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Road lighting - Part 5: Energy performance indicators

Straßenbeleuchtung - Teil 5: Energieeffizienzindikatoren

Éclairage public - Partie 5: Indicateurs de performance énergétique

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ICS:

27.015	Energijska učinkovitost. Ohranjanje energije na splošno	Energy efficiency. Energy conservation in general
93.080.40	Cestna razsvetljava in pripadajoča oprema	Street lighting and related equipment

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

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English Version

Road lighting - Part 5: Energy performance indicators

Éclairage public - Partie 5: Indicateurs de performance énergétique

Straßenbeleuchtung - Teil 5: Energieeffizienzindikatoren

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European foreword

This document (prEN 13201-5:2026) has been prepared by Technical Committee CEN/TC 169 “Light and lighting”, the secretariat of which is held by DIN.

This document is currently submitted to the enquiry.

This document will supersede EN 13201-5:2015.

Significant changes between this document and EN 13201-5:2015 are:

— the terms and definitions included in EN 12665 were deleted to avoid duplication;

— better performing tri-power operation profile replaced the bi-power profile in A.1;

— calculation example in A.2 was improved and extended by two additional lighting situations, the examples were completed by particular values;

— added typical values of energy performance indicators D_E and D_P in A.3;

— form for presentation of energy performance indicators D_E and D_P in Annex D was improved.

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Introduction

The purpose of this European Standard is to define energy performance indicators for road lighting installations. The standard introduces two metrics, the power density indicator (PDI) D_P and the annual energy consumption indicator (AECI) D_E that are always used together.

To quantify the potential savings obtainable from improved energy performance and reduced environmental impact, it is essential to calculate both the power density indicator (D_P) and the annual energy consumption indicator (D_E). In addition, the installation luminous efficacy (η_{inst}) can be used for comparing the energy performances of alternative road lighting installations.

Careful choice of lighting class(es) during the design and specification phase will help to maximize energy savings by ensuring only the necessary levels of illumination provided at the correct times and for the minimum periods necessary. Additional guidance is given in the CEN/TR 13201-1 with regard to the visual needs of road users, e.g. under varying traffic volumes during certain times of night or under varying weather conditions.

When designing a road lighting installation, it is desirable to reduce overlighting to the minimum technically obtainable while ensuring that the design criteria of EN 13201-2 are met. Overlighting can be minimized by the careful selection of the luminaire but the specified lighting class, the designed lighting point spacing and uniformity ratios are all determining factors of the luminous flux emitted by the luminaire and thus the power of the luminaire required. However, this precise luminous flux might not, in reality, exist. Where the luminous flux of the luminaire is greater than that required the designer can by means of continuously variable control gear, compensate for this effect by reducing the luminous flux of the luminaire to the required level resulting in lower energy consumption. The same principles and control gear can be used to compensate for changes in luminous flux emitted throughout the lifetime of the light sources in luminaires.

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The energy levels calculated using this document are not meant to be used as a direct input for the calculation of the load on the electrical distribution system. Such calculations are normally based on the energy requirement derived directly from the lighting and electrical design.

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Examples of operational profiles and examples of calculation of the energy performance indicators are provided in Annex A. Typical values of energy performance indicators are provided to illustrate the energy performance of recent technological level of luminaires and installations.

Annex B introduces the installation luminous efficacy and its factors as a measure of the influence of various light losses and other parameters.

Lighting factor of an installation, as introduced in Annex C, can be additionally used to characterize the energy performance of road lighting installations independently on the lighting components used. Other factors and parameters having influence to the energy performance, such as the maintenance factor (see CIE 154), can be recognized but are not dealt within this document.

Recommendations on presentation of the energy performance indicators are provided in Annex D.

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1 Scope

This document defines how to calculate the energy performance indicators for road lighting installations using the calculated power density indicator (PDI) D_P and the calculated annual energy consumption indicator (AECI) D_E. Power density indicator (D_P) demonstrates the energy needed for a road lighting installation, while it is fulfilling the relevant lighting requirements specified in EN 13201-2. The annual energy consumption indicator (D_E) determines the power consumption during the year, even if the relevant lighting requirements change during the night or seasons.

These indicators may be used to compare the energy performance of different road lighting solutions and technologies for the same road lighting project. The energy performance of road lighting systems with different road geometries or different lighting requirements cannot be compared to each other directly, as the energy performance is influenced by, amongst others, the geometry of the area to be lit, as well as the lighting requirements. The power density indicator (D_P) and annual energy consumption indicator (D_E) apply for all traffic areas covered by the series of lighting classes M, C and P as defined in EN 13201-2.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12665, *Light and lighting - Basic terms and criteria for specifying lighting requirements*

EN 13201-2, *Road lighting - Part 2: Performance requirements*

EN 13201-3, *Road lighting - Part 3: Calculation of performance*

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3 Terms, definitions, symbols and abbreviations

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3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12665 and the following apply.

