the lighting, lighting control is a key requirement. In conjunction with efficient lamps and optimised luminaires and components, it taps the greatest savings potential of all. Where both presence control and daylight regulation are integrated, energy consumption – and thus electricity costs – can be reduced by as much as 80 percent in comparison to the old lighting installation and a better quality of light is sustainably achieved.

Radio control systems also enable presence-dependent switching to be realised in existing lighting installations. When installing presence detectors, always take account of their detection range. If in doubt, install extension sensors.

Daylight regulation and dimmers

If daylight regulation is planned, dimmable ballasts are essential. Most of them today have a DALI interface. Dimmable master luminaires with an integrated lighting management system and similarly dimmable slave luminaires are connected to one another by additionally laid two-core control cables. Offset features are recommended for the systems installed to allow luminaires near windows and those in deeper parts of the room to be controlled separately.

[15] Daylight-dependent lighting control regulates artificial lighting as required and saves a great deal of energy.

[16 + 17] Efficient long-life LED luminaires replace old fluorescent lamps with conventional ballasts in a hospital corridor.

Systematic refurbishment

A structured refurbishment process helps tap efficiency potential and makes for sustainably high lighting quality and low power costs. Five steps lead to success.

Careful analysis and professional design form the basis of any effective lighting refurbishment project. Explain the individual stages of the process to your customers and stress the importance of everyone involved – engineers, buyers, users and decision-makers – cooperating at the earliest possible stage. That is the best way to accomplish the switch to sustainable lighting.

The aim is to produce a comprehensive refurbishment plan that compares and takes account of the feasibility of individual lighting projects. The data collected and calculations made enable an optimal refurbishment strategy to be identified and, at the same time, make it easier to decide which projects, if any, should be fast-tracked for economic reasons. The refurbishment plan can then be implemented in stages over a number of years. In this case, refurbishment commences in rooms or parts of the building with the longest operating times or, alternatively, starts with the types of luminaires and lamps that offer the greatest savings potential.

Stage 1: As-is analysis

Project preparation costs money but pays dividends. Anyone who starts by precisely defining objectives and priorities will easily be able later to quantify the savings made and the gains in lighting quality.

Every refurbishment programme starts with an as-is analysis. Important sources of information for this are:

- energy bills for the last three years
- itemisation of maintenance and repair costs for existing installations
- lighting calculations and review of existing installations
- benchmarks with comparable lighting installations. In the simplest case, the electrical input of the lighting installation is measured in relation to the area illuminated (i.e. W/m² per 100 lux per year).

Stage 2: Designing the lighting

Complex lighting projects require a great deal of expertise.

Lighting design involves defining visual tasks, ensuring observance of numerous standards and regulations, and taking account of lighting quality features. The actual design work is performed in five stages:

- identification of visual tasks, definition of the lighting concept and selection of the types of lighting required
- selection of appropriate luminaires and components
- establishment of the number and arrangement of luminaires required
- where appropriate, definition of the lighting management system, which saves additional energy
- definition of the maintenance schedule.

Feasibility study

Design work also includes conducting a feasibility study on various options and comparing different lighting solutions. The study should take account of all costs over the entire life cycle of the lighting installation. These include capital costs, energy consumption, cleaning, maintenance and repair costs, and the cost of disposal.

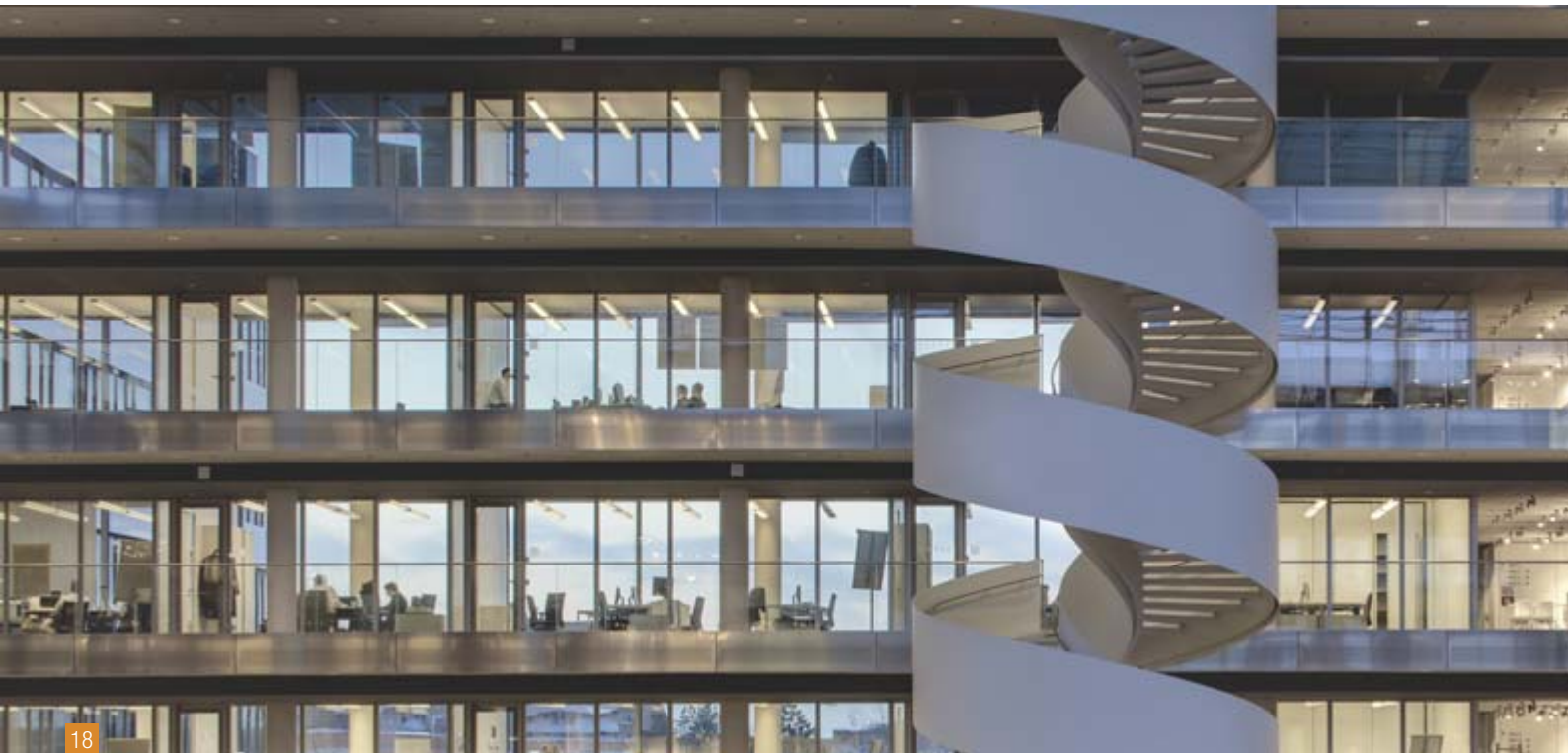
Stage 3: Financing

For municipal authorities and businesses, attractive financing concepts facilitate the switch to energy-efficient lighting – ideally without placing any strain on budgets. Help is available in the form of:

- contracting, where a service provider invests in efficient lighting and assumes the economic risk
- support funding: the German government, the federal states and the government-owned KfW bank operate numerous schemes that support the refurbishment of old lighting installations (see also page 36).

[18] Professionally designed lighting system refurbishment makes for greater efficiency and a better quality of light at the workplace.

[19] DIN standards and workplace regulations (ASR) cite quality features that in toto define the quality of a lighting installation.



18




Stage 4: Efficient procurement

Unlike public contractors, private companies are not bound by public procurement law when they purchase goods and services. Nevertheless, it is advisable to work within the same rules. They facilitate the decision-making process and highlight important criteria such as life cycle, feasibility and return on investment.

