

**TRILUX**  
SIMPLIFY YOUR LIGHT.

RETROFIT

WHITE PAPER





Over approximately the past ten years, LED luminaires have become increasingly established in the market. LED technology, after initially having great momentum, is now approaching a target level as it continues to develop. This also applies to LED retrofit lamps, which are available on the market for lamp replacements and for operating in existing luminaires. These are available in particular as a substitute for fluorescent lamps, which, on the basis of the supplementary directives to the European RoHS Directive, may incrementally no longer be placed on the market from March 2023. Based on these facts, this white paper intends to take stock of the current situation with regard to the possible replacement of existing light sources.

Improved product characteristics have become possible for LED retrofit lamps, just as they have for LED luminaires. However, lighting requirements according to the current state of the art (see below) as well as a generally satisfactory quality of light can hardly be achieved with conversions to LED retrofit lamps, even if, compared to previous operation with fluorescent lamps, the maintenance of illuminance is, in some cases, approximately possible.

Another aspect is that retrofit lamps are available in very large numbers and in very different qualities (see Table 1) and each with specific suitability for different technical framework conditions (e.g. HF operation, see below). This is also true within the respective ranges of established lamp manufacturers, making appropriate selection difficult and confusing.

When deciding whether to replace lamps with LED retrofit lamps or whether it is preferable to replace luminaires with new LED luminaires, the following points should be considered.

- When converting existing luminaires from operation with fluorescent lamps to operation with LED lamps, a fundamental distinction must be made between retrofit lamps and conversion lamps.
  - If an intervention in the electrical structure of the luminaire (e.g. deactivation of the control gear unit) has to be performed to operate the lamp, it is a conversion lamp.
  - If it is only necessary to replace the lamp with the LED lamp and the lamp starter with a replacement device suitable for that lamp, it is a retrofit lamp.
- Converting the luminaire to operate a conversion lamp voids the warranty and product liability of the luminaire manufacturer and transfers them to the person converting the luminaire.
- When LED retrofit lamps are used in luminaires for fluorescent lamps, the warranty and product liability of the luminaire manufacturer expire. This also applies if the LED retrofit lamps to be fitted have a VDE designation.
- Product liability is thereby transferred to the manufacturer of the retrofit lamp.
- The VDE mark on the retrofit lamp indicates that this retrofit lamp has been tested by the VDE in accordance with the European standard DIN EN 62776:2015-12 (VDE 0715-16:2015-12) and that there is no immediate danger from it<sup>1</sup>.
- For the operation of LED retrofit lamps on ECGs for fluorescent lamps (HF operation), it should be noted that a recommendation for their operation is only given for the ECG types listed in a compatibility list of the lamp manufacturer – with reservation. It must therefore at least be ensured that all luminaires in the lighting system contain ECGs<sup>2</sup> specified in the list (see also Fig. 1).
- For dimmable luminaires, conversion to LED retrofit lamps is generally only possible in special cases and in compliance with any restrictions specified in the ECG compatibility list.
- When operating LED retrofit lamps in parallel-compensated luminaires, a very small power factor  $\lambda$  of the circuit can occur and cause a high idle current in the electrical installation (see also Fig. 2 and <https://www.trilux.com/de/beleuchtungspraxis/leuchten/betrieb-von-leuchten-fuer-entladungslampen/blindleistungskompensation/>).
- For tandem circuits (two fluorescent lamps connected in series to one control gear unit), as is common in existing multi-lamp luminaires with 18 watt T8 lamps, the possible operation of LED retrofit lamps must be checked separately. In some cases, conversion of the luminaire may be required (see above).
- When used in chemically contaminated atmospheres, specific incompatibilities may lead to damage and failure of the LED retrofit lamps. Interactions with components of the luminaire can also lead to damage to the luminaire.
- In special applications (e.g. high temperatures, mechanical stress due to vibrations), large deviations from the normal operating behaviour of LED retrofit lamps, and also compared to the operation of fluorescent lamps, are possible.

<sup>1</sup> This standard refers exclusively to retrofit lamps for direct replacement and not to conversion lamps, the operation of which requires intervention into the electrical structure of the luminaire. No VDE mark is issued for conversion lamps.

<sup>2</sup> Note from OSRAM's ECG compatibility list: "OSRAM SUBSTITUBE® LED TUBES"

Important note: This document is for informational purposes and must be treated as a recommendation. The compatibility list is based on tests performed by LEDVANCE in a laboratory simulated environment. Results may vary in certain field applications due to different factors. LEDVANCE does not assume any responsibility, guarantee or liability that these results can be achieved by using the equipment under different conditions or by using successor models of the tested equipment or different models of the same manufacturer. Failure to follow the instructions may result in safety hazards with the LED tube SubstiTUBE® or the HF (ECG) control gear unit, e.g. flickering, no light, overheating, premature aging, failure of equipment etc... The luminous flux may change depending on the control gear unit used. ..."

