
**Energy performance of buildings —
External climatic conditions —**

**Part 1:
Conversion of climatic data for energy
calculations**

*Performance énergétique des bâtiments — Conditions climatiques
extérieures —*

*Partie 1: Conversion des données climatiques pour les calculs
énergétiques*

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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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. 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 on 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 the following URL: www.iso.org/iso/foreword.html.

ISO 52010-1 was prepared by ISO Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all the parts in the ISO 52010 series can be found on the ISO website.

Introduction

This document is part of a series aimed at the international harmonization of the methodology for assessing the energy performance of buildings. Throughout, this series is referred to as a “set of EPB standards”.

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

All EPB standards provide a certain flexibility with regard to the methods, the required input data and references to other EPB standards, by the introduction of a normative template in [Annex A](#) and [Annex B](#) with informative default choices.

For the correct use of this document, a normative template is given in [Annex A](#) to specify these choices. Informative default choices are provided in [Annex B](#).

The main target groups for this document are architects, engineers and regulators.

Use by or for regulators: In case the document is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications. These choices (either the informative default choices from [Annex B](#) or choices adapted to national/regional needs, but in any case following the template of [Annex A](#)) can be made available as national annex or as separate (e.g. legal) document (national data sheet).

NOTE 1 So in this case:

- the regulators will specify the choices;
- the individual user will apply the document to assess the energy performance of a building, and thereby use the choices made by the regulators.

Topics addressed in this document can be subject to public regulation. Public regulation on the same topics can override the default values in [Annex B](#). Public regulation on the same topics can even, for certain applications, override the use of this document. Legal requirements and choices are in general not published in standards but in legal documents. In order to avoid double publications and difficult updating of double documents, a national annex may refer to the legal texts where national choices have been made by public authorities. Different national annexes or national data sheets are possible, for different applications.

It is expected, if the default values, choices and references to other EPB standards in [Annex B](#) are not followed due to national regulations, policy or traditions, that:

- national or regional authorities prepare data sheets containing the choices and national or regional values, according to the model in [Annex A](#). In this case a national annex (e.g. NA) is recommended, containing a reference to these data sheets;
- or, by default, the national standards body will consider the possibility to add or include a national annex in agreement with the template of [Annex A](#), in accordance to the legal documents that give national or regional values and choices.

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the technical report (ISO/TR 52010-2[6]) accompanying this document.

The subset of EPB standards prepared under the responsibility of ISO/TC 163/SC 2, *Thermal performance and energy use in the built environment — Calculation methods*, cover *inter alia*:

- calculation procedures on the overall energy use and energy performance of buildings;
- calculation procedures on the internal temperature in buildings (e.g. in case of no space heating or cooling);

- indicators for partial EPB requirements related to thermal energy balance and fabric features; and
- calculation methods covering the performance and thermal, hygrothermal, solar and visual characteristics of specific parts of the building and specific building elements and components, such as opaque envelope elements, ground floor, windows and facades.

ISO/TC 163/SC 2 cooperates with other TCs for the details on, for example, appliances, technical building systems and indoor environment.

This document provides:

- Standard calculation procedures for the conversion of hourly weather data to apply as input for energy performance calculations, in particular calculation of solar irradiance on an arbitrary inclined surface.
- Procedures for the use of (other) output from ISO 15927-1, ISO 15927-2, and ISO 15927-4) as input for the EPB assessment.

Common standard climatic data shall be used for the all relevant EPB modules. Most of the input data are available from ISO 15927-1, ISO 15927-2, ISO 15927-4, ISO 15927-5 and ISO 15927-6.

These data include the variables per time interval, as described in ISO 52000-1:2017, 11.5.