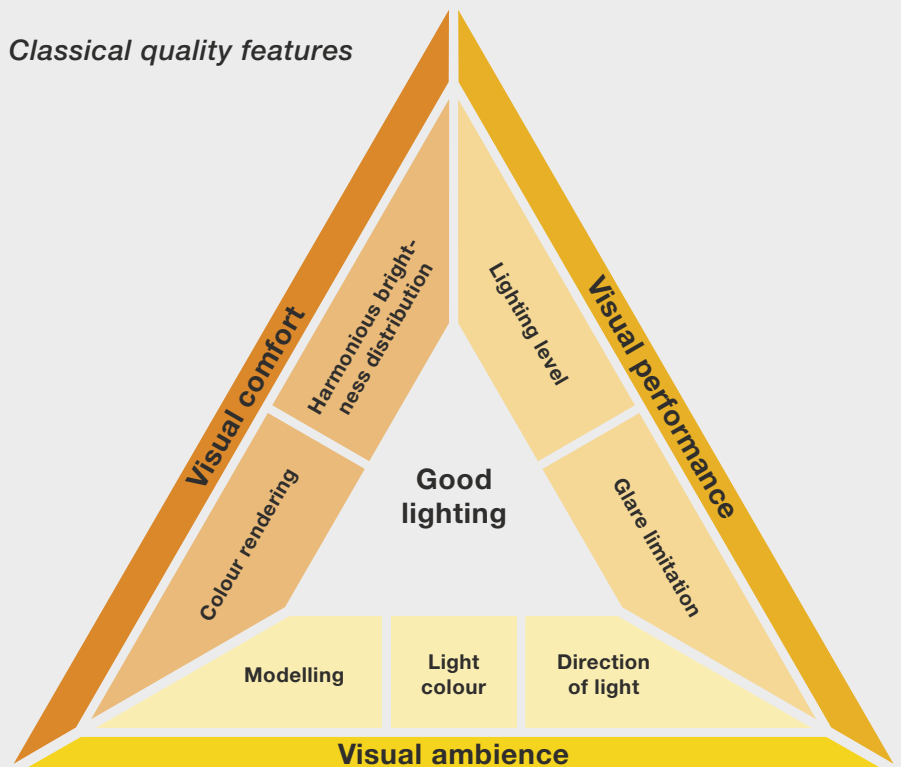
Stage 5: Maintenance and monitoring

According to DIN EN 12464-1, the preparation of a maintenance schedule is also a compulsory part of lighting design work. Optimal maintenance increases the life and efficiency of a lighting installation. Lighting system maintenance furnishes valuable information and indicators for future projects. So it is useful to have a record and assessment of maintenance work performed.

 Lots of information and tips on lighting system refurbishment are provided by the online guide to energy-efficient indoor lighting “Lotse energieeffiziente Innenbeleuchtung”: www.lotse-innenbeleuchtung.de. The guide is a project of the German Energy Agency (dena) in cooperation with the ZVEI and is sponsored by the Federal Ministry for Economic Affairs and Energy.

Lighting quality features according to DIN EN 12464-1

Classical quality features



Other quality features

Daylight integration	Energy efficiency
Change of lighting situation	Scope for personalised settings

19

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20

Ballasts in old installations

Please note: Prior to 2005, reactive power compensation was widely realised by series capacitors in the western German states. The effect of this “lead-lag circuit” is to increase connected loads by an average of eight percent. New LED installations are fitted with electronic operating devices, which do not require efficiency-reducing p.f. correction capacitors.

The input power figures in the following application examples are based on parallel p.f. correction. In the case of an old installation operating on the basis of lead-lag circuitry, the figures would therefore be eight percent higher.

[20 + 21] Good office lighting boosts staff motivation and creates an agreeable atmosphere.



21

Direct luminaire replacement

Recessed louver luminaires with four 18 W lamps (T26) – which are still found in many offices today – can often be directly replaced by recessed LED luminaires with a luminaire luminous flux of 3,700 lumen. Care should be taken to ensure that the luminaires are appropriate for VDU workplaces.

Energy requirements are further reduced by presence detection and daylight-dependent lighting regulation. In a group office with average incident daylight, for example, they can make for an energy saving of 55 percent. Recommended options include lighting management systems with a DALI interface, as is used for lighting with fluorescent lamps.

Office lighting

From phoning to typing, to participating in team meetings – different activities performed in swift succession are a typical feature of modern office life. Well-designed lighting ensures optimal conditions and an inspiring atmosphere.

Whether people work in a one-person, two-person or team office, their motivation and performance increase significantly if they feel comfortable in their working environment. Lighting plays a crucial role here. It promotes concentration and communication – and makes an efficient contribution to greater wellbeing at work. Lighting design takes account of three dimensions of lighting quality.

Visual quality

The right light is vital for trouble-free vision; it promotes visual performance and visual comfort. As a general rule, the more difficult the visual tasks, the higher the illuminance should be. The illuminance at a workplace should be at least 500 lux, for demanding visual tasks at least 750 lux. More light is permissible – and can make for greater visual comfort for more than just older employees. Supplementary task luminaires provide scope for adjustment to personal needs.

It is important to remember the need to avoid interference from glare. Modern lighting systems are helpful here, as are window blinds that regulate daylight incidence. Carefully positioned luminaires prevent annoying reflections on screens and surfaces.

Emotional quality

Daylight and artificial light help shape our response to architecture and indoor space. In conjunction with electronic lighting management, they make for an agreeable lighting atmosphere, enhanced comfort and significant energy savings. Integrated sensors regulate the artificial lighting according to the incident daylight available – and different lighting scenes, which can be programmed in advance, provide diversity.


Biological quality

Light synchronises human biorhythms and has a considerable influence on our health and performance. Modern lighting systems

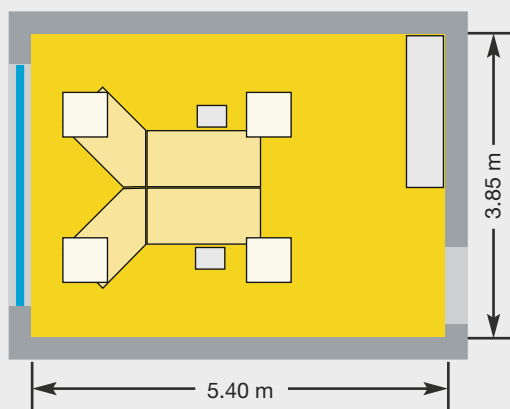
recreate the dynamism of natural daylight in the office. Illuminance levels and light colours change gradually over the course of the day – from stimulating cool white light in the morning to dimmed warm white light in the evening.

Concept

A combination of direct and indirect light is recommended for general office lighting. Also trending are luminaires with large plastic enclosures that are evenly and efficiently illuminated by LEDs.

 More information on the subject is provided in the booklets licht.wissen 04 “Office Lighting: Motivating and Efficient” and licht.wissen 19 “Impact of Light on Human Beings”.

Sample solution



	Old installation	New installation
	Recessed specular louver luminaire* with 4 x 18 W (T26) and LLB comp.	Recessed specular reflector luminaire with LED, lighting control and presence detection
Number of luminaires	4	4
System wattage per luminaire	84 W	43 W
Effective operating hours / year**	2,750	1,238
Energy / year	924 kWh	213 kWh
Energy saving		77%

*Typical luminaire light output ratio approx. 68%. 4 x 1,350 lm x 68/100 = 3,672 lm

**The effective operating hours take account of need-based dimming as well as the activation/deactivation of lights due to presence and daylight detection and constant lighting control.

Corridor and staircase lighting

Staircases and corridors are primarily communication routes. Light is essential here: it facilitates orientation, provides security and sets design accents.

Corridors and staircases lead employees and visitors to different parts of the building. The right light plays a major role in helping to make the route welcoming and avoids the disagreeable “tunnel effect” that can occur in long corridors without daylight. Basically speaking, bright walls and ceilings positively influence our sense of space and wellbeing.

High illuminance is not required in corridors and stairwells: DIN EN 12464-1 stipulates

[22] Bright cheerful lighting has a positive impact on our sense of space.

[23] Pendant luminaires for direct/indirect light distribution set accents in the high-ceilinged corridor.

[24] Skylights admit daylight for the corridor and staircase during the day. In the evening, lighting is provided by LED downlights.

a minimum of 100 lux illuminance. However, if illuminance in adjoining rooms is around 1,000 lux, brightness in the corridor should also be raised so that the eye copes easily with the transition from brighter to darker surroundings and vice versa. Supplementary wall and recessed floor luminaires mark the route and indicate lift and communication areas.


Safety on stairs

Staircases require particularly good, glare-free lighting so that they are safe to use. Downward light from the top landing makes for short, soft shadows on the treads of stairs. The treads are thus clearly distinguished and each individual stair is readily identifiable. Luminaires with a wide-angle intensity distribution curve are a good choice here. In the case of longer staircases, it is often useful to mark stairs with supplementary orientation lights – recessed in the wall or set directly into the treads.

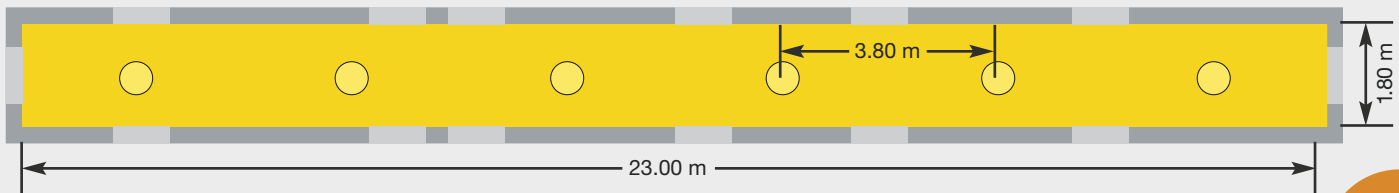
Lighting management is a worthwhile investment

A considerable amount of the energy consumed in buildings goes on lighting for corridors and foyers that are often unoccupied. Lighting control systems with presence sensors ensure that lighting is only activated when it is actually needed. That saves electricity. LED systems are a good solution here. LED downlights, for example, deliver full luminous flux instantly with no start-up delay.