- LED retrofit lamps usually have low colour consistency. Typically, a value for colour tolerance (initial MacAdam) of  $\leq 6$  SDCM is specified by the well-known manufacturers. In some cases of higher efficiency products, a value  $\leq 5$  SDCM is given. Even at 5 SDCM, colour deviations are clearly detectable.
- For LED retrofit lamps, usually no or very "generous" specifications for failure rates are given (e.g. max. 10 % failure within 6,000 h).
- LED retrofit lamps often have a significantly lower luminous flux than T8 fluorescent lamps of the same length. Direct replacement then leads to a significant reduction of illuminance in the room. The lighting no longer complies with standards and occupational safety regulations are no longer met, unless the retrofit lamp is selected with great care.
- The maximum luminous flux of LED retrofit lamps available on the market are also generally tightly measured (e.g. 3,700 lm to replace 5,000 lm in the case of the T8 58W lamp, see Table 1).
- A distribution characteristic of the LED retrofit lamp that differs from that of the T8 fluorescent lamp may result in reduced uniformity of illuminance in the room. Compliance with occupational safety regulations must also be checked in this regard.
- A distribution characteristic of the LED retrofit lamp deviating from that of the T8 fluorescent lamp leads to considerable deviations of the light distribution in suspended luminaires with an indirect component.
- The expected quality of light can therefore at best be approximated to the previously achieved status. Requirements according to the current state of technology, as described in DIN EN 12464-1 in the current version of 2021, are not achieved. Recommended in particular:
  - The availability, when needed, of one to two levels of increased illuminance, which should be controlled by dimmable luminaires and appropriate light management, and
  - Appropriate luminance distribution with minimum illuminances on walls and ceilings, which is often not achieved in existing systems (e.g. with narrow distribution louvre luminaires or darklight luminaires, see example "Illuminating offices").
- The key figures for luminous efficacy with LED retrofit lamps are given for open distribution operation without considering losses due to operation in a luminaire. These are often relativised when LED retrofit lamps are operated in luminaires for fluorescent lamps (examples 1 and 3). Their useful life can also be significantly shortened due to heating inside the luminaire (example 1).
- The useful life of LED retrofit lamps is usually specified in the market for an  $L_{70}$  degradation (luminous flux decrease of 30% to a residual luminous flux of 70% at the end of the service life). With regard to occupational safety, it must therefore be taken into account that at the end of the service life only 70% of the already lower initial luminous flux is still available. For LED luminaires (luminaires with permanently integrated LEDs) – with qualitative luminaires – the service life for residual luminous fluxes are specified to be at least 80% ( $L_{\geq 80}$ ).
- The change in photometric characteristics of the existing luminaire due to the use of LED retrofit light sources can usually only be roughly estimated. Neither the available luminous flux nor the resulting light distribution is known. A statement about the resulting lighting situation in the room after replacing the lamps is therefore only possible to a very limited extent.
- LED retrofit lamps can exhibit considerable flicker that far exceeds that of a fluorescent lamp in operation on LLCG (see also Figure 3.191 b) at <https://www.trilux.com/de/beleuchtungspraxis/leuchten/betrieb-von-leuchten-fuer-entladungslampen/vorschaltgeraete/induktive-vorschaltgeraete/>).



The examples below illustrate the benefits that can result from a luminaire replacement compared to a lamp replacement with retrofit lamps. Important advantages of replacing the luminaire are that

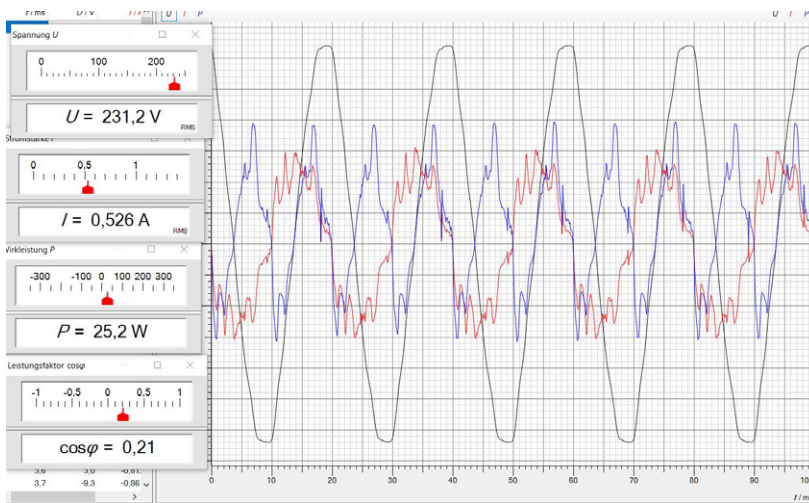
- modern LED luminaires with optimised lighting technology can distribute the light in the specific application in a much more targeted manner than was possible with fluorescent lamp luminaires,
- this makes them particularly energy-efficient,
- they have high colour consistency (color locus tolerance  $\leq 3$  SDCM) due to high quality binning,
- for modern LED luminaires, virtually no failures (failure rate close to zero) are to be expected over their entire service life,
- contemporary requirements for lighting quality can be met,
- photometric data sets are available for these to verify the resulting illumination,
- disturbances of visual comfort due to 100 hertz flicker are avoided by designated low flicker factors,
- the electrotechnical operating data are also known in detail and guaranteed by the luminaire manufacturer – including product liability,
- when replacing lamps with LED retrofits, defective sockets of the existing luminaires may not be able to be replaced, and
- a thus better economic efficiency of the LED luminaires is achieved compared to lamp replacements with LED retrofit lamps (examples 1, 2 and 3).

