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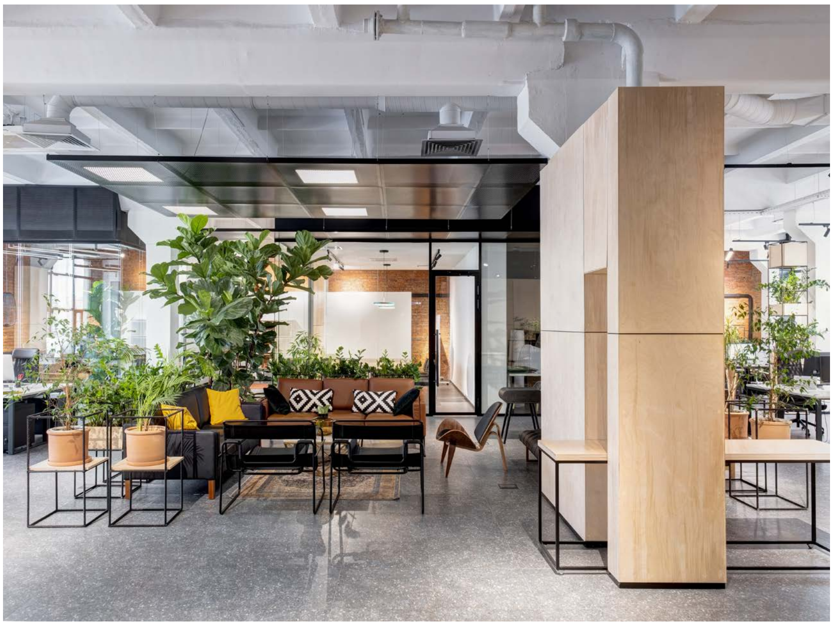

Creating Brighter Spaces with the new Indoor Lighting Standard EN-12464-1

A **HELVAR** WHITEPAPER

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the new lighting standard EN-12464-1

The EN-12464-1 lighting standard specifies lighting requirements for people in indoor workplaces.

It covers all indoor working areas including but not limited to offices, industry, healthcare, retail, restaurants, hotels, museums, libraries, schools, and car parks. You could say it is easier to mention what it doesn't cover — outdoor working areas, underground mining or emergency lighting.

This Standard replaces the previous 2011 version. **The main changes include:**

— The recommendations provided in the tables account for user needs more so than in the past

— The impact of visual and non-image forming effects of light are elaborated

— Requirements for walls, ceilings and cylindrical illuminances are moved to tables

— More advises on applying the requirements when designing lighting

—The new informative Annex clarifies glare requirements

— Flicker and stroboscopic effect are updated

Arguably, the most crucial change in the Standard was changing the structure so that more information is added to the tables. Previously, many users have solely focused on the minimum requirements in the tables, missing key details in the Standard, resulting in bad design and bad lighting. Or at least not as good lighting that the previous Standard was requesting. Although the tables now have more information, it is still important to note that the central part of the Standard are the chapters before the tables.

This whitepaper looks at the Standard through lighting control glasses. To understand the bigger picture, every designer must read the entire Standard.

Ēm and maintenance factor

Before we dive deeper into the Standard, it's worth explaining a significant term mentioned throughout the Standard — Maintained illuminance.

Maintained illuminance is illuminance at the time when maintenance is expected to take place. It should be achievable even without any daylight, just by artificial lighting. All lighting systems and environments get old and/or dirty, and how much this influences illuminance depends on the lighting system, environment, and especially maintenance.

Ēm refers to the illuminance level and is the value below which the average illuminance on a specified area should not fall. Ēm is the figure that should always be measurable in the specified area. In practice, it means that initial illumination in the new installation needs to be higher. Lighting designers use maintenance factor to take this into account in their design. So, for example: if the required amount is 1000 lux, the initial value could be 1250 lux (maintenance factor 0.8. —1250*0.8=1000) and then on the site, the light sensors can be used to control the lighting in a way that there is 1000 lux.