It is important to note that safety lighting is normally required for communication routes inside buildings. It needs to kick in if the mains voltage fails.

 More information on the topic of safety lighting is found in the booklet licht.wissen 10 “Emergency Lighting, Safety Lighting”.

Sample solution



Energy-saving
80%

	Office corridor, old installation	New installation
	Downlight*, 2 x TC 18 W, LLB comp.	LED-Downlight with DALI interface
Number of luminaires	6	6
System wattage per luminaire	52 W	26 W
Effective operating hours / year**	2,750	1,100
Energy / year	858 kWh	172 kWh
Energy saving		80%

*Typical luminaire light output ratio approx. 70%. 2 x 1,200 lm x 70/100 = 1,680 lm

**The effective operating hours take account of need-based dimming as well as the activation/deactivation of lights due to presence and daylight detection and constant lighting control.



22



23

DALI switch makes for savings

In corridors, the LED is an attractive option because of its high switching resistance, which distinguishes it sharply from the compact fluorescent lamp. The use of presence sensors can thus be recommended even where switch times are short.

Experience has shown that even better results are obtained with a simple DALI switch, which lowers the lighting level to 20 percent when no one is present. It makes high acceptance possible even where switch times are very fast and permits relative energy savings of up to 77 percent. The dimming also impacts favourably on the longevity of the LEDs.

Conventional sensors support this corridor feature for a number of luminaires without the need for programming.



24

Production plant lighting

Workplace lighting in industry and trade needs to meet the highest quality and safety standards. The right light demonstrably helps reduce error rates and absenteeism.

Explain to your customers that good lighting technology is a worthwhile investment: modern solutions are considerably more efficient than old installations and reduce maintenance costs. Numerous studies also show that good light and higher illuminance can boost productivity in a company:

- Older employees generally require more light.
- Younger employees are also more focused and productive.
- There is a measureable downturn in error rates.
- Work-related accidents and absenteeism decrease sharply.

Luminaire selection

For the general lighting in a production hall up to 6 metres high, wide- and narrow-

[25 + 27] Good work lighting promotes motivation and performance, guards against accidents and saves energy and costs.

[26] Combining high luminous intensity with a long life, LEDs are in increasingly widespread use in production premises.

beam continuous rows should be installed parallel to the main viewing direction. Supplementary workplace luminaires need to be tailored to the specific visual tasks performed. Alternatively, dedicated task area luminaires can be installed at workplaces. For halls over 6 metres high, high-bay reflector luminaires are the right choice.

Lighting in industry and trade often needs to satisfy exacting requirements in terms of electrical, thermal and mechanical reliability. Explain the luminaire protection classes and degrees of protection required and find out about any fire and explosion protection regulations that need to be observed as well as the mechanical loads to which luminaires are exposed. Make sure that standard-compliant emergency and safety lighting is installed.


Glare-free lighting

As a general rule, ergonomically correct lighting needs to be glare-free and should have very good colour rendering properties, especially where demanding visual tasks

need to be performed. Neutral or daylight white light is a time-honoured solution. Guidance on design is provided by DIN EN 12464-1 and workplace regulations (Arbeitsstättenrichtlinien).

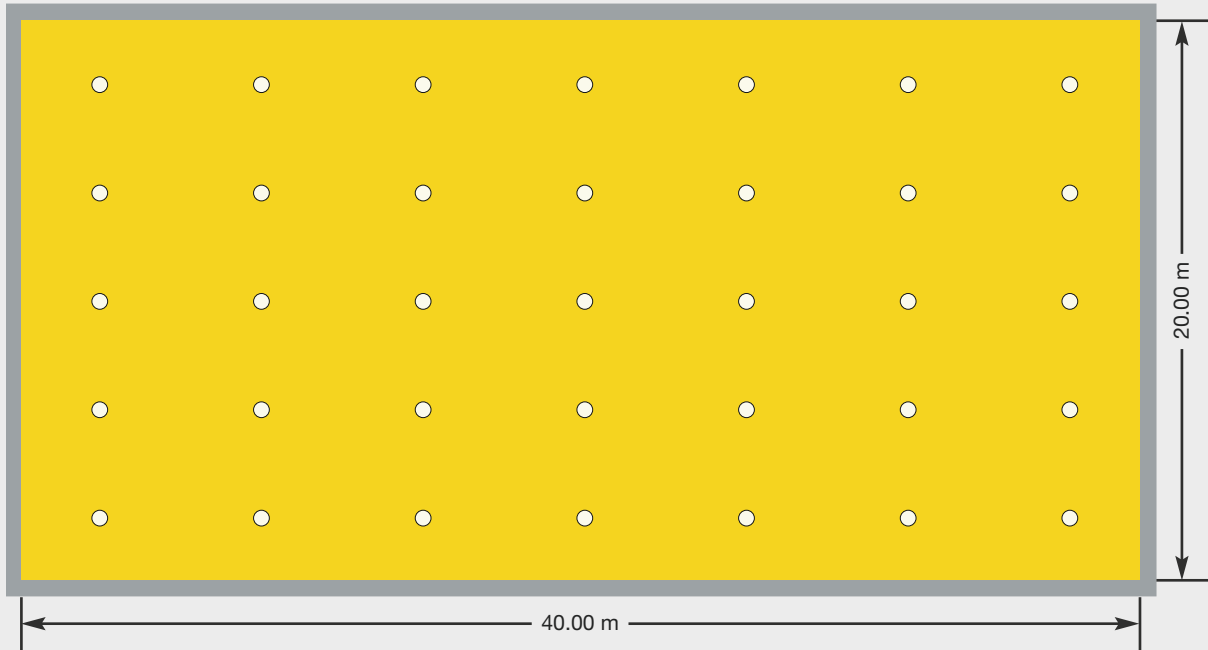
LEDs in production premises

LED luminaires are in increasingly widespread use in production premises. With a long life and extremely efficient, they deliver instant flicker-free uniform light and are impervious to vibration. Further significant savings can be achieved by harnessing daylight, e.g. through a saw-tooth roof or domelights. The artificial lighting is then regulated to supplement daylight only as required. That saves electricity costs and reduces the need for maintenance.

 More information on this subject can be found in the booklet licht.wissen 05 "Industry and Trade" while further information about safety lighting is found in the booklet licht.wissen 10 "Emergency lighting, safety lighting".



Sample solution



Energy-saving
50%

	Old installation	New installation
	Spot HME 250 W, LLB comp.*	LED spot
Number of luminaires	35	35
System wattage per luminaire	266 W	134 W
Effective operating hours / year**	4,000	4,000
Energy / year	37,240 kWh	18,760 kWh
Energy saving		50%

*Typical luminaire light output ratio approx. 80%. 14,000 lm x 80/100 = 11,200 lm

**The effective operating hours take account of need-based dimming as well as the activation/deactivation of lights due to presence and daylight detection and constant lighting control.

Reflector lamp replacement

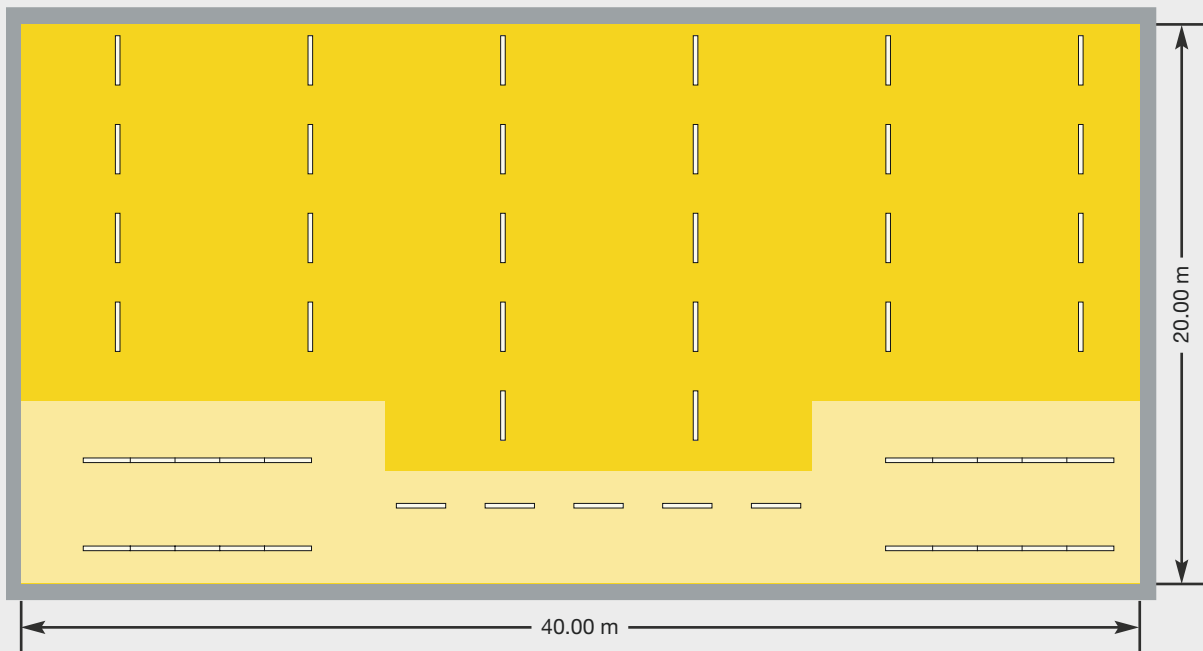
Even in industrial buildings it is often advisable and possible to retain the existing arrangement of luminaires when lighting is refurbished. Special LED luminaires have been specifically developed for this purpose. They maximise savings potential while at the same time delivering sufficient net luminous flux in an appropriate light distribution pattern to replace an old reflector luminaire fitted with high-pressure mercury vapour lamps (e.g. with 250 W ratings). As of 2005, this type of lamp is no longer allowed to be placed on the EU market because of its poor energy balance (Commission Regulation 245/2009/EC).

