INTERNATIONAL STANDARD

**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

Performance énergétiques des bâtiments — Besoins d'énergie pour le chauffage et le refroidissement, les températures intérieures et les chaleurs sensible et latente —

Partie 1: Méthodes de calcul

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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.

This document was prepared by 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 parts in the ISO 52016 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 accompanying this document (ISO/TR 52016-2[1]).

The subset of EPB documents 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 e.g. appliances, technical building systems and indoor environment.

This document presents a coherent set of calculation methods at different levels of detail, for the energy needs involved in the space heating and cooling and for (de-)humidification of a building and/or for the internal temperatures and (sensible or latent) heat loads, including the influence from technical buildings systems, control aspects and boundary conditions where relevant for the calculation.

The result of the design loads is also of possible use for the checking of the appropriate sizing of the equipment at the occasion of inspections.

References are made to other International Standards or to national documents for input data and detailed calculation procedures not provided by this document.

This document supersedes ISO 13790:2008. The main differences are:

— integration in the set of EPB standards, as specified in the overarching EPB standard (ISO 52000-1). Including removal of calculation elements that are covered or to be covered in other standards (for instance, the general rules for zoning (partitioning) of the building is now at overarching level (EPB module M1-8); the conditions of use are now assumed to be in a separate standard (module M1-6);

— major editorial changes based on the detailed technical rules for all EPB standards. Including moving all informative annexes to a separate accompanying Technical Report (ISO/TR 52016-2[1]);

— revision of the monthly calculation method and removal of the seasonal method;

— replacement of the simple hourly calculation method by a more direct and transparent method, with no need to add input data;

— integration of the calculation of the design heating and cooling load, including latent heat load, initially prepared as prEN 16798-11:2015 by CEN/TC 156.

Relevant editorial changes have been made based on the detailed technical rules for all EPB standards, including moving all informative annexes, if not covered elsewhere, to a separate accompanying Technical Report (ISO/TR 52016-2[1]).

Together with ISO 52017-1 this document also supersedes ISO 13791:2012[3] and ISO 13792:2012[4].

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[7] 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 Clause 2 and Tables A.1 and B.1.

Table 1 — Position of this document (in casu M2-2, M2-3, M2-6, M3-3, M4-3, M6-3, M7-3), within the modular structure of the set of EPB standards

	Overarching		Building (as such)		Technical Building Systems									
Sub module	Descriptions		Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic hot water	Lighting	Building automation 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	52016-1	Needs								a	
3	Applications		(Free) Indoor conditions without systems	52016-1	Maximum load and power	52016-1	52016-1		52016-1	52016-1				
4	Ways to express energy performance		Ways to express energy performance		Ways to express energy performance									
5	Building categories and building boundaries		Heat transfer by transmission		Emission and control									
6	Building occupancy and operating conditions		Heat transfer by infiltration and ventilation	52016-1	Distribution and control									
7	Aggregation of energy services and energy carriers		Internal heat gains		Storage and control									
8	Building zoning		Solar heat gains		Generation and control									
9	Calculated energy performance		Building dynamics (thermal mass)		Load dispatching and operating conditions									
10	Measured energy performance		Measured energy performance		Measured energy performance									
11	Inspection		Inspection		Inspection									
12	Ways to express indoor comfort				BMS									
13	External environment conditions													
14	Economic calculation													
NOTE The shaded modules are not applicable.														

Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads —

Part 1: Calculation procedures

1 Scope

This document specifies calculation methods for the assessment of:

a) the (sensible) energy need for heating and cooling, based on hourly or monthly calculations;

b) the latent energy need for (de-)humidification, based on hourly or monthly calculations;

c) the internal temperature, based on hourly calculations;

d) the sensible heating and cooling load, based on hourly calculations;

e) the moisture and latent heat load for (de-)humidification, based on hourly calculations;

f) the design sensible heating or cooling load and design latent heat load using an hourly calculation interval;

g) the conditions of the supply air to provide the necessary humidification and dehumidification.