[Table 1](#) shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

NOTE 2 In ISO/TR 52000-2[2] the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 3 The modules represent EPB standards, although one EPB standard could cover more than one module and one module could be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See also [Tables A.1](#) and [B.1](#)

Table 1 — Position of this document (in casu M1–13), within the modular structure of the set of EPB standards

		Overarching		Building (as such)		Technical Building Systems									
Submodule		Descriptions		Descrip- tions		Descrip- tions	Heat- ing	Cool- ing	Ven- tila- tion	Hu- mid- ifi- cati- on	De- hu- mid- ifica- tion	Do- mes- tic hot water	Light- ing	Build- ing auto- ma- tion and control	PV, wind, ..
sub1			M1		M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
1		General		General		General									
2		Common terms and definitions; symbols, units and subscripts		Building energy needs		Needs								a	
3		Applications		(Free) Indoor conditions without systems		Maxi- mum load and power									
4		Ways to express energy performance		Ways to express energy perform- ance		Ways to express energy perform- ance									
5		Building categories and building boundaries		Heat transfer by trans- mission		Emission and control									
6		Building occupancy and operating conditions		Heat transfer by infiltra- tion and ventila- tion		Distribu- tion and control									
7		Aggregation of energy services and energy carriers		Internal heat gains		Storage and control									
8		Building zoning		Solar heat gains		Genera- tion and control									
9		Calculated energy perfor- mance		Building dynamics (thermal mass)		Load dispatch- ing and operating condi- tions									
10		Measured ener- gy performance		Measured energy perform- ance		Meas- ured energy perform- ance									
11		Inspection		Inspection		Inspec- tion									

^a The shaded modules are not applicable.

Table 1 (continued)

	Overarching		Building (as such)		Technical Building Systems									
Submodule	Descriptions		Descriptions		Descriptions	Heat- ing	Cool- ing	Ven- tila- tion	Hu- mid- ifi- cati- on	De- hu- mid- ifica- tion	Do- mes- tic hot water	Light- ing	Build- ing auto- ma- tion and control	PV, wind, ..
sub1		M1		M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
12	Ways to express indoor comfort				BMS									
13	External environment conditions	ISO 52010-1												
14	Economic calculation													
^a The shaded modules are not applicable.														

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Energy performance of buildings — External climatic conditions —

Part 1: Conversion of climatic data for energy calculations

1 Scope

This document specifies a calculation procedure for the conversion of climatic data for energy calculations.

The main element in this document is the calculation of solar irradiance on a surface with arbitrary orientation and tilt. A simple method for conversion of solar irradiance to illuminance is also provided.

The solar irradiance and illuminance on an arbitrary surface are applicable as input for energy and daylighting calculations, for building elements (such as roofs, facades and windows) and for components of technical building systems (such as thermal solar collectors, PV panels).

Other parameters of climatic data needed to assess the thermal and moisture performance of buildings, building elements or technical building systems [like wind, temperature, moisture and long-wave (thermal) radiation] are to be obtained according to the procedures in ISO 15927-4. These data are listed in this document as input and passed on as output without any conversion.

NOTE 1 The reason for passing these data via this document is to have one single and consistent source for all EPB standards and to enable any conversion or other treatment if needed for specific application.

NOTE 2 [Table 1](#) in the Introduction shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes 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.

ISO 7345, *Thermal insulation — Physical quantities and definitions*

ISO 9488, *Solar energy — Vocabulary*

ISO 15927-4, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 4: Hourly data for assessing the annual energy use for heating and cooling*

ISO 52000-1, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*

ISO 52016-1, *Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 1: Calculation procedures*

NOTE Default references to EPB standards other than ISO 52000-1 are identified by the EPB module code number and given in [Annex A](#) (normative template in [Table A.1](#)) and [Annex B](#) (informative default choice in [Table B.1](#)).

EXAMPLE EPB module code number: M5-5, or M5-5.1 (if module M5-5 is subdivided), or M5-5/1 (if reference to a specific clause of the standard covering M5-5).

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345, ISO 9488, ISO 52000-1 and the following apply.

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

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1
EPB standard
standard that complies with the requirements given in ISO 52000-1, CEN/TS 16628 and CEN/TS 16629

Note 1 to entry: These three basic EPB documents were developed under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480), and support essential requirements of EU Directive 2010/31/EU on the energy performance of buildings (EPBD). Several EPB standards and related documents are developed or revised under the same mandate.

[SOURCE: ISO 52000-1:2017, definition 3.5.14]

3.2
solar declination
angle between direction of the direct solar radiation and the equatorial plane of the earth

3.3
illuminance
<at a point of a surface> quotient of the luminous flux incident on an element of the surface containing the point, divided by the area of that element

Note 1 to entry: This is expressed in lux, $1 \text{ lx} = 1 \text{ lm}\cdot\text{m}^{-2}$.