Another option is to program this constant light output to a led driver. The luminaire then automatically dims up overtime to compensate for lost lumen output resulting from ageing. The Standard defines maintained illuminance on the working area in its surroundings and for ceilings and walls. Maintained semicylinderical illuminance is also defined in the tables. All of these have the same logic; artificial lighting should, at least, be able to always produce this amount of light to the defined areas.

scale of illuminance

In a similar way to the previous 2011 version of the Standard, recommended steps of illuminance are given in the new Standard referring to EN12665: 5 - 7,5 - 10 – 15 - 20 - 30 - 50 - 75 - 100 - 150 - 200 - 300 - 500 - 750 - 1 000 - 1 500 - 2 000 - 3 000 - 5 000 - 7 500 - 10 000. Under certain conditions, designers are recommended to use higher steps. If one or two conditions apply, one step is required, and if more than two conditions apply, then two steps are required.

Mentioned conditions **for increase of maintained illuminance** visual work is critical:

— errors are costly to rectify;

— accuracy, higher productivity or increased concentration is of great importance;

— task details are of unusually small size or low contrast;

— the task is undertaken for an unusually long time;

— the task area or activity area has a low daylight provision;

— the visual capacity of the worker is below normal.

When you think about these conditions, many of them are often very valid. The first two, 'errors are costly to rectify', and 'accuracy, higher productivity or increased concentration is of great importance and are valid in several working areas.

The cost of lighting is around 0.01% of the total cost of work. Lighting related devices, installation, and maintenance are quite small compared to the cost of space, training, and salaries. We could even say that errors are always more costly to rectify than increasing light level if that influences the error rate.

Arguably, the rarest condition is the middle one; 'task details are of unusually small size or low contrast'. The last three conditions require future knowledge.

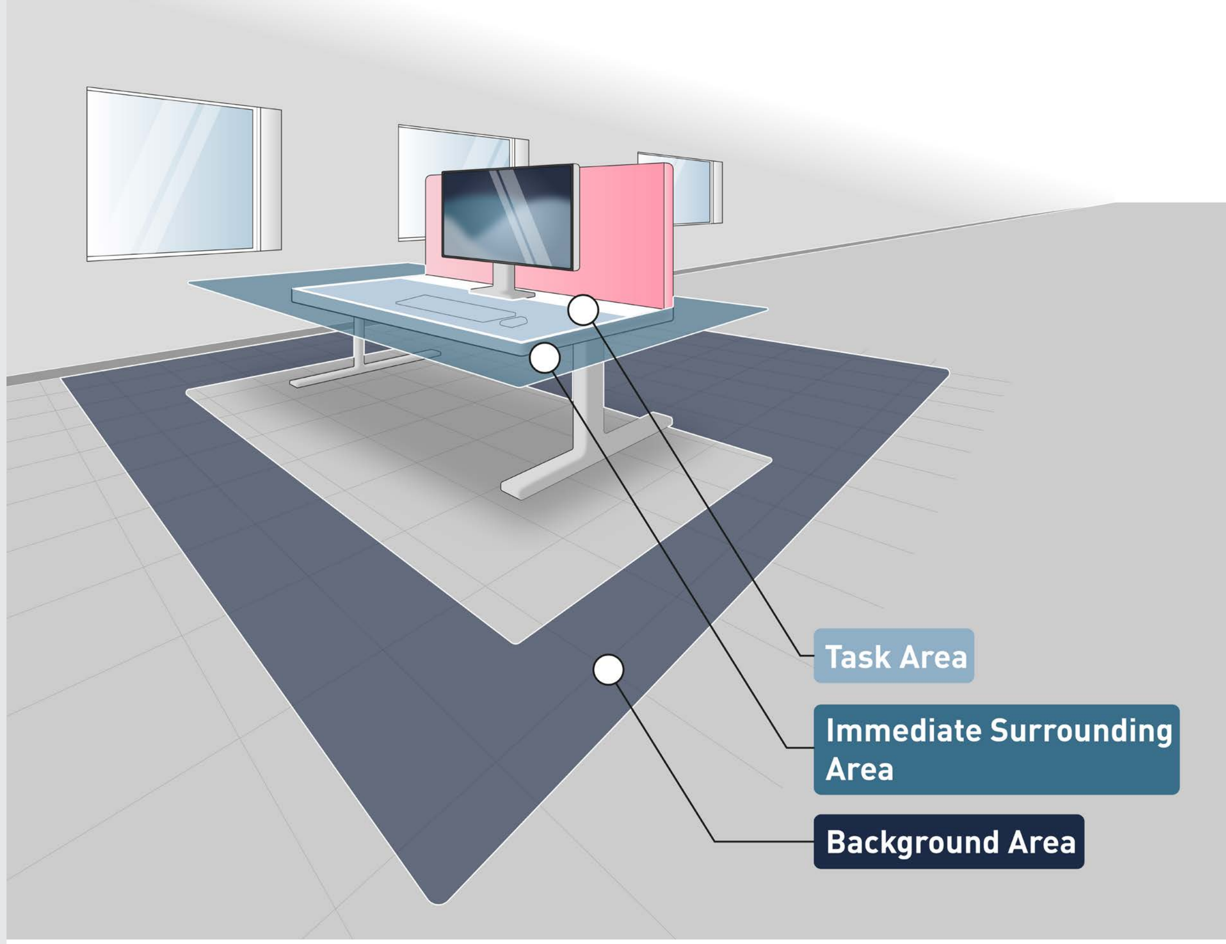
A designer should know how long people are working and their visual capacity. They might know the plan initially; however, it is difficult to know what happens after a short period.