In particular, an increased, available lighting level with simultaneous possible dimmability, as described in the current EN 12464-1, can be achieved by using LED luminaires in combination with suitable light management. This opens up additional energy-saving potential with increased lighting quality.

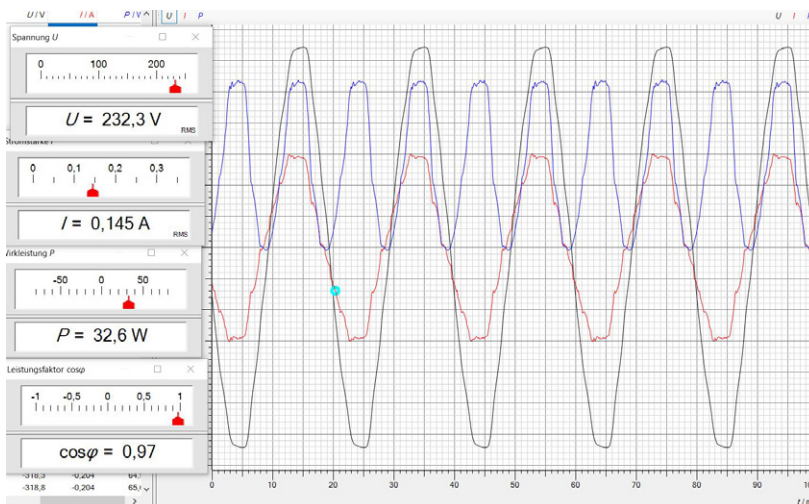
# T8 LED RETROFIT LAMP VS. LED LUMINAIRE

T8	OSRAM SubstiTUBE PRO U0 UN	SubstiTUBE Value	Philips Master	CorePro
18 W 1300 lm	6.7 W 1100 lm (-15 %)	7.3 W 800 lm (- 38 %)	8 W 1050 lm (- 19 %)	8 W 800 lm (- 38 %)
36 W 3200 lm	14.3 W 2500 lm (- 22 %)	16.4 W 1800 lm (- 44 %)	15.5 W 2500 lm (- 22 %)	18 W 2000 lm (- 38 %)
58 W 5000 lm	23 W 3700 lm (- 26 %)	20 W 2200 lm (- 56 %)	23 W 3700 lm (- 26 %)	23 W 2700 lm (- 46 %)

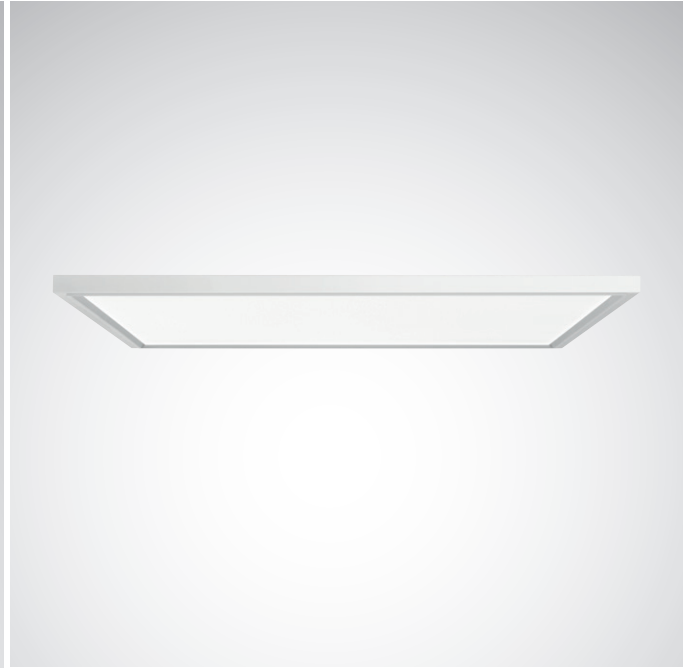
**Table 1:** Examples of T8 LED retrofit tubes: power consumption and luminous flux  
<https://www.ledvance.com/professional/products/lamps/led-tubes-c7009>  
<https://www.lighting.philips.de/produkte/master-ledtubes>



**Fig. 1:** Measurement with LED retrofit lamp 23 W/4000 K 1500 mm in TRILUX luminaire with non-approved ECG. The lamp is operated with increased wattage (32.6 W instead of 23 W).