3.1.1
system power (of a lighting installation in a given state of operation)
P
total power of the road lighting installation needed to fulfil the required lighting classes as specified in EN 13201-2 in all the relevant sub-areas, and to operate and control the lighting installation (unit: W)

3.1.2
power density indicator (of a lighting installation in a given state of operation)
PDI
D_P
value of the system power divided by the value of the product of the surface area to be lit and the calculated maintained average illuminance value on this area according to EN 13201-3 (unit: $W \cdot lx^{-1} \cdot m^{-2}$)

3.1.3
installation luminous efficacy
η_{inst}
minimum luminous flux needed to provide the minimum lighting level for the specified area divided by the total average power consumption of the lighting installation (unit: $lm \cdot W^{-1}$)

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3.1.4
constant light output (of a road lighting installation)
CLO
regulation of the road lighting installation aiming at providing a constant light output from the light sources

Note 1 to entry: This functionality aims to compensate for the light loss caused by ageing of the light sources.

3.1.5
installation lighting factor
q_{inst}
dimensionless factor accounting for the relation of the calculated average maintained luminance of road surface over the calculated average maintained horizontal illuminance on this surface and the average luminance coefficient of the r-table adopted in luminance calculation

3.1.6
lighting operation factor
c_{op}
dimensionless ratio between the value of AECI for the actual operational profile and the AECI for full power operation

3.1.7
illuminance reduction factor
k_E
dimensionless ratio between the light level of the actual operational lighting class and the designed lighting class

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Note 1 to entry: The illuminance reduction factor, often managed via adaptive lighting systems, involves reducing light levels by one lighting class or greater (for example a reduction factor of 0,8 = 80 %) for energy efficiency. When reducing lighting levels, a “dimming curve” is used to manage the change.

3.1.8
power reduction factor for the reduced lighting level
k_P
dimensionless ratio between the reduced power at a given reduced lighting level and the full power

Note 1 to entry: The power reduction factor (PRF) quantifies how much electrical power a lighting system uses when dimmed to a lower light output level compared to the electrical power used at the full light output level.

3.2 Symbols and abbreviations

Table 1 — Symbols and abbreviations

Symbol or abbreviation	Name or description	Unit
A	Area to be lit	m^2
C_L	Correction factor for luminance or hemispherical illuminance based lighting designs	-
c_{op}	Lighting operation factor	-
CLO	Constant Light Output	
D_E	Annual energy consumption indicator (AECI)	$Wh \cdot m^{-2}$

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Symbol or abbreviation	Name or description	Unit
D_P	Power density indicator (PDI)	$W \cdot lx^{-1} \cdot m^{-2}$
$\overline{E}$	Average maintained horizontal illuminance	lx
E_{hs}	Hemispherical illuminance	lx
$\overline{E}_{min}$	Minimum required average illuminance	lx
E_R	Calculated average maintained illuminance on the carriageway	lx
EIR	Edge illuminance ratio	
f_M	Overall maintenance factor (MF) of the lighting installation	-
k_E	Illuminance reduction coefficient for the reduced lighting level	-
k_P	Power reduction coefficient for the reduced lighting level	-
$\overline{L}$	Average maintained luminance	$cd \cdot m^{-2}$
$\overline{L}_{min}$	Minimum required average luminance	$cd \cdot m^{-2}$
LOR	Light output ratio	
m	Number of operation time periods for different levels of operational power P	-
n	Number of sub-areas to be lit	-
n_{lp}	Number of light points associated with the lighting installation or the representative section	-
P	System power of all the luminaires designed to lit the relevant area	W
P_{ad}	Total active power of any devices not considered in the operational power P but necessary for operation of the road lighting installation	W
P_{ls}	Power of light aource(s) inside the luminaire	W
R_{LO}	Light output ratio (LOR) of luminaires used in the lighting installation	-
q_{inst}	Lighting factor of an installation	-
Q_o	Average luminance coefficient	sr^{-1}
t	Duration of the operation time for a particular system power P over a year	h
U	Utilance of the lighting installation	-
Φ_A	Luminous flux reaching the area to be illuminated	lm
Φ_{ls}	Luminous flux emitted from the light source(s) in a luminaire	lm
δ	Detection probability coefficient	-
η_{inst}	Installation luminous efficacy	$lm \cdot W^{-1}$
η_{ls}	Luminous efficacy of the light sources used in the installation	$lm \cdot W^{-1}$
n_{lu}	Number of luminaires considered in the calculation	-
η_P	Power efficiency of luminaires used in the lighting installation	-

