ISO/CIE PRF TR 3092:2023(E)

ISO TC 274/JWG 1/CIE JTC 6

Date: 2023-01-2006-26

Light and lighting — Energy performance of lighting in buildings — Explanation and justification of ISO/CIE 20086

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
~~Email: copyright@iso.org~~
Email: copyright@iso.org
Website: ~~www.iso.org~~www.iso.org

CIE Central Bureau
Babenbergerstraße 9/9A
A-1010 Vienna, Austria
Phone: +43 1 714 3187
~~Email: ciecb@cie.co.at~~
Email: ciecb@cie.co.at
Website: ~~www.cie.co.at~~ www.cie.co.at

Published in Switzerland/Austria

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see ~~www.iso.org/directives~~www.iso.org/directives).

~~Attention is drawn~~ISO draws attention to the possibility that ~~some of~~ the ~~elements~~implementation of this document may ~~be~~involve the ~~subject~~use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights~~.~~ in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights. ~~Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).~~

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see ~~www.iso.org/iso/foreword.html~~www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 274, *Light and lighting*, in cooperation with CIE Joint Technical Committee 6.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html~~www.iso.org/members.html.

Introduction

It is important that lighting schemes are designed appropriately to provide the right light in the right place at the right time, while being energy efficient and ~~to conform~~conforming to local, regional, and/or national regulations. It is also important that the lighting systems are operated energy efficiently and managed by suitable lighting control systems.

Carrying out a comprehensive lighting design (daylight and electric lighting) for new or refurbished buildings will yield both effective and energy efficient lighting solutions that fulfil the lighting criteria specified in the lighting application standards. The lighting design process will show how much daylight will be available and how much electric lighting is needed and what scheme solutions will satisfy the required lighting conditions during the occupied and unoccupied periods.

~~The~~ISO/CIE 20086 gives a procedure to estimate the required energy and the energy efficiency of the electric lighting scheme ~~can be estimated by using the procedure given in ISO/CIE 20086~~.

There is ~~often~~ a risk that the purpose and limitations of ISO/CIE 20086 will be misunderstood, unless the background and context to its content is explained in some detail to users. If this information would have been placed in ISO/CIE 20086, the standard would be ~~flooded~~overloaded with ~~the~~ informative content; and the result is likely to be confusing and cumbersome, especially if ISO/CIE 20086 is referenced in local, regional, or national building codes.

Therefore, this technical report accompanies ISO/CIE 20086 and provides informative content to support the correct understanding, use and national implementation of the lighting standard. It also provides explanation of the lighting energy calculation methodology, working examples and descriptions of integrated lighting control options. ISO/CIE 20086 defines the methods for estimating or measuring the amount of energy required or used for lighting in buildings. The method of separate metering of the energy used for lighting will also give regular feedback on the effectiveness of the lighting control. The methodology of energy estimation not only provides values for the Lighting Energy Numeric Indicator (LENI) but it will also provide input for the heating and cooling load estimations for the combined total energy performance of building indicator.

LENI represents the absolute amount of energy required for a lighting scheme and does not directly provide indications on the efficiency of the lighting technology employed. Therefore, a concept of expenditure factors intending to render energy flows in lighting systems more transparent is introduced in ISO/CIE 20086:2019, 6.5 and Annex E to complement LENI.

Light and lighting — Energy performance of lighting in buildings — Explanation and justification of ISO/CIE 20086

1 Scope

This document is a technical report supporting ISO/CIE 20086~~, *Light and lighting — Energy performance of lighting in buildings*~~.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes ~~additions~~requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CIE S 017, *ILV: International Lighting Vocabulary*

~~ISO 8995-1/CIE S 008[1], *Lighting of work places — Part 1: Indoor*~~

~~ISO 10916:2014[2], *Calculation of the impact of daylight utilization on the net and final energy demand for lighting*~~

~~ISO 30061/CIE S 020, *Emergency Lighting*~~

ISO/CIE 20086:2019, *Light and lighting — Energy performance of lighting in buildings*

~~ISO/CIE TS 22012:2019, *Light and lighting — Maintenance factor determination — Way of working*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/CIE 20086, CIE S 017 and the following apply.

ISO and IEC maintain ~~terminological~~terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at ~~https://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at ~~http://www.electropedia.org/~~https://www.electropedia.org/

CIE maintains a terminology database for use in standardization at the following address:

— e-ILV: available at ~~https://cie.co.at/e-ilv~~https://cie.co.at/e-ilv

~~[1] Under revision, next edition will be published as ISO/CIE 8995-1.~~
~~[2] Under revision, next edition will be published as ISO/CIE 10916.~~

3.1
useful floor area
total gross floor area of all enclosed spaces, measured to the internal face of the external walls

Note 1 to entry: The total useful floor area can have a different value than the total floor area in the building.