Nevertheless, lighting design evidence is still required to ensure that health and safety requirements are met. If sufficient daylight is available, even more energy can be saved in some cases by constant lighting regulation.





Sample solution



- Order picking area with maintained lighting
- Storage area with conveyor vehicles and presence-dependent lighting

**Energy-saving
65%**

	Old installation	New installation
	Continuous row* 1 x 58 W, LLB comp.	Continuous row with LED gear trays
Number of luminaires	26 + 25	26 + 25
System wattage per luminaire	66 W	36 W
Effective operating hours / year	8,760 / 8,760	2,600 / 8,760**
Energy / year	29,486 kWh	10,317 kWh
Energy saving		65%

*Typical luminaire light output ratio approx. 75%. $5,200 \text{ lm} \times 75/100 = 3,900 \text{ lm}$

**In contrast to the old installation, the refurbished installation takes account of the light required in the different zones.

With need-based control by presence detectors, the number of effective operating hours in the storage area is thus reduced.

LED lighting techniques

For warehouses and logistics centres with long operating times, modern LED luminaires offer particularly clear advantages. In halls up to six metres high, the continuous row system should feature different lighting techniques so that storage, order picking, packaging and despatch area lighting can be optimised and tailored to requirements. Integrated lighting techniques that make supplementary reflectors superfluous are particularly efficient and easy to install.

For halls over six metres high, LED high-bay reflector luminaires are recommended.

The instant luminous flux delivered by LEDs and the high switching resistance of the luminaires are perfect for use with presence detectors in aisles. This taps a great deal of additional energy-saving potential.



Warehouse lighting

Storage rooms and warehouses are often served by little or no natural daylight. Their design presents special lighting requirements. Presence control systems ensure efficiency and security.

Less light is needed for warehouse work than for production operations. But good lighting can still make a difference – by compensating for lack of daylight and promoting staff wellbeing.

Relatively high illuminance is particularly important where small items are handled and for all order-picking operations that involve labelling and form-filling. For high-bay racking, high vertical illuminance is a key requirement. So the 100 lux to 200 lux (for constantly manned storage facilities) average illuminance set out in DIN EN 12464-1 is often not enough; licht.de recommends 300 lux for reading tasks.

Vertical illuminance

The highest requirements are presented by high bay warehouses, which often have very narrow aisles. Narrow-angle luminaires are the right choice here, along with wide-angle or asymmetrical luminaires to provide the vertical illuminance needed for reading and searching tasks. In cold stores, dedicated luminaires for damp interiors need to be used. LED systems lend themselves


very well to this application because of their good luminous flux delivery at low temperatures.

Lamps with a warm white or neutral white light colour are an appropriate choice for storage facilities. Good colour rendering is also important; the colour rendering index should be at least R_a 80.

Point out to your customers that warehouse operating costs can also be substantially lowered by

- energy-saving lamps such as LEDs and modern fluorescent lamps,
- electronic ballasts and
- intelligent lighting control.

Motion detectors automatically activate lighting when it is needed. If no movement is registered within a pre-specified time, the lighting is automatically deactivated again.

 More information on the subject can be found in the booklets licht.wissen 05 “Industry and Trade” and licht.wissen 10 “Emergency Lighting, Safety Lighting”.

[28] Efficient LED luminaires or fluorescent lamps are used in warehouses up to six metres high. For facilities higher than six metres, high-pressure discharge lamps are an alternative.

[29] Luminaires for high-bay warehouses have special angled reflectors. In many LED luminaires, the technical feature is already integrated.



30

Classroom lighting

Studying places heavy demands on our eyes. Good lighting supports demanding visual tasks and delivers the quality of light needed to promote performance and wellbeing.

School, university, adult education – whatever the learning environment, light plays an absolutely crucial role in study. The right lighting ensures that we are able to absorb information swiftly and accurately. At the same time, light influences our emotional responses: correctly used, it makes for a greater sense of wellbeing in the classroom, boosts motivation and promotes concentration and communication.

Design issues

Before designing the lighting, check the seating arrangement in the room. A directional arrangement is not necessarily

standard today; room-related lighting ensures good lighting conditions even where room use is flexible.

According to DIN EN 12464-1, 300 lux is correct for classrooms, 500 lux for special subject classrooms and adult education.

Board and presentation lighting

The lighting design must also take account of the fact that teaching methods have become more diverse – and the classical blackboard is supplemented by other teaching media such as whiteboards and media presentations. The lighting needs to cater for this by making dimmable light available.


Lighting control: efficient and convenient

So, good lighting needs more than an on/off switch. The optimal lighting solution for both efficiency and convenience is offered by a combination of lighting control systems and efficient light sources such as LEDs. Pre-set lighting scenes – e.g. for

presentations or classroom work – facilitate the different tasks performed during the course of the school day. Further savings are possible with

- presence control
- and daylight-dependent regulation.

Optimum conditions for study are provided by lighting management systems for dynamic lighting: changes in brightness and light colour modify the lighting atmosphere to suit the relevant classroom situation. Activating daylight-white light and high illuminance help students overcome tiredness and improve concentration and memory skills, while dimmed warm-white light helps them relax. When lighting is refurbished, control systems can also be realised for individual rooms or groups of rooms.

 More information on the subject is available in the booklet licht.wissen 02 “Good Lighting for a Better Learning Environment”.

[30 + 31] Good lighting has been proven to facilitate academic progress.



Lighting management makes for savings

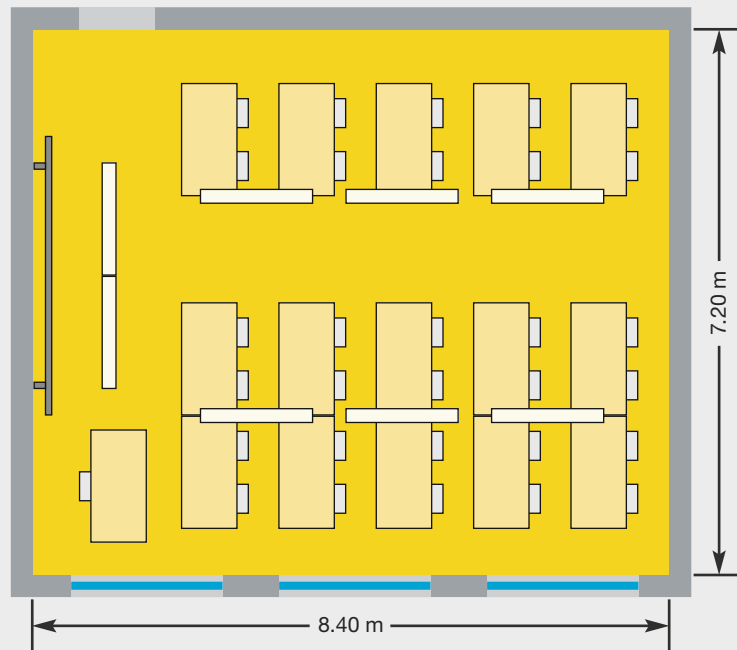
The most energy-efficient refurbishment solutions possible can normally only be realised in classrooms on the basis of computer-aided lighting design. Merely swapping existing luminaires for new models should rarely be considered.

Considerable savings are achieved in classrooms by daylight utilisation and constant lighting regulation. Board lighting, which is required in most classrooms, should be realised as supplementary lighting – separately switched but governed by the presence detectors of the lighting management system.