**Fig. 2:** Measurement with SubstiTUBE T8 UN Pro Ultra Output 23 W/4000 K 1500 mm in a TRILUX weather-proof luminaire (Aragon 158K, date of manufacture approx. 2010) with inductive CG and parallel compensation. A power factor of  $\lambda = 0.21$  leads to a high reactive current and, in a lighting installation with many luminaires, possibly to an excessive line load and the tripping of the circuit-breaker. The VDE certificate for retrofit lamps does not take into account such practical malfunctions, but only evaluates the possible occurrence of a safety risk, which is avoided in a proper installation by the circuit-breaker.



- **1.1 Lighting of a dispatch hall**

- direct replacement of T8 lamp with LED retrofit lamps in a single-lamp weather-proof luminaire.
- 1-to-1 replacement with TRILUX Aragon Fit luminaires

- 

- **1.2 Lighting of a clean production facility**

- direct replacement of T8 batten lamps with LED retrofit lamps
- replacement of E-Line gear trays and T8 lamps with current LED gear trays

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- **1.3 Lighting of an office**

- direct replacement of T8 lamps in a louvre luminaire with LED retrofit lamps
- 1-to-1 luminaire replacement with TRILUX Arimo Fit LED luminaires
- new installations/new design with TRILUX LED luminaires.

Existing installation: 84 weather-proof luminaires, T8 58W, single-lamp

Floor space: 600 m<sup>2</sup>

Requirements: D mark required (areas subject to fire hazards), IP ≥ 50, Ra ≥ 65

#### In comparison:

1. Previous operation of T8 lamps in 1-lamp luminaires of higher protection rating (see planning).
2. Replacement with LED retrofit lamps<sup>3</sup>, exemplified by OSRAM and Philips:
  - OSRAM ... SubstiTUBE PRO U0 UN
  - Philips... MASTER LEDtube VLE 1500 mm U0 24W 840 T8
3. Direct replacement with TRILUX Aragon Fit luminaires

#### to 1: Previous operation with T8 fluorescent lamps

The required illuminance was just achieved.

#### to 2: Replacement with LED retrofit lamps

A comparison of the available luminous flux per luminaire shows that at the end of the lamp service life (maintenance time), the required illuminance in the hall shown cannot be achieved with the LED retrofit lamps.

	Fluorescent lamp	Retrofit lamp
Luminous flux of the lamp (new)	5,200 lm	3,700 lm
Luminaire light output ratio	0.8	< 0.95 <sup>2</sup>
Luminous flux of the luminaire (new)	4,160 lm	3,515 lm
LLMF	0.8	0.7
Available luminous flux of a luminaire at the time of maintenance	4,160 lm · 0.8 = 3,328 lm	3,515 lm · 0.7 = 2,461 lm

With approximately the same light distribution, the retrofit lamp generates an illuminance of

$$\bar{E}_m \leq 309 \text{ lx} \cdot \frac{2,461 \text{ lm}}{3,328 \text{ lm}} = 229 \text{ lx}$$

#### to 3: Direct replacement with TRILUX Aragon Fit luminaires

Luminaires with suitable luminous flux packages and light distributions, e.g. 4,400 lm, wide beam, are available to provide optimised lighting. The luminaires are in a dimmable version (DALI) for operation with a light management system.

<sup>3</sup>Typically 5% optical losses in a weather-proof luminaire





**Planning of interior lighting  
DIN EN 12464-1**

TRILUX-LENZE GmbH + Co KG  
Heidestraße D-59759 Arnsberg  
D-59759 Arnsberg  
Postbox 1960  
D-59753 Arnsberg

<b>Project description</b>	<b>Dispatch hall</b> Dispatch hall with weather-proof luminaires 1x58 W, CCG
<b>Date/processor</b>	19.01.2012 / Ev
<b>Project file</b>	Dispatch hall
<b>Calculation file</b>	Aragon_existing

**Room dimensions**

Length	30.00 m
Width	20.00 m
Height	7.00 m
Height of luminaire level	5.95 m

**Project planning data**

Maintenance factor	0.80
Maintenance value of illuminance	300 lx
Number of calculation points (x/y/z)	14 / 9 / 9

**Mean reflectance**

Ceiling	0.60
Wall 1	0.50
Wall 2	0.50
Wall 3	0.50
Wall 4	0.50
Ground	0.20

**Calculation results**

UGR value	Direction of view from wall			
	1	2	3	4
	24.6	18.9	24.6	18.9
Connected load	5.71 KW			
Specific connected load	9.5 W/m <sup>2</sup> (*) 9.5 W/m <sup>2</sup> (**)			
(electrical rating performance according to DIN V 18599-4)				
Net energy demand	1084 kWh/a(*) 1075 kWh/a(**)			
(*) actual value (**) related to the maintenance value of illuminance (300 lx)				
Utilisation profile according to DIN V 18599-10 (Em modified): Warehouse (technology, archive)				
Reference value according to EnEV 2009: 1239 kWh/a				