[SOURCE: ISO 16817:2012, 3.14]

4 Symbols and abbreviations

4.1 Symbols

For the purposes of this document, the symbols from ISO 52000-1 and the following apply.

NOTE If, within this document, a symbol is more or less uniquely linked with a specific subscript, the symbol is shown with the subscript.

Symbol	Name of quantity	Unit
D	wind direction	°
f	brightness coefficients (Perez model)	–
E_v	global illuminance	lx
F	coefficient	–
G	irradiance	W/m ²
H	height	m
H	(accumulated, monthly) solar irradiation	kW h/m ²
i	index	–
I	calculated irradiance	W/m ²
K_v	Global luminous efficacy	lm/W
k_T	clearness index	–
L	distance	m

Symbol	Name of quantity	Unit
m	air mass	–
n	number	–
R_{dc}	earth orbit deviation	°
n	index	–
t	time	min, h
TZ	time zone	h
u_{10}	wind speed	m/s
x	moisture content or mixing ratio	kg/kg
α	angle	°
β	angle	°
γ	angle	°
δ	solar declination	°
ε	clearness parameter (Perez model)	–
θ	Celsius temperature	°C
θ	angle	°
λ	longitude	°
φ	relative humidity	–
φ	angle, latitude	°
ρ	reflectivity	–
ω	hour angle	°

4.2 Subscripts

For the purposes of this document, the subscripts given in ISO 52000-1 and the following apply.

NOTE Relevant subscripts already given in ISO 52000-1 are included if necessary for the understanding of this document.

Subscript	Term	Subscript	Term
a	atmosphere, air	ic	surface of any inclination
an	annual, yearly	l	long-wave
b	beam	m	monthly
c	constant	obst	obstacle
circum	circumsolar	segm	segment
d	day	sol	solar, sun
d	diffuse	sh	shading
dif	diffuse	tot	total
dir	direct	v	visual, light
eq	equation	w	weather station
ext	extra-terrestrial	z	zenith
g	global	0, 1, ...	index
grnd	ground	11, 12,	index

5 Description of the methods

5.1 Output of the method

This document covers primarily the generic hourly calculation methodology of the solar irradiance on a surface of any orientation and tilt, optionally including the effect of shading by distant objects.

To avoid serious errors in case of separate calculation of the effect of shading in case of overlapping shading objects, it is recommended that the calculation of the effect of shading by external objects is done in the application standard where the position, location and surroundings of the irradiated surface is known.

For that purpose the output provides the solar irradiance not only as a total, but also as different components. Additional output needed for the calculation of the effect of shading in standards using the output from this document as input is the position of the sun.

The time interval of the output is hourly.

Other data from the climatic data set (not related to solar radiation) do not need any conversion, but can be used directly in the relevant EPB standards. These are also listed in the table with output quantities.

NOTE The reason for passing these data via this document is to have one single and consistent source for all EPB standards and to enable any conversion or other treatment if needed for specific application.

5.2 General description of the method

The method gives procedures to calculate the distribution of solar irradiance on a non-horizontal plane based on hourly solar radiation data on a horizontal surface.

NOTE The explanation and justification is given in ISO/TR 52010-2[6]. The model is named after Mr Perez. Several improvements were made in the course of time, see the list of references in the bibliography of the technical report. The calculation procedure described in this document is based on the “simplified Perez model” proposed in the early 1990s.

Essentially, the model is composed of three different components:

- a) a geometric representation of the sky dome;
- b) a parametric representation of the insolation conditions, and;
- c) a statistic component linking both components mentioned before.

It is a model of anisotropic sky, where the sky dome is geometrically divided into three areas, each of them showing a constant radiance, different from the other two.

These three areas are:

- isotropic diffuse (for the sky hemisphere);
- circumsolar radiation;
- horizon brightness.

For the purposes of this document the following is added:

- isotropic ground reflected radiation.

The diffuse (sky) radiation for the surface uses as input hourly values of diffuse horizontal and direct beam solar radiation. Other inputs to the model include the sun's incident angle to the surface, the surface tilt angle from the horizontal, and the sun's zenith angle.