In addition to relevant technical standards and health and safety regulations, it may also be advisable for the educational lighting designer to consult "Beleuchtung 2011", a booklet (No. 114) published by the AMEV (Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities).

31

Sample solution



Energy-saving
83%

	Old installation	New installation
	Surface-mounted specular louver luminaire* with 2 x 58 W (T26) and LLB comp.	Surface-mounted specular louver luminaire with LED, symmetrical/asym. for board with lighting regulation and presence detection
Number of luminaires	6	6 + 2
System wattage per luminaire	132 W	42 W / 58 W
Effective operating hours / year	1,400	482** / 560***
Energy / year	1,109 kWh	187 kWh
Energy saving		83%

*Typical luminaire light output ratio approx. 65%. $2 \times 5,200 \text{ lm} \times 65/100 = 6,760 \text{ lm}$

**The effective operating hours take account of need-based dimming as well as the activation/deactivation of lights due to presence and daylight detection and constant lighting control.

***The effective operating hours of the board lighting take account of need-based manual activation and deactivation of the lighting.



Luminaire replacement makes for savings

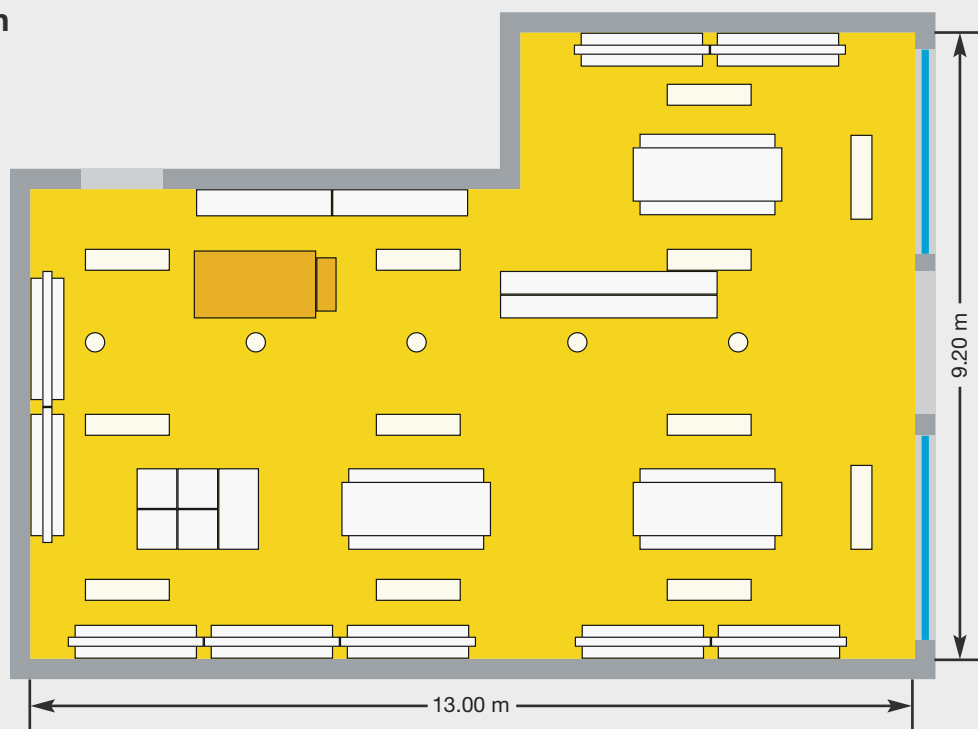
General shop lighting is another area where old luminaires for fluorescent lamps can often be replaced one for one by LED luminaires. Energy savings of more than 50 percent are often achieved here.

Even more energy can be saved by refurbishing the supplementary accent lighting. Where luminaires for low-voltage halogen lamps are installed, for example, replacing them with LED luminaires – typically swapping the halogen lamps for 17 Watt LEDs – can reduce energy requirements by as much as 70 percent.

Take care to ensure that LED luminaires with good colour rendering and appropriate light distribution are used.

32

Sample solution



Energy-saving
54%

	Old installation	New installation
	Louver luminaires 2 x 36 W, LLB comp. and downlights 2 x 18 W*	LED recessed luminaires with microprismatic enclosure and LED downlights
Number of luminaires	12 + 5	12 + 5
System wattage per luminaire	84 W / 52 W	40 W / 21 W
Effective operating hours / year**	3,600	3,600
Energy / year	4,565 kWh	2,106 kWh
Energy saving		54%

*Typical luminaire light output ratio approx. 70%. 2 x 3,350 lm x 65/100 = 4,355 lm, 2 x 1,200 lm x 70/100 = 1,680 lm

**The effective operating hours take account of need-based dimming as well as the activation/deactivation of lights due to presence and daylight detection and constant lighting control.

Shop and salesroom lighting

Light is an important tool for sales promotion: it creates atmosphere, directs attention to the merchandise on display and underlines image. But lighting's contribution to commercial success extends beyond sales: energy-efficient operation and low maintenance are equally important.

Supermarket, boutique or greengrocer's – whatever the store, the customer expects an agreeable shopping experience. And lighting plays an important role in that – both in the shop window and in the salesroom. Light arouses interest, permits swift orientation, highlights displays and defines the atmosphere of the salesroom.

Good lighting solutions are always tailored to the product range and its presentation. For general lighting, illuminated ceilings or

large-format luminaires for uniform light distribution are recommended options. Continuous rows or wallwashers direct the eye to shelves and vertical displays. For accentuating sales areas, directional precision is offered by spots with different beam angles or downlights. DIN EN 12464-1 recommends a minimum of 300 lux illuminance for salesrooms and at least 500 lux for till areas.


LEDs for salesrooms

The right light colour underlines product presentation. Cool fresh light colours are suitable for food and high-tech presentations, for example, while warm colours are the right choice for fabrics or bakery products. Efficient LED luminaires with variable light colours are a high convenience option here. The facility to switch between warm and cool white light while maintaining constant good colour rendering permits a flexible lighting design that can swiftly be adjusted to suit changing displays. LED light also has no UV or infrared content and does not affect merchandise. Furthermore, because LEDs are not sensitive to cold,

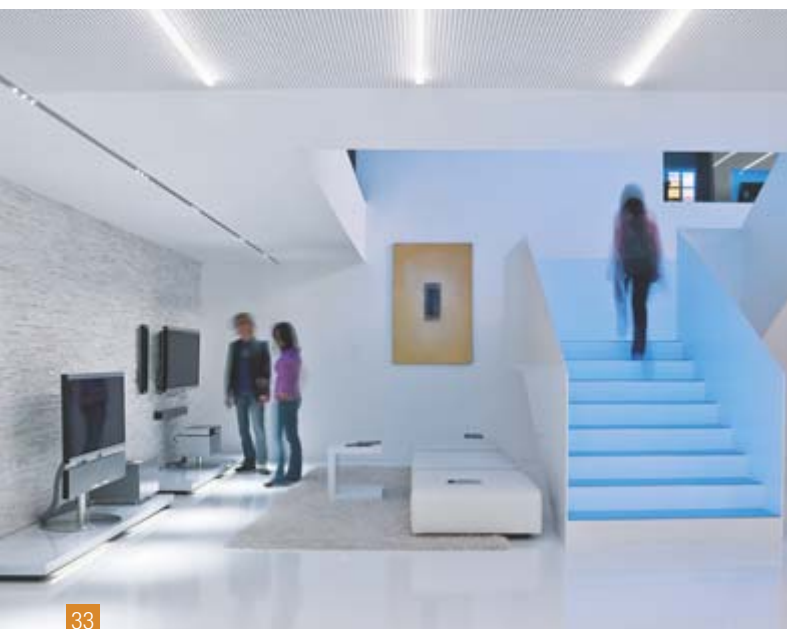
they have no problems coping with the low temperatures maintained in refrigerated counters.

Cutting energy costs

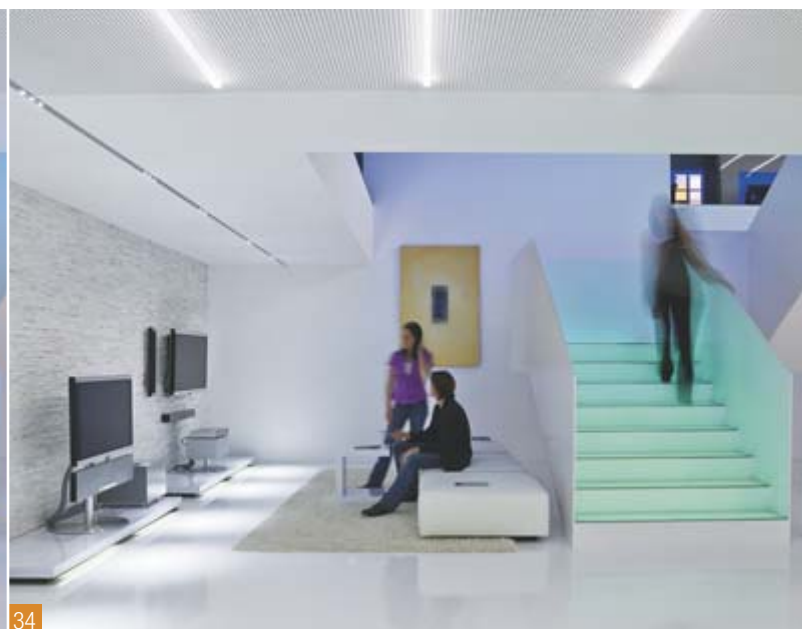
The energy efficiency of lighting is an important criterion because lighting is a significant cost factor, accounting for 62 percent of total energy costs in non-food retail. Explain to your customers that the potential for savings cannot be tapped by merely replacing conventional lamps. It makes better sense to ensure that the system as a whole is well coordinated. That includes luminaires with a high light output ratio, quality lamps with a low energy consumption rating and intelligent lighting management. It allows creative lighting productions and at the same time saves energy if lighting is regulated according to the incident daylight available.