**Selected luminaires**

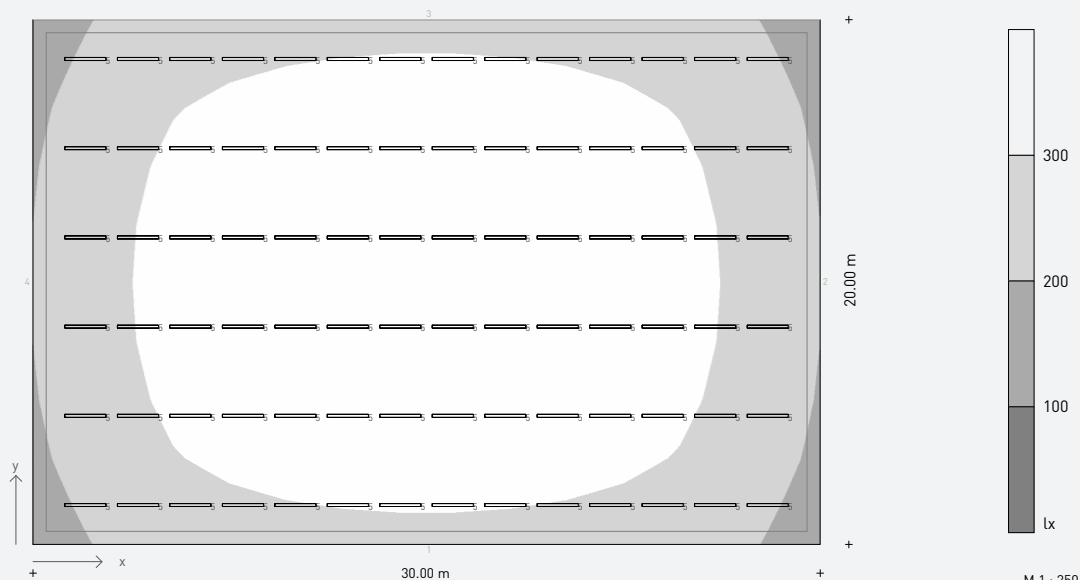
Type	Quantity	Luminaire designation	z*	Configuration	File name
5	84	Aragon 158	5.95 m	1 x 58 W IND G13 (Ø) - 5200 lm	TX3725.ELX

\*z: Suspension height of luminaires above floor (centre of luminaire)

**Calculation results for areas of vision tasks**

1: Area of visual task 1 (Eh)	Area of visual task		Immediate surroundings	
	Em/lx	Emin/Em	Em/lx	Emin/Em
	309	0.65	223	0.67

**Grayscale diagram – total space (h=0.80 m)**



The specified system data form the basis for the photometric calculations. As a result of process-related deviations, differences may arise between planning and execution results in accordance with national and international recommendations.

Existing lighting system with 2-lamp E-Line gear trays with white reflector (see planning)

Requirements: 300 lx, IP20, Ra >80

#### In comparison:

1. Replacement of T8 lamps
2. Replacement with LED retrofit lamps<sup>4</sup>, exemplified by OSRAM and Philips:
  - OSRAM ... SubstiTUBE PRO UO UN
  - Philips ... MASTER LEDtube VLE 1500mm UO 24W 840 T8
3. Direct replacement of old gear trays with TRILUX E-Line LED gear trays

#### to 1: Direct replacement of old gear trays with TRILUX E-Line LED gear trays

The required illuminance was just achieved.

#### to 2: Replacement with LED retrofit lamps

A comparison of the available luminous flux per luminaire shows that at the end of the lamp service life (maintenance time), the required illuminance in the production hall shown cannot be achieved with the LED retrofit lamps.

	Fluorescent lamp	Retrofit lamp
Luminous flux of the lamp (new)	2 · 5,000 lm	2 · 3,700 lm
Luminaire light output ratio	0.72	< 0.90 <sup>2</sup>
Luminous flux of the luminaire (new)	7,200 lm	≤ 6,660 lm
LLMF	0.8	0.7
Available luminous flux of a luminaire at the time of maintenance	7,200 lm · 0.8 = 5,760 lm	6,600 lm · 0.7 = 4,662 lm

With approximately the same light distribution, the retrofit lamp generates an illuminance of

$$\bar{E}_m \leq 340 \text{ lx} \cdot \frac{4,662 \text{ lm}}{5,760 \text{ lm}} = 275 \text{ lx}$$

The normative lighting requirements that applied at the time of setting up the lighting system may therefore no longer be attainable.

#### to 3: Direct replacement with TRILUX E-Line gear trays

Gear trays with suitable luminous flux packages and light distributions, e.g. 8,000 lm, wide beam, are available to provide standard-compliant lighting.

The gear trays are also available in dimmable (DALI) and Active (DALI DT8 with variable colour temperature) versions to enable energy-saving operation with a light management system. The recommendations of current standards and regulations, e.g. the European lighting standard DIN EN 12464-1 of 2021, can thus be additionally taken into account.

#### Cost efficiency

A comparison of the economic efficiency cannot be made in the specific example considered here, since the use of retrofit lamps does not lead to a permissible solution of the lighting task.

However, to make a hypothetical comparison, a situation can be assumed in which the available luminous flux of the retrofit lamps should be sufficient. In that case, an E-Line gear tray with a net luminous flux of 6,500 lm can be considered at least equivalent. The comparative calculation below shows that the use of new gear trays, in addition to all the technical advantages listed above, also has a financial savings potential at least identical to that of replacement with retrofit lamps.