The calculation methods can be used for residential or non-residential buildings, or a part of it, referred to as "the building" or the "assessed object".

This document also contains specifications for the assessment of thermal zones in the building or in the part of a building. The calculations are performed per thermal zone. In the calculations, the thermal zones can be assumed to be thermally coupled or not.

The calculation methods have been developed for the calculation of the basic energy loads and needs, without interaction with specific technical building systems, and for the calculation of the system specific energy loads and needs, including the interaction with specific systems. The hourly calculation procedures can also be used as basis for calculations with more extensive system control options.

This document is applicable to buildings at the design stage, to new buildings after construction and to existing buildings in the use phase.

NOTE   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 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*

ISO 10292, *Glass in building — Calculation of steady-state U values (thermal transmittance) of multiple glazing*

ISO 13789:2017, *Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method*

ISO 15099, *Thermal performance of windows, doors and shading devices — Detailed calculations*

ISO 15927-2, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 2: Hourly data for design cooling load*

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 15927-5, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 5: Data for design heat load for space heating*

ISO 52000-1:2017, *Energy performance of buildings — Overarching EPB assessment – Part 1: General framework and procedures*

EN 410, *Glass in building — Determination of luminous and solar characteristics of glazing*

EN 673, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 12831-1, *Energy performance of buildings - Method for calculation of the design heat load - Part 1: Space heating load, Module M3-3*

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, in ISO 52000-1 and the following apply.

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

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

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

3.1   Building

3.1.1
assessed object
building, part of a building or portfolio of buildings that is the object of the energy performance assessment

Note 1 to entry: The assessed object comprises all spaces and technical systems which may contribute to or influence the energy performance assessment.

Note 2 to entry: The assessed object may include one or several building units, if these are not individually object of the energy performance assessment.

Note 3 to entry: A distinction may be made between e.g. a designed building, new building after construction, existing building in the use phase and existing building after major renovation.

[SOURCE: ISO 52000-1:2017, 3.1.1]

3.1.2
building
construction as a whole, including the fabric and all technical building systems, where energy may be used to condition the indoor environment, to provide domestic hot water and illumination and other services related to the use of the building

Note 1 to entry: The term refers to the physical building as a whole or to all parts thereof that at least include the spaces and technical building systems that are relevant for the energy performance assessment.

Note 2 to entry: Parts of a building can be physically detached, but are on the same building site. For example: a canteen or a guard house or one or more classrooms of a school in a detached part of a building; or an essential space in a dwelling (e.g. bedroom).

[SOURCE: ISO 52000-1:2017, 3.1.2]

3.1.3
building category
unit category
classification of buildings and/or building units related to their main use or their special status, for the purpose of enabling differentiation of the energy performance assessment procedures and/or energy performance requirements

EXAMPLE   Buildings officially protected as part of a designated environment or because of their special architectural or historical merit, buildings used as places of worship and for religious activities, residential buildings, (a) single-family houses of different types;(b) apartment blocks;(c) offices;(d) educational buildings;(e) hospitals;(f) hotels and restaurants;(g) sports facilities;(h) wholesale and retail trade services buildings;(i) data centers; (j) other types of energy-consuming buildings.

Note 1 to entry: Building regulations often make a distinction between building categories.

Note 2 to entry: The building category, for instance, may determine if energy performance assessment is mandatory (e.g. not for religious or historic buildings) and which are the minimum energy performance requirements (e.g. for new buildings); in some countries measured energy performance of a building is prescribed for specific categories of buildings (e.g. apartment buildings, large public buildings), etc. Another type of categorization is the distinction between new and existing and renovated buildings.

Note 3 to entry: Many buildings or building units of a given (use) category contain spaces of different (use) categories; for instance an office building may contain a restaurant; see 3.1.20 definition of space category.