The condition: 'the task is undertaken for an unusually long time' is often valid, although we would instruct workers to take regular breaks. 'The task area or activity area has a low daylight provision' is often true and is deeper in the rooms and work, which is completed outside of daylight hours. For certain tasks and parts of the globe, this is quite normal.

The remaining condition: 'the visual capacity of the worker is below normal' might be the most difficult to neglect if, at the design phase, the workers are unknown. So, in practice, most of these conditions are valid in most projects, meaning that two steps of higher illuminances are recommended to be available for users in working areas.

The Standard also allows the use of a one-step lower illuminance under certain conditions: 'task details are of an unusually large size or high contrast, or the task is undertaken for an unusually short time'. These options are possible from time to time.

task area, immediate surrounding area and background area



Relationship of illuminances on immediate surrounding to the illuminance on the task area or activity area

Illuminance on the task area or activity area $\bar{E}m$ lx	Illuminance on immediate surrounding areas lx
≥ 750	500
500	300
300	200
200	150
≥ 150	*equal to task area*

The Standard refers to the task area, immediate surrounding area and background area. Most of the focus has always been around the task area — the area where the task is and often not the horizontal layer.

Close to that is the immediate surrounding area. It is at least a 0.5m area around the task area and its illuminance relates to the task area illuminance. If the task area has 750 lx or more, the immediate surrounding area should have at least 500 lx.

The background area is a horizontal area on the floor level. It is adjacent to the immediate surrounding area within the limits of space and should be illuminated with a maintained illuminance of 1/3 of the value of the immediate surrounding area. For larger rooms, the band should be at least 3m wide.

52 tables

Towards the end, the Standard provides several tables. It is essential to read the entire Standard and not focus solely on the tables. Below is part of an example of arguably one of the most commonly referred tables - Offices. For specifiers, looking at this one table is not enough. There are always other areas than those mentioned in the table in every office. For example, Table - Traffic zones inside buildings and Table - General areas inside buildings: rest, sanitation and first aid room. These two tables are also relevant in almost every office.

Type of task/activity area	$\bar{E}_m$ lx **required**[a]	$\bar{E}_m$ lx **modified**[b]	**U_o**	**R_a**	**R_{UGL}**	$\bar{E}_{m,z}$ lx ($U_o \geq 0{,}10$)	$\bar{E}_{m,wall}$ lx ($U_o \geq 0{,}10$)	$\bar{E}_{m,ceiling}$ lx ($U_o \geq 0{,}10$)	**Specific requirements**
Writing, typing, reading, data processing	500	1000	0,60	80	19	150	150	100	DSE-work, see 5.9 room brightness, see 6.7 and Annex B Lighting should be controllable, see 6.2.4 For smaller cellular offices the wall requirement applies to the front wall. For other walls a lower requirement of minimum 75 lx could be accepted.
Technical drawing	750	1500	0,70	80	16	150	150	100	DSE-work, see 5.9 room brightness, see 6.7
CAD workstations	500	1000	0,60	80	19	150	150	100	DSE-work, see 5.9
Conference and meeting rooms	500	1000	0,60	80	19	150	150	100	Lighting should be controllable, see 6.2.4
Conference table	500	1000	0,60	80	19	150	150	100	Lighting should be controllable, see 6.2.4

As previously mentioned, there are more recommendations provided in the tables than in the past. The most significant change is the addition of the column 'modified' to the tables. This forces specifiers to think: what is the illuminance level needed? In earlier versions, this was only explained in the text and not shown in the tables, which resulted in a misuse of the Standard.