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3.3 Indices

Table 2 — Indices

Index	Name or description
C	Cycle path
F	Footpath
FL	Left footpath
FP	Full power period
FR	Right footpath
LN	Late night period
LT	Low traffic period
R	Carriageway

4 Power density indicator (PDI)

4.1 Calculation of the power density indicator

Power density indicator for an area divided into sub-areas for a given state of operation shall be calculated with the following formula:

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$$D_P = \frac{P}{\sum_{i=1}^{n}\left(\overline{E_i} \cdot A_i\right)} \quad (1)$$

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where

D_P is the power density indicator, in watt per lux per square metre;

P is the system power of the lighting installation used to light the relevant areas (see 4.3), in watt;

$\overline{E_i}$ is the maintained average horizontal illuminance of the sub-area *i* determined in accordance with 4.2, in lux;

A_i is the size of the sub-area “i” lit by the lighting installation, in square metre;

n is the number of sub-areas to be lit.

If the required lighting class changes during the night and/or through the seasons (for example reductions in lighting class due to decreased traffic density, changes in the visual environment or other relevant parameters), the power density (D_P) should be calculated separately for each of the lighting classes. Alternatively, where multiple lighting classes are used during the night or year the power density (D_P) may be calculated as an average over this period. The calculation shall clearly indicate the assumptions used for calculation of the power density (D_P) and how this value was evaluated.

Values of the power density indicator (D_P) shall be always presented and used together with the annual energy consumption indicator (D_E) for assessment of the energy performance of a particular lighting system.

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4.2 Average horizontal illuminance to be used for calculation of the power density indicator

For illuminance based lighting classes (C and P) the maintained average horizontal illuminance ($\bar{E}$) to be used for the power density (D_P) calculation shall be calculated according to EN 13201-3.

For luminance based lighting classes (M) the maintained average horizontal illuminance ($\bar{E}$) to be used for the power density (D_P) calculation shall be the average of illuminance values calculated on the same grid of points which are used for the calculation of luminance in accordance with EN 13201-3.

For hemispherical illuminance based lighting classes (HS) the maintained average horizontal illuminance ($\bar{E}$) to be used for the power density (D_P) calculation shall be the average of illuminance values calculated on the same grid of points which are used for the calculation of hemispherical illuminance in accordance with EN 13201-3.

Some lighting installations may be over lit in terms of significantly higher lighting levels than those required or specified. When such overlighting occurs, it should be determined if this is as a result of poor design or as an unavoidable consequence of other requirements. From an energy efficiency and environmental perspective corrective action should be taken to minimize any overlighting.

From an energy efficiency and environmental perspective the calculated lighting level for any lighting installation should not exceed the required lighting level of the next higher lighting class (or not exceed the required lighting level by 50 % in case of the highest class) without considering other design solutions.

4.3 System power (*P*) to be used for calculation of the power density indicator

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The system power (P) shall be calculated from the sum of the operational power of the light sources, control gear(s) and any other electrical device(s) (lighting point control unit(s), switch(es), photoelectric cell(s), etc.) which are directly associated with the lighting of the area to be lit and installed in order to operate or regulate the installation. The system power (P) should be calculated for the complete lighting installation or the representative section used during the lighting design according to the following formula:

$$\mathrm{P} = \sum_{k=1}^{n_{\mathrm{lp}}} P_k + P_{ad} \tag{2}$$

where

P is the total system power of the lighting installation or its representative section, in W;

P_{k} is the operational power of the kth lighting point (light source, gear, any other device like lighting point control unit, switch or photoelectric cell and component, which are associated with the lighting point and necessary for its operation), in W;

P_{ad} is the total operational power of any devices not considered in P_{k} but necessary for the operation of the road installation such as a remote switch or photoelectric cell, centralized luminous flux controller or centralized management system, etc. in W.

Where the system power is calculated for a representative area the total operational power P_{ad} should be proportioned according to the number of luminaires used to illuminate the area over the total number of luminaires supplied from the devices represented by P_{ad}.

n_{lp} is the number of lighting points associated with the lighting installation or the representative section whichever is used in the calculation.

If light sources (and other electrical devices) are operated on constant power, this power shall be used when the system power (P) is calculated.

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