4 Symbols and abbreviations

4.1 General

~~Considering~~As given in CIE S 017, considering that LED technology has mostly replaced the conventional form of lamps, the term "lamp" should be replaced with the more general term "light source" to follow changes already introduced in some definitions of terms ~~as given in CIE S 017.~~. However, as this document intends to accompany ISO/CIE 20086, the terms and definitions used in this document are consistent with ISO/CIE 20086 by using the term "lamp". Still, whenever the term "lamp" is used in this document, it also refers to the term "light source".

4.2 Symbols and abbreviations

For the purposes of this document, the symbols given in ISO/CIE 20086 and the specific symbols listed in Table 1 apply.

Table 1 — Symbols and units

Symbol	Name of quantity	Unit
A	Total useful floor area in the building	m^2
a_D	Depth of daylight area	m
b_D	Width of the daylight area	m
A_i	Total useful floor area of the relevant zone or area	m^2
A_s	Sum of task areas within the room or zone	m^2
b_D	Daylight width	m
D	Daylight factor	%
D_{CA}	Daylight factor of the raw building carcass opening	%
E_{sur}	Maintained illuminance on immediate surround of task area	lx
E_{task}	Maintained illuminance on the task area	lx
F_A	Absence factor	1
F_c	Constant illuminance dependency factor	1
F_{CA}	Correction factor for reduced power of area	1
F_{cc}	Factor for the efficiency of the constant illuminance control	1
F_D	Daylight dependency factor	1
$F_{D,C}$	Lighting control factor	1

Symbol	Name of quantity	Unit
$F_{D,S}$	Daylight supply factor	1
F_L	Correction factor for the light source efficiency	1
f_m	Maintenance factor	1
F_{CMF}	Correction factor for maintenance factor	1
f_{LLM}[a]	Lamp luminous flux maintenance factor	1
f_{LS}[a]	Lamp survival factor	1
f_{LM} [a]	Luminaire maintenance factor	1
f_{RSM} [a]	Room surface maintenance factor	1
F_O	Occupancy dependency factor	1
F_{OC}	Controls function factor	1
h_{Li}	Height of the window lintel above the floor	m
h_m	Mounting height of luminaire	m
H_{dir}/H_{glob}	Luminous exposure ratio	1
h_{Ta}	Height of the task area above the floor	m
I_{RD}	Room depth index	1
I_{Sh}	Shading index	1
I_{Tr}	Transparency index	1
K	Room index	1
L_x	Time period at which x % of the measured initial luminous flux value is maintained	h
L_R	Length of room	m
n_{La}	Number of lamps in the luminaire	1
$P_{c,i}$	Control standby power of luminaire i	W
P_{em}	Total emergency standby power	W
$P_{e,i}$	Emergency charging power of luminaire i	W
P_i	Power of luminaire i	W
P_j	Power density of area j	W/m²
$P_{j,lx}$	Illuminance-normalized power density of area j	W/(m²lx)
P_n	Total power of n luminaires	W
P_{pc}	Total standby power for automatic lighting controls	W
P_r	Declared (marked) lamp rated power	W
Q_{LENI}	Lighting energy numeric indicator (LENI) for a building	kWh/m²
$Q_{LENI,sub}$	Lighting energy numeric indicator for an area or relevant zone	kWh/m²

Symbol	Name of quantity	Unit
t_e	Battery charge time	h
t_D	Daylight time	h
t_N	Daylight absence time	h
t_s	Specified time step	hour, month, year
t_{tot}	Total operating hours	h
t_y	Number of hours in a standard year	h
W	Total annual energy used for lighting	kWh
W_{az}	Annual energy required for lighting for an area or a zone	kWh
$W_{L,t}$	Total energy for illumination	kWh
W_{mt}	Total metered energy used for electric lighting	kWh
$W_{P,t}$	Total energy for standby	kWh
W_t	Energy used for lighting per time step	kWh
W_{pc}	Standby energy density for automatic lighting controls per year	kWh/m²
W_{pe}	Standby energy density for battery charging of emergency luminaires per year	kWh/m²
W_R	Width of the room or zone	m

[a] The symbols for lamp luminous flux maintenance factor, lamp survival factor, luminaire maintenance factor and room surface maintenance factor have changed according to CIE S 017 *ILV* and differ from ISO/CIE 20086.

~~4.3 Subscripts~~

For the purposes of this document, the specific subscripts listed in Table 2 apply.