Two further significant additions to the tables are: 'Maintained values of cylindrical illuminance' and 'illuminance on the ceiling and walls'. These were also only mentioned in the text and not shown in the tables. The values of these two have also been increased which may influence lighting design considerably.

If you're a lighting designer, here's a small exercise for you to check with your old designs done by Dialux or Relux. If you have carried out a design aiming 500 lux to a task area just by using direct lighting – look at the values at the ceilings. It is not easy to reach 100 lux at the ceiling using only direct lighting and only "required" column values.

The Standard provides a strong recommendation: "This standard recommends the use of the higher maintained illuminance $\bar{E}_m$' to give the user the full use of the lit environment. Designing a basic lighting installation only fulfilling the minimum criteria limits the possible benefits of good lighting quality." By increasing, for example, the illuminance at the ceiling; it is very challenging even to try not to use higher lighting levels also on the task area.

lighting control

The last column in the tables in the new Standard includes 'specific requirements'. Several areas note that "lighting should be controllable". To fully understand this topic, it is crucial to read chapters 6.2.4 and 6.6, where more instructions are provided, and the reasoning explained.

The Standard states that "lighting should be adjustable to the actual user needs". This opens the idea of lighting being able to be tailored to individual needs. Personal lighting provides the opportunity to tune the light settings on your very own desk according to your needs, allowing you to manage the light settings you prefer. This can boost satisfaction and productivity since we all feel better in environments that are tuned to our own needs.

If you are unaware of who the users are, it is practical to design and install good quality light for different users and different circumstances.

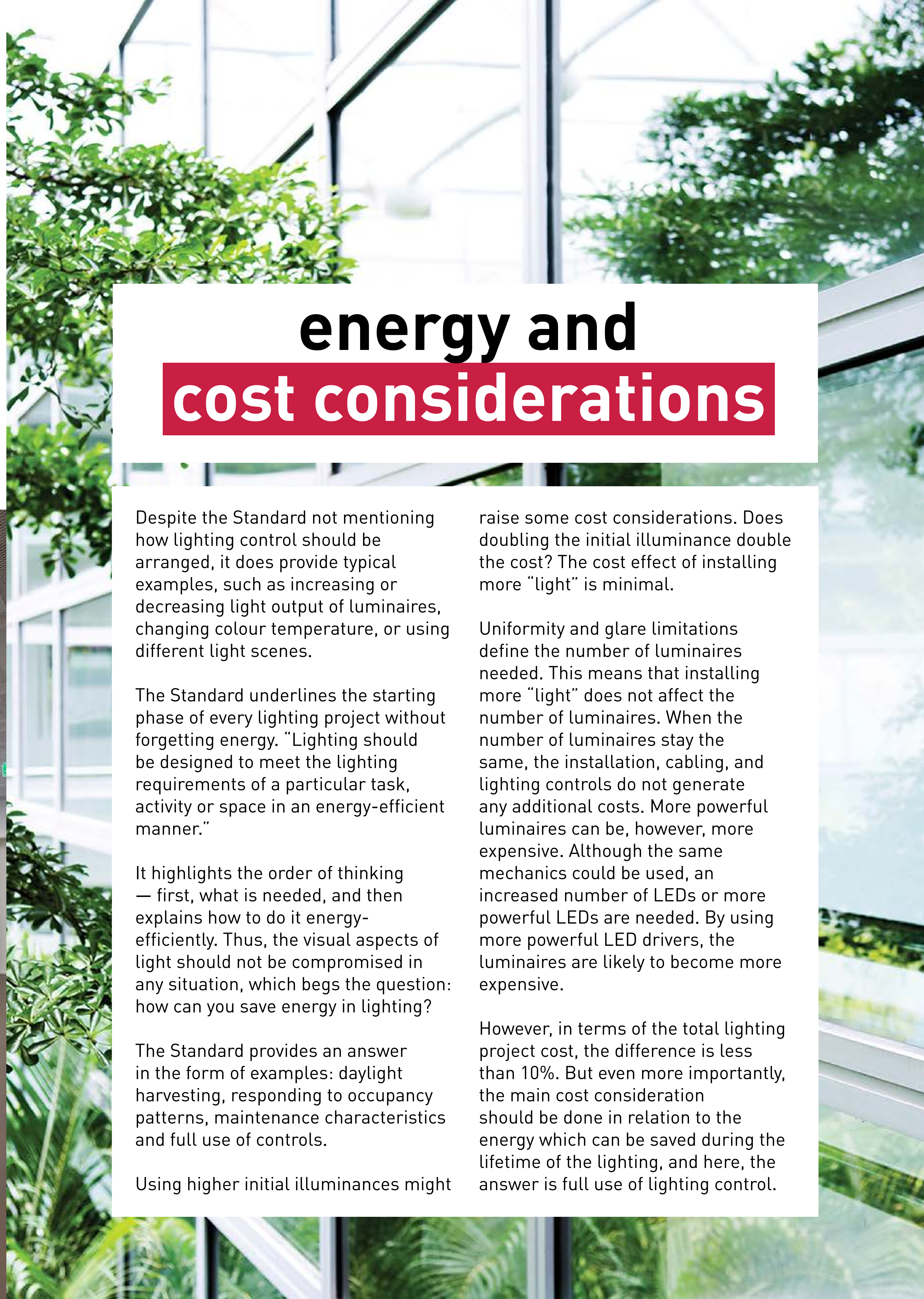
The Standard lists this in the form that an adjustable system ensures that:

—The benefit of available daylight is maximised
—Occupancy of the space can be taken into account
—Changes in visual tasks can be catered for
—Changes of occupant's preferences or needs can be catered for

The overall focus of the Standard is on the visual aspects of lighting. It does, however, discuss the influences of light on health and wellbeing. It repeats the known effects of light on one's mood, emotion, mental alertness, and circadian rhythms.

Varying illuminances and varying colour temperature or spectrum per time and season can enhance people's wellbeing. The new Standard, however, does not give exact information on how this variability should be done. Instead, it refers to CEN/TR 16791 and CIE S 026 and highlights general information about non-image forming effects in the informative annex (B.5).

Arguably, the most interesting variability of light-related specific requirements to note is: "variability of light is important in spaces that are occupied for extended periods." Examples of these types of areas include classrooms, healthcare, offices, and production spaces — pretty much covering a large variety of spaces; you could say the variability of light is essential almost everywhere.



energy and cost considerations

Despite the Standard not mentioning how lighting control should be arranged, it does provide typical examples, such as increasing or decreasing light output of luminaires, changing colour temperature, or using different light scenes.

The Standard underlines the starting phase of every lighting project without forgetting energy. "Lighting should be designed to meet the lighting requirements of a particular task, activity or space in an energy-efficient manner."

It highlights the order of thinking — first, what is needed, and then explains how to do it energy-efficiently. Thus, the visual aspects of light should not be compromised in any situation, which begs the question: how can you save energy in lighting?

The Standard provides an answer in the form of examples: daylight harvesting, responding to occupancy patterns, maintenance characteristics and full use of controls.

Using higher initial illuminances might raise some cost considerations. Does doubling the initial illuminance double the cost? The cost effect of installing more "light" is minimal.

Uniformity and glare limitations define the number of luminaires needed. This means that installing more "light" does not affect the number of luminaires. When the number of luminaires stay the same, the installation, cabling, and lighting controls do not generate any additional costs. More powerful luminaires can be, however, more expensive. Although the same mechanics could be used, an increased number of LEDs or more powerful LEDs are needed. By using more powerful LED drivers, the luminaires are likely to become more expensive.