 Detailed information about the subject is found in the booklet licht.wissen 06 "Shop Lighting – Attractive and Efficient".

[33 + 34] The coloured LED staircase lighting adds drama to the simple white salesroom scene. Even more variety is provided by dynamic colour sequencing control.



33



34



Vertical illuminance

Examination and treatment rooms are viewed for lighting purposes like the equivalent rooms in a hospital. They should additionally have an agreeable, homely atmosphere.

In general medical treatment rooms, visual communication between doctor and patient is a priority. Good vertical illuminance on faces is important here. Suspended LED task zone luminaires are a good choice. At the treatment couch, supplementary lighting needs to be provided to deliver the 1,000 lux required. Dimmable luminaires are recommended here: in dimmed operation – e.g. at 20 percent – they help provide agreeable general lighting; set for full output, they deliver the light needed for examinations and treatment.

Depending on requirements, a separately switched examination light should be provided.

Doctor's surgery lighting

Reception area, consulting room, examination room – lighting for a doctor's surgery needs to meet a range of requirements. Tailored design ensures that the right light is available for all visual tasks and that patients feel they are in good hands.

Lighting design for a doctor's surgery has two defining aspects. First of all, physicians and surgery staff require optimal functional light for the work they perform in treatment rooms, at VDU workplaces and in the laboratory. Secondly, waiting areas and consulting rooms should have a lighting atmosphere that patients find reassuring and relaxing. With flexible LED systems and comfortable lighting control, lighting concepts can be easily and efficiently implemented for diagnosis, therapy and wellbeing.

Reception and waiting room

The reception is the calling card of a doctor's surgery. It makes the first impression on the patient and, at the same time, constitutes a workplace for receptionists. Bright, uniform, cheerful lighting is correct here. For work at the computer, VDU workplace stipulations require at least 500 lux and freedom from glare.

Good reading light for waiting areas is provided by suspended luminaires – if neces-


sary supplemented by wall luminaires for direct/indirect light distribution – delivering 300 lux illuminance. Accents can be set by e.g. coloured light from diffuse LED light tiles.

Treatment rooms

In the consulting room, physician and staff need good general lighting with a uniform 500 lux illuminance as well as flexible lighting for examinations. Where an intelligent control system is installed, the lighting can easily be switched and dimmed to the optimal illuminance, which can range from 5 lux, e.g. for special eye and ear examinations, to several thousand lux. Very good colour rendering – at least $R_a M 90$ – is obligatory.

Bright LEDs are increasingly the light source of choice for examination rooms. Their advantages here are their longevity – which keeps maintenance to a minimum – their low heat gain and the possibility of integrating LEDs of different colour temperatures in a single luminaire. This colour

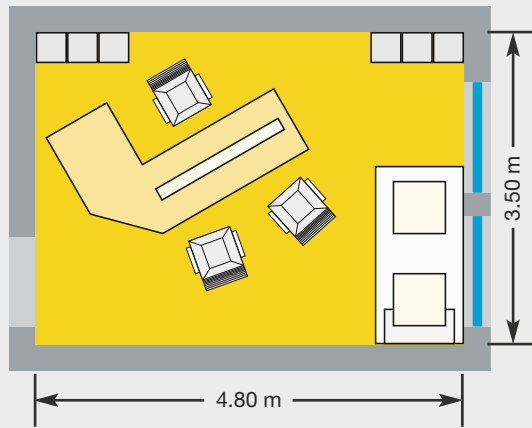
mix offers the option of varying light colour at the push of a button or by remote control to suit the examination in question: neutral white for general examinations, for example, warm white light for assessing the condition of skin, cool white light for quickly identifying blood vessels. Minimum lighting requirements are set out in DIN EN 12464-1 and DIN 5035-3.

 More information on the subject can be found in the booklets licht.wissen 07 "Light as a Factor in Health" and licht.wissen 17 "LED – The Light of the Future".

[35] In a treatment room, good light is needed for examinations, communication between doctor and patient and VDU work.

[36] Coloured light in the waiting area makes for a greater sense of wellbeing and can help patients relax.

Sample solution



Energy-saving
68%

	Old installation	New installation
	Standalone luminaire 4 x TC-L 55 W and 2 x surface-mounted luminaire 4 x 18 W*	Suspended LED task zone luminaire and 2 x surface-mounted LED luminaire
Number of luminaires	1 + 2	1 + 2
System wattage per luminaire	244 W / 84 W	98 W / 37 W
Effective operating hours / year	2,750	2,750 / 1,200**
Energy / year	1,133 kWh	358 kWh
Energy saving		68%

*Where luminaires with very different beam characteristics are used, it is not useful to compare luminaire luminous flux.
**Need-based operation in the treatment area with dimmable luminaires.

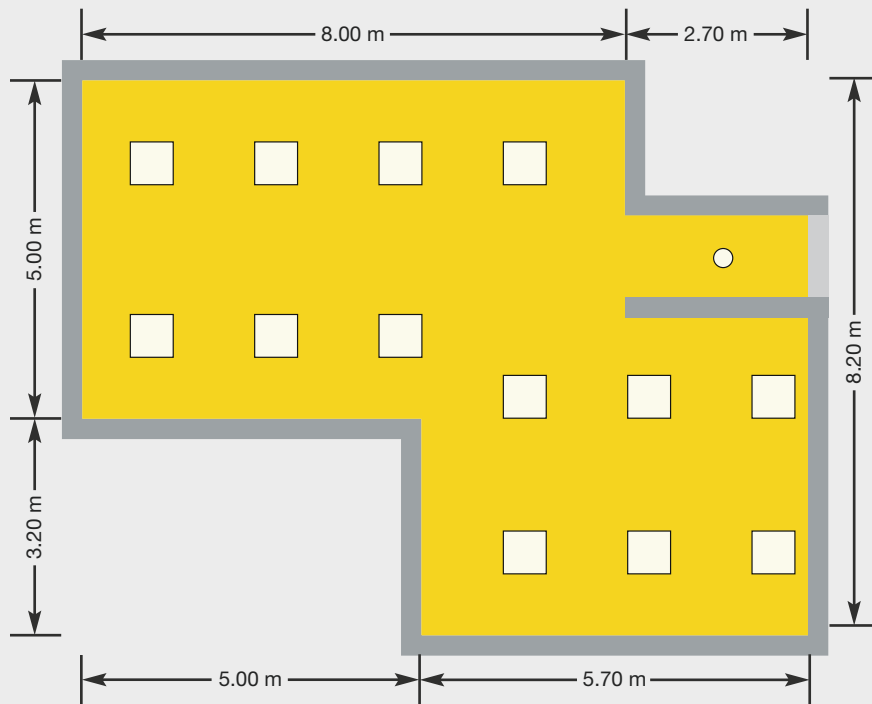
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37

Sample solution



Energy-saving
44%

	Old installation	New installation
	Louver luminaires 4 x 18 W, LLB comp.*	Recessed LED luminaires with microprismatic enclosure and colour temperature control, warm white and daylight white
Number of luminaires	13	13
System wattage per luminaire	84 W	(2 x) 47 W**
Effective operating hours / year	5,475	5,475
Energy / year	5,979 kWh	3,345 kWh
Energy saving		44%

*Typical luminaire light output ratio approx. 68%. 4 x 1,350 lm x 68/100 = 3,672 lm
 **Power input: 47 W with variable light colour, warm white/daylight white.



38

Dynamic lighting

Fitness rooms are often located in rooms with little incident daylight in commercial building complexes. Where this is the case, high luminous efficacy makes for major energy savings.

And that is not all: the advantages of modern LED lighting technology can give lighting for such facilities a totally new quality: luminaires with a widely variable light colour, i.e. flexible colour temperature control, make it possible to create the stimulating effect of daylight indoors at relatively little additional expense. This supports the natural human day/night rhythm and promotes wellbeing, motivation and relaxation.