<sup>4</sup> Typically 10% optical losses in a louvre luminaire



**Planning of interior lighting  
DIN EN 12464-1**

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Heidestraße D-59759 Arnsberg  
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**Project description** Retrofit in industrial space  
Existing system, E-Line T8

**Date/processor** 19.01.2012 / Ev

**Project file** Retrofit in industrial space

**Calculation file** E\_Line\_existing\_IP20

**Room dimensions**

Length 30.00 m  
Width 20.00 m  
Height 7.00 m  
Height of luminaire level 6.94 m

**Project planning data**

Maintenance factor 0.80  
Maintenance value of illuminance 300 lx  
Number of calculation points (x/y/z) 14 / 9 / 9

**Mean reflectance**

Ceiling 0.60  
Wall 1 0.50  
Wall 2 0.50  
Wall 3 0.50  
Wall 4 0.50  
Ground 0.20

**Calculation results**

UGR value Direction of view from wall  
1 2 3 4  
23.2 23.9 23.2 23.9

Connected load 3.96 KW  
Specific connected load 6.6 W/m<sup>2</sup> (') 6.0 W/m<sup>2</sup> (")  
(electrical rating performance according to DIN V 18599-4)

Net energy demand 8910 kWh/a(') 8063 kWh/a('")  
(') actual value (") related to the maintenance value of illuminance (300 lx)

Utilisation profile according to DIN V 18599-10 (Em modified):  
Warehouse (technology, archive)

Reference value according to EnEV 2009: 15328 kWh/a

**Selected luminaires**

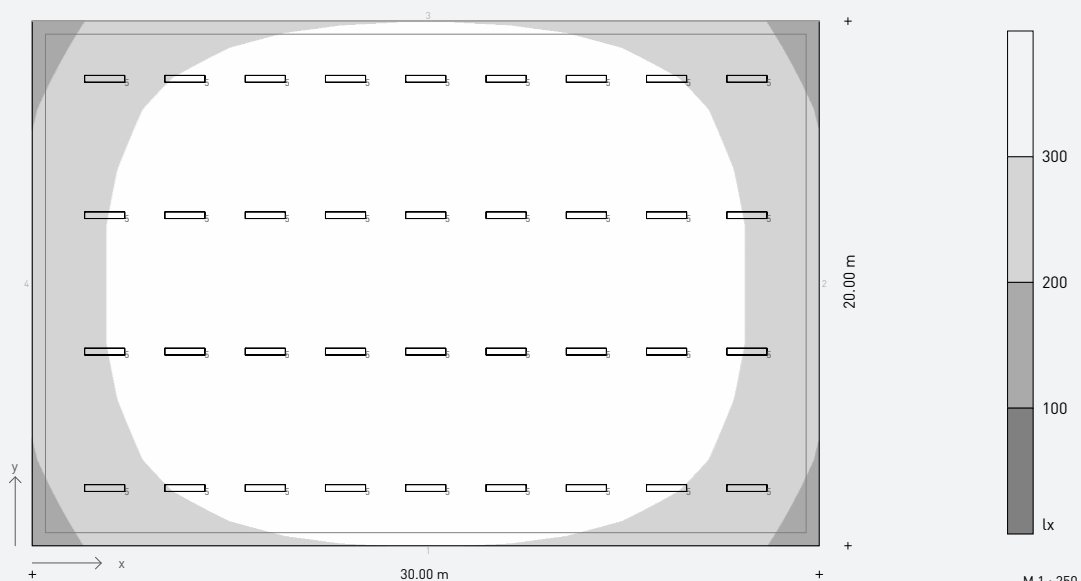
Type	Quantity	Luminaire designation	z*	Configuration	File name
5	36	E-Line T8 R 2x58W	6.94 m	2 x 58 W ED G13 - 10000 lm	TX007761.ELX

\*z: Suspension height of luminaires above floor (centre of luminaire)

**Calculation results for areas of vision tasks**

1: Area of visual task 1 (Eh)	Area of visual task		Immediate surroundings	
	Em/lx	Emin/Em	Em/lx	Emin/Em
	340	0.63	238	0.65



**Grayscale diagram – total space (h=0.80 m)**



The specified system data form the basis for the photometric calculations. As a result of process-related deviations, differences may arise between planning and execution results in accordance with national and international recommendations.