Note 4 to entry: The allocation of a building category may also have a strong impact on other parts of the building regulations, for instance on safety (e.g. emergency exits, strength of floor) or indoor environmental quality (e.g. minimum ventilation rates)

[SOURCE: ISO 52000-1:2017, 3.1.3]

3.1.4
building element
integral component of the technical building systems or of the fabric of a building

[SOURCE: ISO 52000-1:2017, 3.1.4]

3.1.5
building fabric
all physical elements of a building, excluding technical building systems

EXAMPLE   Roofs, walls, floors, doors, gates and internal partitions.

Note 1 to entry: It includes elements both inside and outside of the thermal envelope, including the thermal envelope itself.

Note 2 to entry: The fabric determines the thermal transmission, the thermal envelope airtightness and (nearly all of) the thermal mass of the building (apart from the thermal mass of furniture and technical building systems). The fabric also makes the building wind and water tight. The building fabric is sometimes described as the building as such, i.e. the building without any technical building system.

[SOURCE: ISO 52000-1:2017, 3.1.5]

3.1.6
building portfolio
set of buildings and common technical building systems whose energy performance is determined taking into account their mutual interactions

Note 1 to entry: An example of common equipment is an energy generation system (PV panels, wind turbine, cogen unit, boiler etc.) serving the building portfolio

[SOURCE: ISO 52000-1:2017, 3.1.6]

3.1.7
building thermal zone
thermal zone
internal environment with assumed sufficiently uniform thermal conditions to enable a thermal balance calculation according to the procedures in the standard under EPB module M2-2

Note 1 to entry: The EPB standard under module M2–2 is this document.

[SOURCE: ISO 52000-1:2017, 3.1.6, modified - Note 1 to entry modified to "this document"]

3.1.8
building unit
section, floor or apartment within a building which is designed or altered to be used separately from the rest of the building

EXAMPLE   A shop in a shopping mall, an apartment in an apartment building or a rentable office space in an office building.

Note 1 to entry: The building unit can be the assessed object.

[SOURCE: ISO 52000-1:2017, 3.1.8]

3.1.9
conditioned space
room or enclosure that is covered by one or more of the EPB services

3.1.10
cooled space
room or enclosure, which for the purposes of a calculation is assumed to be cooled to a given temperature set-point or set-points

[SOURCE: ISO 52000-1:2017, 3.1.9]

3.1.11
elementary space
space
room, part of a room or group of adjacent rooms that belongs to one thermal zone and one service area of each service, used to administer the boundaries of the thermal zones and service areas and to administer the exchange of data between the service areas and thermal zones

[SOURCE: ISO 52000-1:2017, 3.1.10]

**3.1.12
external dimension**
dimension measured on the exterior of a building

Note 1 to entry: See ISO 13789:2017, Figure 1.

[SOURCE: ISO 13789:2017, 3.13]

**3.1.13
heated space**
room or enclosure, which for the purposes of a calculation is assumed to be heated to a given temperature set-point or set-points

[SOURCE: ISO 52000-1:2017, 3.1.11]

**3.1.14
internal dimension**
dimension measured from wall to wall and floor to ceiling inside a room of a building

Note 1 to entry: See ISO 13789:2017, Figure 1.

[SOURCE: ISO 13789:2017, 3.11]

**3.1.15
overall internal dimension**
dimension measured on the interior of a building, ignoring internal partitions

Note 1 to entry: See ISO 13789:2017, Figure 1.

[SOURCE: ISO 13789:2017, 3.12]

**3.1.16
projected area of solar collecting elements**
area of the projection of the surface of the element on to a plane parallel to the transparent or translucent part of the element

Note 1 to entry: In the case of non-flat elements, this refers to the area of the imaginary of the smallest plane connecting the perimeter of the element.

EXAMPLE   Windows.

**3.1.17
projected area of frame elements**
area of the projection of the frame element on to a plane parallel to the glazing or panel that is held by the frame

EXAMPLE   Window frames.

**3.1.18
reference floor area**
floor area used as a reference size

Note 1 to entry: See definition of reference size.