Lighting control is provided by conventional components on the basis of a DALI interface.

Sports and leisure facility lighting

Leisure sport plays an important role in many people's life. Whether it is football, indoor climbing or yoga – the right light keeps us safe, helps us unwind and is energy-efficient.

The primary purpose of lighting in fitness studios and sports halls is safety: athletes need to be able to use equipment with confidence and, in fast games like squash, identify balls and their trajectory with ease. Supplementary accent lighting enhances visual comfort, lends structure to the room and makes for a greater sense of wellbeing.

Lighting control for convenience

The lighting requirements of sports facilities are almost as diverse as the sports they cater for. So, intelligent planning of switching circuits and thought-through lighting control are crucially important. They take account of different requirements and ensure greater efficiency.

Lighting should always be dimmable, at least in certain areas or individual rooms, so that the light can be more finely tuned to the needs of those training: more light for a ballet workout, lower lighting for relaxation exercises on the floor. Care must be taken to ensure that people lying on their back are not dazzled by the light from luminaires.


Light sources need to be appropriately shielded and angled. Variety is offered by lighting that permits dynamic changes of colour. This is a particularly popular option for fitness centres and can be achieved, for example, with LED luminaires or RGB fluorescent lamps.

Avoidance of glare

Guidance on illuminance is provided by DIN EN 12193. In many sports, at least 200 lux illuminance is sufficient for training. In spinning or weight training on machines, a minimum of 300 lux is required. It is important to ensure that reflected glare on screens and displays is avoided.

In a multi-purpose hall, the lighting level needs to be appropriate for the sport with the most exacting requirements. A regular luminaire arrangement is normally adopted. Fitment options – recessed luminaires, surface-mounted luminaires or suspended continuous rows – depend on the height of the hall and the type of ceiling. Luminaires for fluorescent lamps, high-bay reflector

lamps and recessed spots for metal halide lamps have a proven track record here. LED luminaires are also a good choice. Their pluses: a very long life, good colour rendering and low energy costs.

 More information on the subject can be found in the booklet licht.wissen 08 "Sport and Leisure".

[37 + 38] Comfortable, glare-free lighting guards against accidents during sport. The horizontal illuminance in the training area should be at least 300 lux.

Enclosed parking facility lighting

The vehicle entrances and exits of underground and indoor parking facilities are accident black spots. Good lighting guarantees smooth traffic flows and heightens safety.

Road safety is the main priority in indoor and underground parking facilities, because they are used simultaneously by moving and parking car drivers, motorcyclists and pedestrians. Good lighting without dark zones lowers the risk of accidents, facilitates orientation and makes vehicles, persons and obstacles easier to recognise.

For indoor car parks, DIN EN 12464-1 stipulates a minimum of 300 lux illuminance at vehicle entrances and exits during the day. If the barrier is not in the same zone,

it should be separately illuminated to facilitate use of the key card reader. At night, at least 75 lux is required throughout the parking area. However, more light is useful – and makes for greater safety for pedestrians and motorists. At the same time, good lighting is an effective safeguard against criminal assault. Luminaires are installed on the left and right of access ramps and should provide uniform lighting. Appropriate enclosures and precise alignment prevent motorists being dazzled; a high degree of protection prevents damage due to moisture and dirt.

LEDs and lighting management


The lighting in enclosed parking facilities is often in operation 24 hours a day. So operators are interested in minimising the operating costs. Explain to your customer how those costs can be saved:

- LED light sources are an optimal option. They are very energy-efficient, easily controllable and insensitive to cold. And they have a very long life, which cuts maintenance costs. The emergency

lighting required in enclosed parking facilities can also be easily integrated in LED systems.

- Electronic lighting management makes for considerable savings and additional comfort. It includes presence detectors, for example, which activate lighting and automatically raise the brightness when vehicles or persons approach. If the parking facility is also served by daylight, intelligent control adjusts the artificial lighting as required.

Where operating times are long and electricity prices are rising, the capital costs of a refurbishment measure are quickly recouped. The longer lights are on, the faster an efficient installation pays for itself.

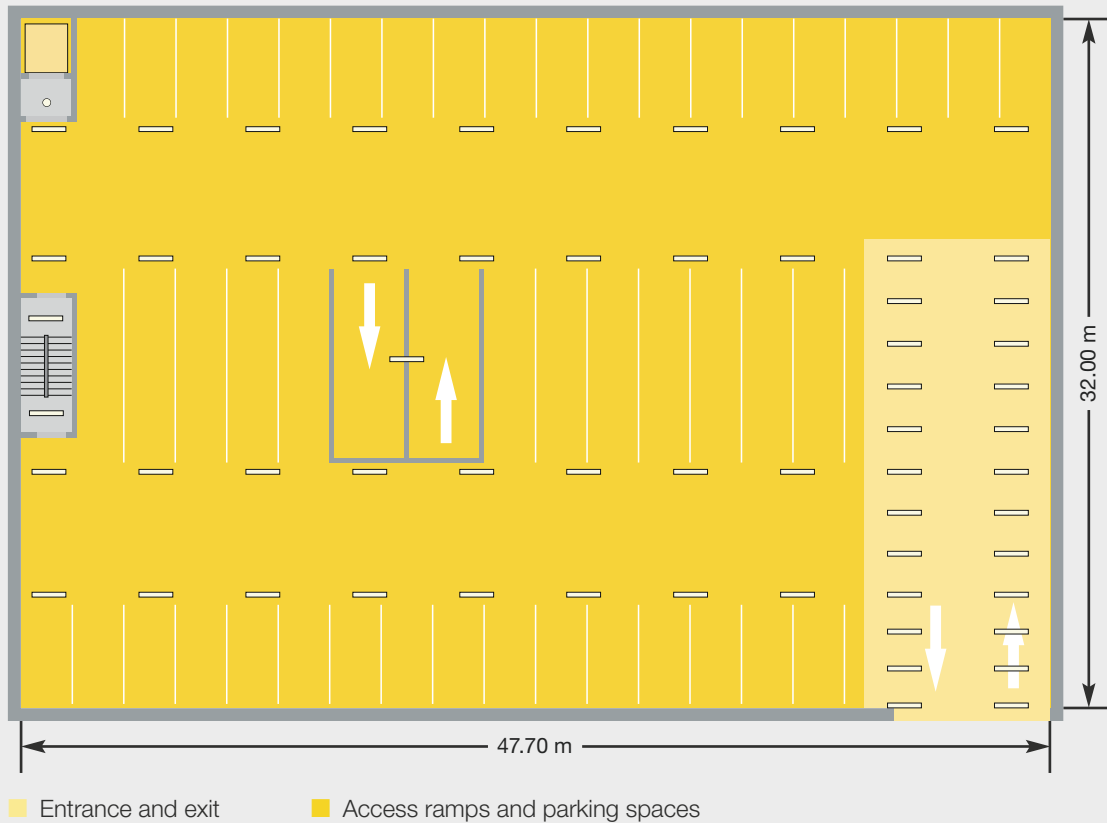
 More information on the subject can be found in the booklet licht.wissen 10 “Emergency Lighting, Safety Lighting”.

[39] Vehicle entrances and exits need to be illuminated to at least 75 lux at night.

[40] Uniform lighting with comfortable illuminance makes for greater safety in enclosed parking facilities.



Sample solution



Energy-saving
58%

	Old installation	New installation
	Plastic luminaires* 1 x 58 W, LLB comp.	LED diffuser luminaires
Number of luminaires	59	24 + 35
System wattage per luminaire	66 W	45 W
Effective operating hours / year**	2,555	2,555 + 918
Energy / year	9,949 kWh	4,206 kWh
Energy saving		58%

*Typical luminaire light output ratio approx. 80%. $5,200 \text{ lm} \times 80/100 = 4,160 \text{ lm}$

**The effective operating hours take account of need-based dimming due to presence detection.

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Selective dimming makes for savings

Luminaires for damp interiors with plastic housing and fluorescent lamps can in some cases be directly replaced by wide-beam LED luminaires. Professional lighting design is absolutely essential here to ensure standard compliance. High savings potential can be tapped by selectively raising the lighting level only in areas where movement is detected.

Lighting dimmed to 20 percent elsewhere is sufficient for reliable orientation.

The entrance lighting must always be at 100 percent when a vehicle enters or exits the facility. Lighting management systems with DALI interface are an option that is also recommended here.



40

Support funding

Many companies and municipalities have limited funds available for investing in the modernisation of lighting installations. Point out solutions and inform your customers about attractive support funding options.

Government supports the switch to sustainable lighting and subsidises refurbishment projects that help mitigate climate change by making more efficient use of energy. The German government has set up various support programmes that help even small and medium-size enterprises – so-called SMEs - refurbish obsolete lighting installations. The examples below provide pointers for talks with customers.