Table 2 — Subscripts

i	Relevant element under consideration or Month number, 1-12
j	Relevant area under consideration

5 Description of the methods

5.1 General

ISO/CIE 20086 provides three methods for the assessment of the energy required for electric lighting within buildings: ~~(1) comprehensive, (2) quick calculation and (3) direct metering (see figure 1).~~

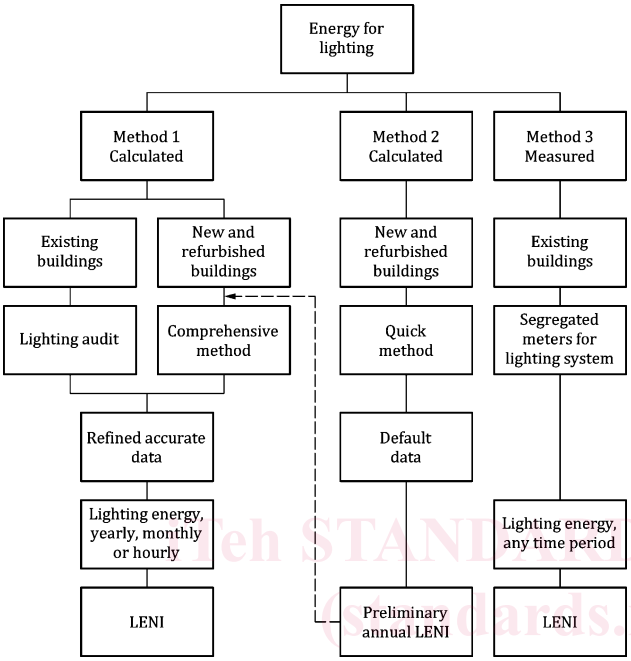
a) Method (1): comprehensive;

b) Method (2): quick calculation;

c) Method (3): direct metering (see figure 1).

These methods can provide the information on the electric energy required for lighting in the selected time steps and the Lighting Energy Numeric Indicator (LENI) for the whole building, individual room or zones. LENI can be used for comparison of similar buildings and as a measure of the lighting energy performance of the building.

Methods (1) and (2) are based on ~~the~~ calculations, and Method (3) is based on the direct metering of the lighting circuit. The calculation methods [(1) and (2)] can be used during feasibility studies or detailed design of new or refurbished buildings, and for the assessment of energy use in existing buildings by first performing a lighting installation audit [(1)]. The metered Method (3) can only be used in existing buildings that have segregated lighting circuits that include meters to facilitate direct metering of the energy used for lighting only or a building management system that can measure lighting energy use.



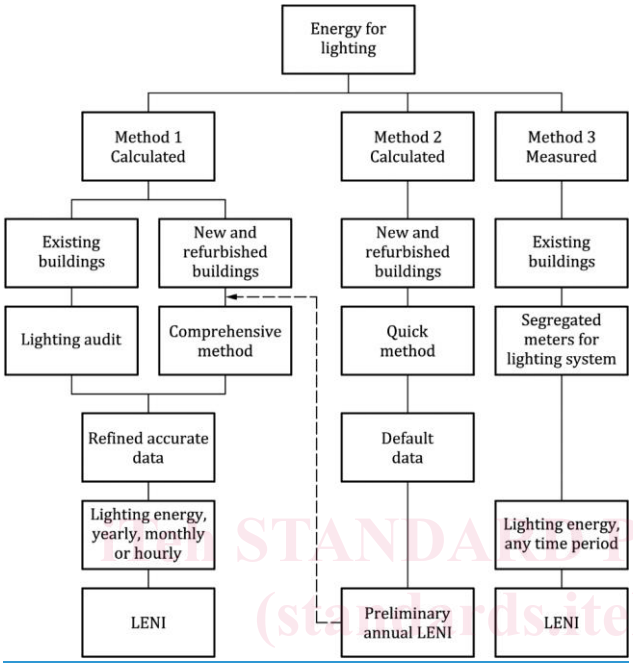


Figure 1 — Flow chart illustrating alternative routes to determine energy use

In terms of the outcome for the installed power, occupancy estimation and daylight availability, Method 1, which relies upon a comprehensive lighting design, is a more accurate calculation procedure than Method 2, which provides a quick estimation based on default values used during pre-design. Method 3 provides the actual energy use for lighting information; however, it can only be used for existing buildings that are lighting end-use metered, commissioned and occupied.

5.2 Method 1 – Comprehensive method

Method 1 provides the most accurate calculation procedure as it relies upon a comprehensive lighting scheme design that is based on real data of the specified products as the main input to the energy calculation. This method can be used for new and refurbished buildings and for assessing existing buildings where it involves a detailed audit of the existing lighting system to establish the installed lighting load. The lighting energy (kWh) per time step (month or hour) normalized to an area unit (m^2) of the useful applicable zone area provides a sub-LENI value for the building zone. In a case of the yearly time step, and for total useful building area, this is the total annual Lighting Energy Numeric Indicator (LENI).