However, in terms of the total lighting project cost, the difference is less than 10%. But even more importantly, the main cost consideration should be done in relation to the energy which can be saved during the lifetime of the lighting, and here, the answer is full use of lighting control.

full use of lighting control

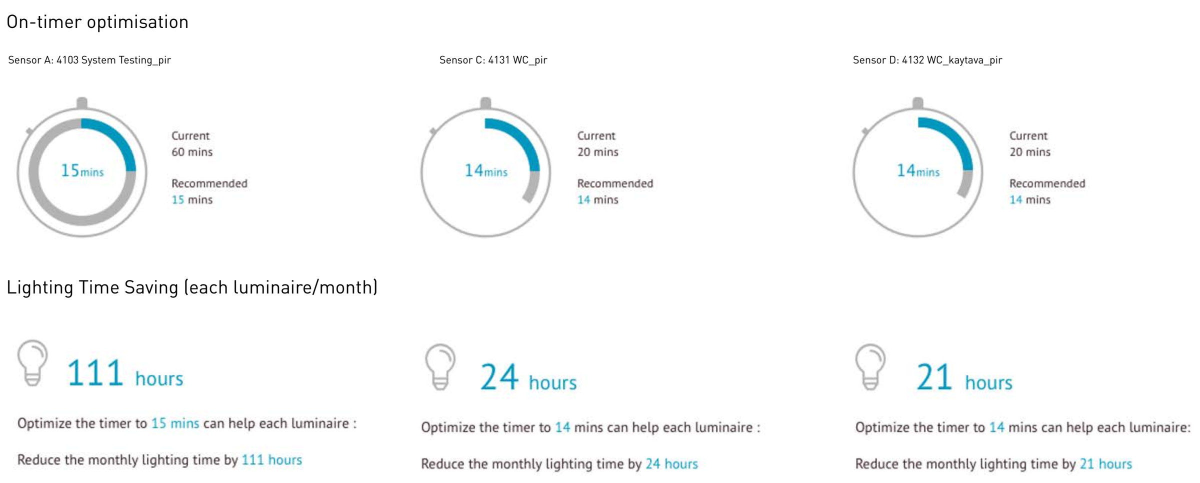
But what exactly does 'full use of lighting control' actually mean?

Traditionally, we might have thought of adding occupancy sensing and light sensors as they help keep light 'on' only when needed at the planned level. Nowadays, however, we have the opportunity to add more intelligence to lighting control.

By smartly using sensor data, we can take a step towards full use of lighting control. Intelligence, such as self-learning capabilities, would boost functionality and future flexibility further. The next level of lighting control would mean enhancing lighting data, for example, at cloud platform, and tuning levels and parameters based on data.

The picture below shows a movement detector optimisation report. This is created by analysing sensor data in the cloud platform to detect if the system's fade times are optimised from an energy-efficiency and wellbeing perspective. This is just one practical example of using more intelligence to make spaces brighter.

Implementing report recommendations can be done manually; however, a more intelligent way might be to let AI tune lighting parameters continuously or periodically.



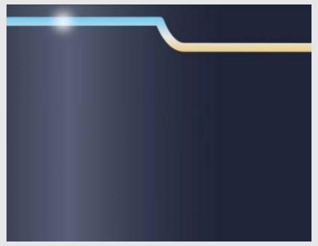
Helvar Light over Time®

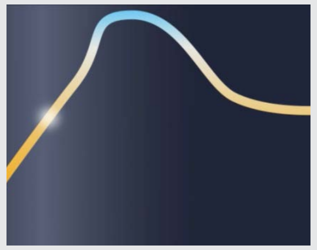
Helvar's lighting profile creation and implementation tool, designed to balance the artificial lighting in our daily environment and provide a more natural lighting cycle.

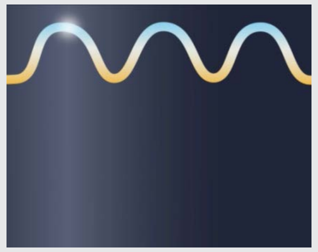
In the direct context of EN-12464-1, this could be used in a way that the required higher lighting level would be used during working hours and beyond that time when occupancy and lighting levels would be according to the required minimum.

Click here to read more about **Light over Time**

Watch the video


WELLBEING


NATURAL

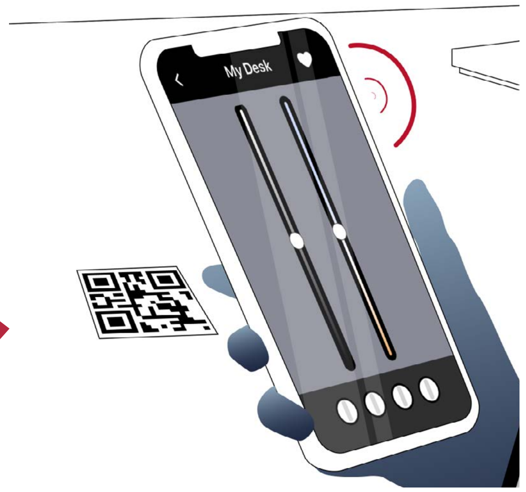

ALERTNESS

As stated in the Standard, lighting should be controllable according to user needs. The traditional way has been to use different kinds of user interface panels. They can be wireless, self-powered devices that are positioned in the most suitable location.