BAFA: Up to 100,000 euros for systemic optimisation

Last year, a new support programme aimed specifically at SMEs was launched by the Federal Office for Economic Affairs and Export Control (BAFA) – a federal authority subordinated to the Federal Ministry of Economics and Technology (BMWi) – to promote the use of highly efficient cross-sectional technologies. The BAFA offers large grants of up to 30 percent of net outlay – subject to a ceiling of 100,000 euros – for energy-saving refurbishment projects.

The programme covers two types of project. Major lighting projects from 30,000 euros upwards are supported under the heading “Systemic Optimisation”. The aim is to promote an integrated approach to technological systems.

Before any investment is made, an individual energy-saving concept needs to be developed by a KfW-approved energy consultant, verifying and assessing the optimisation possible. Good to know: KfW foots up to 80 percent of the bill for consultation and energy concept.

In 2014, the BAFA also started providing assistance for individual LED lighting projects up to 30,000 euros. No energy consultation is required for this uncomplicated support.

KfW: “Energieberatung Mittelstand”

The government-owned KfW bank operates various support programmes. Energy

counselling is an important element here because it helps ensure that potential can be identified and successively harnessed as required. Consultation services such as those required for the BAFA programme outlined above are covered by the “Energieberatung Mittelstand” (SME Energy Counselling) programme. Please note: applications for support funding need to be submitted before projects commence.

Support funding is available for

- initial and detailed advice by KfW-approved energy consultants,
- initial advice (80 percent grant, max. 1,280 euros),
- detailed advice (60 percent grant, max. 4,800 euros).

KfW Energy Efficiency Programme

KfW supports the switch to energy-saving lighting with attractive loans. The KfW Energy Efficiency Programme (Energieeffizienzprogramm, No. 243 / 244) is aimed at SMEs and freelance professionals and offers:

- loans up to 25 million euros,
- loan periods up to 20 years with grace periods.



More information on the web:

- KfW – www.kfw.de
- Federal Office for Economic Affairs and Export Control (BAFA) – www.bafa.de
- Funding database of the Federal Ministry for Economic Affairs and Energy with all federal, state and EU programmes – www.foerderdatenbank.de.

Checklist: Lighting Installation Review

General information

Project name:

Client's name:

Address, date:

Building information

Age of building _____ years

Owned or leased? owned leased

Are there problems with the current lighting installation?

Significant lamp failure High energy costs
 Maintenance problems / spare parts
 Illuminance not standard-compliant
 Large number of different lamp and luminaire types

Refurbishment / sustainability targets?

Refurbishment strategies and targets:

Standard compliance Yes No
 New installation should match the values of the existing installation Yes No
 Maximum energy saving Yes No
 Retrofit solution Yes No
 One-to-one replacement Yes No
 Type reduction Yes No
 Amortisation period or ROI Amortisation _____ years
 ROI _____ %

Refurbishment according to budget
Indication of highest saving potentials per room and luminaire type Yes _____ € No
 Refurbishment according to room type
e.g. rooms with longest operating times first Yes No
 Refurbishment according to luminaire types
e.g. luminaires with high savings potential first Yes No
 Observation period for life cycle cost analysis _____ years

Lighting information

Age of existing installation: _____ years

Maintenance of installation: regular as required seldom

Man-hour price: _____ € / hr.

Lamp replacement by: own personnel external installer

Lamp replacement : individually on failure group replacement
 Group replacement last performed _____ years ago
 Group replacement scheduled in _____ years

Dismantling and assembly Possible during work time? Yes No

Price of electricity: Present price _____ € / kWh Yes No
 Price rise anticipated? Yes No
 _____ € / year

Operating hours per year: _____ hrs / year

Documentation:

Building plans available in conventional formats (pdf, dwg)? Yes No
 Luminaire arrangement for each room available? Yes No
 Ceiling plan showing existing luminaires available? Yes No

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Checklist: Room-specific information

Room number, purpose:

Operating time (hrs): per day: _____ per week: _____ per year: _____

Room dimensions: length: _____ width: _____ height: _____

Type of ceiling: visible T-section concealed T-section
 strip ceiling plasterboard ceiling concrete ceiling
 grid dimensions in mm length: _____ width: _____

Illuminance in the room: standard-compliant Yes
Min. 6 measuring points above-standard Yes high medium low
 below-standard Yes high medium low

Existing luminaires and lamps:

Luminaire and lamp type _____
 Lamp rating _____ Watt Lumen? _____ lm
 Number of lamps per luminaire _____ pcs.
 Number of luminaires per room _____ pcs.
 Continuous rows: _____ pcs. blanked
 Ballast? CB LLB EB
 Emergency lighting Yes No
 Operating hours (if different from room)
 per day: _____ per week: _____ per year: _____
 Number of activations/deactivations per day: _____

Control: Available? Yes No
 Required? No No
 presence detection daylight control

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licht.de design tools

Luminaire replacement or complete re-design of the lighting installation – every refurbishment project starts with a detailed review of the as-is situation and a summary of the objectives of refurbishment.

On the left are two sample checklists that will help you analyse an existing lighting installation.

At the licht.de website, you will also find lots of practical application examples and guidance on important standards and more checklists.

[41 +42] Checklists facilitate the performance of everyday tasks, help assess the current situation and are useful design tools.

licht.de publications

Each Booklet!

€ 10,-



licht.wissen 10

Emergency Lighting, Safety Lighting

52 pages on emergency and safety lighting. Booklet 10 looks at relevant standards and regulations, explains lighting and electrical requirements and presents numerous application examples showing the importance of safety lighting.



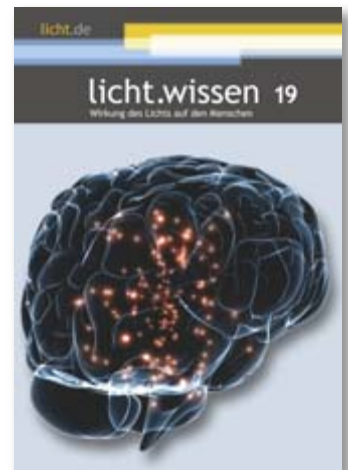
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[licht.wissen 17] 60 pages of information on LEDs. Longevity and efficiency are helping the LED conquer the realm of lighting. Booklet 17 presents up-to-the-minute application examples, explains how LED technology works and looks at the quality features of the light emitting diode.



[licht.wissen 19] 56 pages on the biological impact of light on human beings. Booklet 19 reports on the current state of research and uses real-life examples to explain how melanopic lighting should be approached.

licht.wissen in English – all booklets are available as PDFs, free download at www.licht.de/en

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All about light!

Impartial information

licht.de provides information on the advantages of good lighting and offers a great deal of material on every aspect of artificial lighting and its correct usage. The information is impartial and based on current DIN standards and VDE stipulations.

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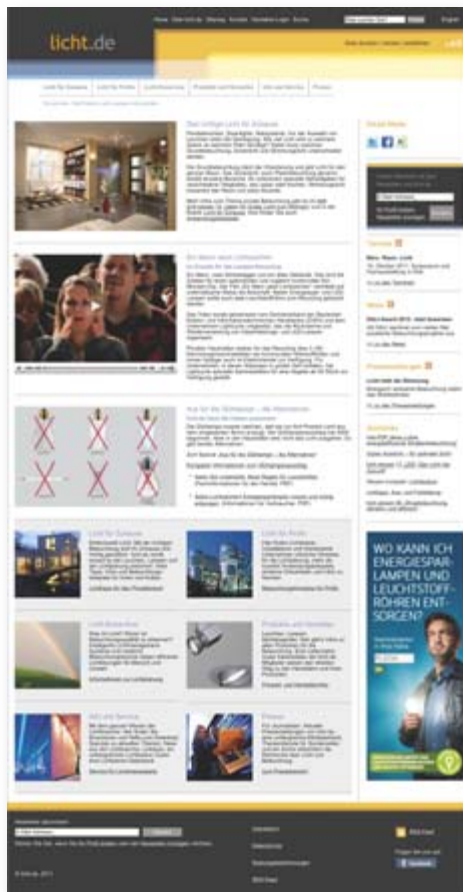
The booklets 1 to 20 of the licht.wissen series provide information on the use of lighting. Themed and packed with practical examples, they explain the basics of lighting technology and present exemplary solutions. They thus facilitate cooperation with lighting and electrical specialists. The lighting information contained in all of these booklets is of a general nature.


licht.forum


licht.forum is a compact specialist periodical focusing on topical lighting issues and trends. It is published at irregular intervals.

www.licht.de

The industry initiative also presents its knowledge of lighting on the Internet. At www.licht.de, architects, designers, lighting engineers and end consumers have access to around 5,000 pages of practical tips, details of a host of lighting applications and up-to-the-minute information on light and lighting. An extensive database of product overviews provides a direct link to manufacturers.



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		43
44	45	46
47	48	49

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Refurbishment in Trade,
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