[SOURCE: ISO 52000-1:2017, 3.1.12]

**3.1.19
reference size**
relevant metric to normalize the overall or partial energy performance and energy performance requirements to the size of the building or part of a building and for the comparison against benchmarks

[SOURCE: ISO 52000-1:2017, 3.1.13]

3.1.20
space category
classification of building spaces related to a specific set of use conditions

EXAMPLE   Office space, restaurant space, entrance hall, toilet, living space, assembly hall, shop, residential bed room, indoor car park, heated indoor stair case, unheated indoor stair case, etc.

Note 1 to entry: The space category is relevant for the calculation of the energy performance assessment and for defining the reference size.

[SOURCE: ISO 52000-1:2017, 3.1.14]

3.1.21
thermal envelope area
total area of all elements of a building that enclose thermally conditioned spaces through which thermal energy is transferred, directly or indirectly, to or from the external environment

Note 1 to entry: The thermal envelope area depends on whether internal, overall internal or external dimensions are being used.

Note 2 to entry: The thermal envelope area does not include the area to adjacent buildings; see ISO 13789.

Note 3 to entry: The thermal envelope area may play a role in the ways to express the overall and partial energy performance and energy performance requirements and comparison against benchmarks.

[SOURCE: ISO 13789:2017, 3.9, modified, Notes 2 and 3 to entry added]

3.1.22
thermally conditioned space
heated and/or cooled space

[SOURCE: ISO 52000-1:2017, 3.1.16]

3.1.23
thermally unconditioned space
room or enclosure that is not part of a thermally conditioned space

[SOURCE: ISO 52000-1:2017, 3.1.17]

3.1.26
useful floor area
<for EPB assessment> area of the floor of a building needed as parameter to quantify specific conditions of use that are expressed per unit of floor area and for the application of the simplifications and the zoning and (re-)allocation rules

[SOURCE: ISO 52000-1:2017, 3.1.18]

3.2   Indoor and outdoor conditions

3.2.1
condition of use
requirement and/or restriction for the use of a building space category, related to the services for the energy performance assessment and/or the boundary conditions

EXAMPLE   Heating set-point, cooling set-point, minimum amount of ventilation related to air quality, net domestic hot water needs (e.g. per m^2 floor area or per person), lighting levels, internal heat gains, etc. ; including the distribution over time (operation). Where relevant, the numbers are based on the number of occupants per m^2 per type of building space.

[SOURCE: ISO 52000-1:2017, 3.2.1]

3.2.2
external temperature
temperature of outdoor air

[SOURCE: ISO 52000-1:2017, 3.2.3]

3.2.3
intermittent heating or cooling
heating or cooling pattern where normal heating or cooling periods alternate with periods of reduced or no heating or cooling

3.2.4
internal temperature
operative temperature
weighted average of the air temperature and the mean radiant temperature at the centre of the thermal zone

Note 1 to entry: Internal temperature is the approximate operative temperature according to ISO 7726.

Note 2 to entry: Operative temperature is the term used in this document.

Note 3 to entry: ISO 52017-1 uses a more generic definition.

[SOURCE: for internal temperature: ISO 52000-1:2017, 3.2.4, modified, Notes 2 and 3 to entry added]

3.2.5
internal air temperature
temperature of the air in the internal environment

3.2.6
mean radiant temperature
uniform surface temperature of the internal environment in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform enclosure

3.2.7
set-back temperature
minimum internal temperature to be maintained during reduced heating periods, or maximum internal temperature to be maintained during reduced cooling periods

3.2.8
set-point (of the internal) temperature
internal (minimum intended) operative temperature for the calculation of the energy load or need for heating, or internal (maximum intended) temperature for the calculation of the energy load or need for cooling

Note 1 to entry: The values and duration (pattern) are specified in the standard under EPB module M1-6. For monthly and seasonal methods, the value of the set-point can include adjustment for intermittency, as specified in 6.6.11. For system-specific calculations the values may be adjusted due to system control features.

3.2.9
solar irradiance
power density of radiation incident on a surface, i.e. the quotient of the radiant flux incident on the surface and the area of that surface, or the rate at which radiant energy is incident on a surface, per unit area of that surface

[SOURCE: ISO 52000-1:2017, 3.2.6]