This whitepaper is written during the covid-19 era where touching panels is not so favourable. In these circumstances, the ability to personally control the lighting can be beneficial. Personal control can be done via mobile phones.

ActiveTune is just one example. Once you have scanned the QR code on the desk, the user will have control over the lighting in that area.

This is just one intelligent lighting solution option for lighting design according to the new Standard requirements. However, the Standard does not define "how", so it is important to remember that a designer has a lot of freedom to use their imagination.



is there room left for direct lighting?

It's still possible to use only ceiling-mounted luminaires aiming for uniform lighting in an area. Luminaires can illuminate task areas, immediate surroundings, and background areas evenly. This type of installation is a perfect choice, primarily when task areas are not known well enough in advance. It also provides flexibility should changes be needed in the future.

Despite this, this general solution is not without its problems. For example, suppose there are shadowing objects, such as the separation wall in the picture below. In that case, the installation density needs to be enough, or the location needs to be well planned to avoid shadows from objects or users of the task area.

With direct lighting, the most critical lighting parameter might be ceiling illuminance. Ceiling based area sensors can measure this value. They fit this role better than their traditional role, where they are used to evaluate how much light is at the task area below.

In practice, this type of lighting control could work in a way that the lighting on the ceiling is always kept at 100lux, and the lighting below, at task area, can be, for example, 600lux to 1000lux. Occupancy can be detected by area sensors controlling several luminaires. Alternatively, another option could be to locate sensors to every luminaire. This would improve measurements density leading to more exact lighting levels and more significant energy savings.

flexibility of location and direction

One option for lighting installation in a room is to use direct or indirect illuminance. If both directions are controlled in the same way, the solution is quite similar to the previous ceiling illuminance example.

Controlling indirect lighting and direct separately could provide exciting benefits. For example, indirect lighting could be 'on' when part of the space is occupied. This would take care of suitable ceiling illuminance, well illuminance, and background illuminance in the whole space.

Direct lighting could be used for task area and immediate surrounding area lighting. This is possible to do with area sensors by grouping luminaires in the correct way. It is essential to note that luminaires need two addresses to make this work well.

If there is enough indirect lighting, task area illuminance can be reached at the required level. This model could work so that the whole room's indirect lighting is at the level that fulfils the ceiling, wall and background illuminance requirements.

Occupancy sensors boost indirect lighting to a level where "minimum" task illuminance is achieved. Direct lighting is then manually put on by users that need higher illuminance levels.

Direct and indirect solutions provide alternatives to a different use of sensors. Area sensors could control indirect lighting in the whole room or around the task area. Luminaire-based sensors could tune direct lighting depending on the specific task area.

One option could be to use direct or indirect general lighting in a room and add freestanding luminaires as and where required.

With all of these solutions, it is essential to consider the whole lighting experience. The controlling system should offer a seamless experience so that you don't recognise that it is working. Pretty clever stuff, right?

To get full use of lighting control, you should always consider connecting the system to a centralised intelligence, such as a cloud platform, which provides the scalability and flexibility needed in the future.

our closing remarks

When considering the new Standard, it's essential to put the needs of end-users at the heart when designing future-proof lighting.

It is often the case that the requirements of end-users are unknown since the end-users themselves are unknown. Light should be tuned according to users' needs, and lighting control already offers excellent tools.

The Standard strongly advises building variability and adjustability to lighting. Using only the minimum in the tables goes against the Standard. If any of the conditions mentioned in the Standard exist, you are recommended to use higher maintained levels.

Many of these conditions, such as: "accuracy, higher productivity or increased concentration is of great importance", "the task is undertaken for an unusually long time"," the task area or activity area has a low daylight provision" and "the visual capacity of the worker is below normal", exist very often.

The future-proofness of installation will increase with higher available illuminance, and then building lighting control strategies beyond energy-savings are possible.