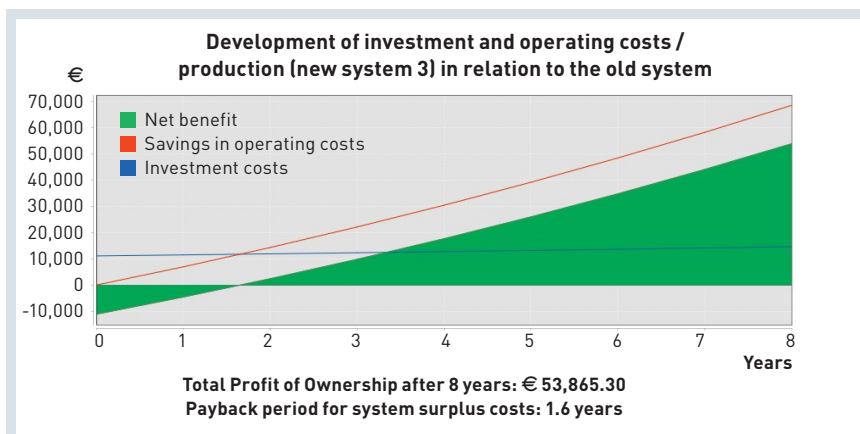
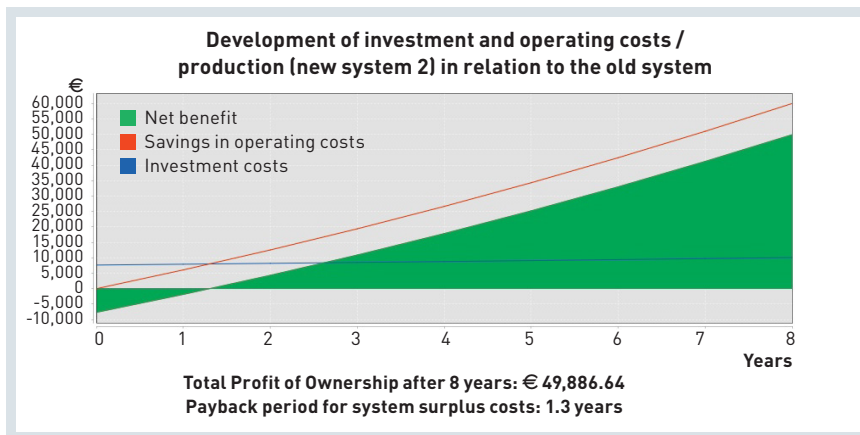
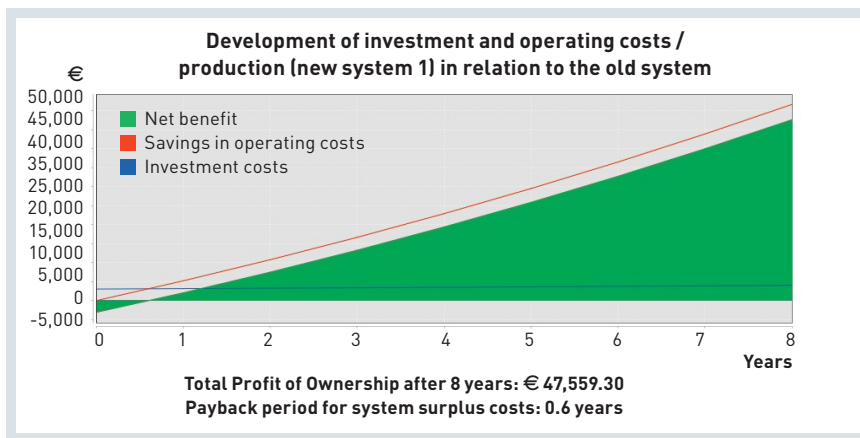
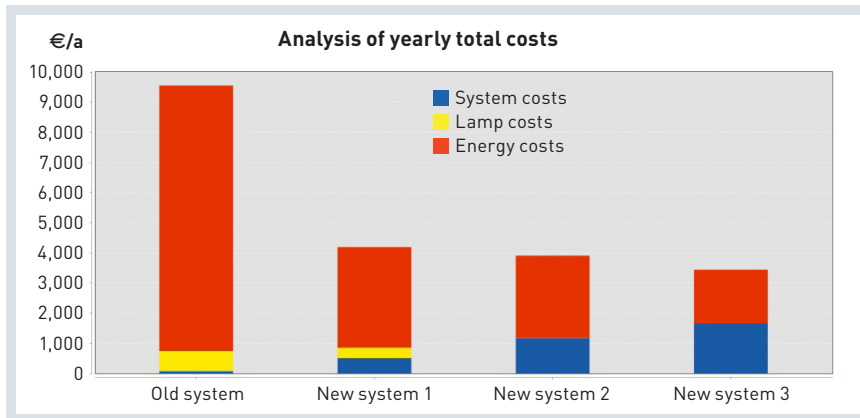
## Production

## Calculation

Luminaire selection					
System		Old system	New system 1	New system 2	New system 3
Figure					
Luminaire reference		E-Line T8 RW 2x58W	Retrofit Pro	7650B LED6500-840 ET	7650B LED6500-840 ETDD
System and usage data					
Number of luminaires according to photometric calculation	Pcs.	36	72	36	36
Lamp type		T8	LED	LED	LED
Rated lamp power	W	58	0		
Number of lamps per luminaire	Pcs.	2	1	1	1
Type of control gear unit		LLCG	ET	ET	ETDD
Number of operating hours (daily)	Hrs.	24.00	24.00	24.00	24.00
Number of operating days (per year)	Days	345	345	345	345
Number of operating hours (per year)	Hrs./a	8,280	8,280	8,280	8,280
Expected useful life of the system	Years	8	8	8	8
System costs					
Price of a luminaire	€	0.00	25.00	203.00	247.30
Price for light management	€	0.00	0.00	0.00	1,600.00
Costs for mounting and connecting a luminaire	€	0.00	25.00	25.00	25.00
Installation costs of light management system	€	0.00	0.00	0.00	250.00
Repair costs of existing luminaire	€	15.00	0.00	0.00	0.00
Total investment	€	<b>540.00</b>	<b>3,600.00</b>	<b>8,208.00</b>	<b>11,652.80</b>
Luminaire costs + costs of light management					
Percentage of annual linear depreciation	%/a	12.50	12.50	12.50	12.50
Interest rate of capital used (service of debt)	%/a	3.5	3.5	3.5	3.5
Σ Annual system costs (useful life)	€/a	<b>76.95</b>	<b>513.00</b>	<b>1,169.64</b>	<b>1,660.52</b>
	%	<b>100%</b>	<b>667%</b>	<b>1,520%</b>	<b>2,158%</b>
Lamp and maintenance costs					
Total number of lamps	Pcs.	72	72	36	36
Price of a lamp	€	3.00	12.50	0.00	0.00
Relamping costs per luminaire	€	15.00	25.00	8.00	0.00
Price of a starter	€	0.00	0.00	0.00	0.00
Lamp service life	Hrs.	11,000	50,000	70,000	70,000
12B10 service life (12 hour switching rhythm / 10% failure rate), after termination of which complete replacement of all lamps should be implemented					
Lamp in scope of supply		No	Yes	Yes	Yes
Number of changes during service life		7	1	0	0
Σ Mean lamp/maintenance costs per year	€/a	<b>661.50</b>	<b>337.50</b>	<b>0.00</b>	<b>0.00</b>
	%	<b>100%</b>	<b>51%</b>	<b>0%</b>	<b>0%</b>
Energy costs					
System power consumption of one lamp	W	66.0	25.0	41.0	41.0
System power consumption for one luminaire	W	132.0	25.0	41.0	41.0
Total connected load of lighting system	W	4,752	1,800	1,476	1,476
Expected energy savings via light management	%	0.00	0.00	0.00	35.00
Total annual energy consumption	kWh/a	39,347	14,904	12,222	7,944
Work price per kWh	€	0.20	0.20	0.20	0.20
Yearly inflation rate for electricity costs	%/a	3.0	3.0	3.0	3.0
Σ Mean energy costs per year	€/a	<b>8,813.63</b>	<b>3,338.50</b>	<b>2,737.57</b>	<b>1,779.42</b>
	%	<b>100%</b>	<b>38%</b>	<b>31%</b>	<b>20%</b>
<b>Total costs yearly</b>	€/a	<b>9,552.08</b>	<b>4,189.00</b>	<b>3,907.21</b>	<b>3,439.94</b>
	%	<b>100%</b>	<b>44%</b>	<b>41%</b>	<b>36%</b>

Production

Figures



Legal note:

The contents and calculations provided with this presentation are for information purposes only and are not legally binding. The results are derived from mathematical calculations based, among other things, on specifications and assumptions of DIN V 18599, DIN EN 12464, etc. Measurements were not performed. For example, the specific behaviour of the users of a lighting system can lead to different results, as can the presence of other electricity consumers on the same circuit. TRILUX cannot assume any liability or guarantee for the correctness of the assumptions and the efficiency calculations. The calculation formulas, product parameters, and product information for both the new lighting system and the existing lighting system to be replaced reflect the knowledge available at the time of data entry. However, this data does not claim to be complete or accurate. Changes and errors must be reserved. Please note that a purchase, work or service contract cannot be concluded with TRILUX online. Prices are non-binding. Emergency/safety lighting was implemented and must be provided on-site if desired.

Existing lighting system with 4-lamp recessed louvre luminaires with darklight louvre requirements: 500 lx, IP20, Ra >80,  $R_{UGL} \geq 19$

In some cases, after replacement of the LED retrofit lamps, it is possible to achieve the lighting criteria required at the time of installing the lighting system according to the version of DIN EN 12464-1 applicable at that time. As a result, they then remain at best at this former level, which is then fixed for the period of operation of the retrofit lamps.



a) In early morning and from late afternoon



b) During the day at noon

**Fig. 1:** Curve of colour temperature of artificial lighting adapted to daylight in an open-plan office

When the luminaires are replaced, a contemporary lighting quality is achieved that takes into account the current state of technology. The requirements for lighting criteria according to the new lighting standard DIN EN 12464-1; 2021-11 are also achieved. In addition, the installation of controlled lighting is possible, possibly with melanopic effectiveness to support the circadian rhythm.

If **luminaire replacement might be problematic due to structural (building) reasons**, TRILUX can offer, on request, **socket-free luminaire inserts** based on LED modules. In individual cases it can be checked whether the optical system can also be replaced with modern lighting technology and whether light management is possible.