PD CEN ISO/TR 52000-2:2017

BSI Standards Publication

# Energy performance of buildings - Overarching EPB assessment

Part 2: Explanation and justification of ISO 52000-1 (ISO/TR 52000-2:2017)

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# National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/540/2, Building performance - Moisture.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2017

ISBN 978 0 580 82981 9

ICS 91.120.10

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 September 2017.

**Amendments/corrigenda issued since publication**

| Date | Text affected |
|---|---|

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TECHNICAL REPORT

RAPPORT TECHNIQUE

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# CEN ISO/TR 52000-2

July 2017

ICS 91.120.10

Supersedes CEN/TR 15615:2008

English Version

# Energy performance of buildings - Overarching EPB assessment - Part 2: Explanation and justification of ISO 52000-1 (ISO/TR 52000-2:2017)

Performance énergétique des bâtiments - Évaluation globale de la PEB - Partie 2: Explication et justification de l'ISO 52000-1 (ISO/TR 52000-2:2017)

Erläuterung der allgemeinen Zusammenhänge zwischen verschiedenen Europäischen Normen und der europäischen Richtlinie über die Gesamtenergieeffizienz von Gebäuden (EPBD) - Übergreifendes Dokument (ISO/TR 52000-2:2017)

This Technical Report was approved by CEN on 24 February 2017. It has been drawn up by the Technical Committee CEN/TC 371.

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# European foreword

This document (CEN ISO/TR 52000-2:2017) has been prepared by Technical Committee CEN/TC 371 “Energy Performance of Buildings project group", the secretariat of which is held by NEN, in collaboration with Technical Committee ISO/TC 163 " Thermal performance and energy use in the built environment".

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This document supersedes CEN/TR 15615:2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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TECHNICAL REPORT

# ISO/TR 52000-2

First edition
2017-06

# Energy performance of buildings — Overarching EPB assessment —

## Part 2: Explanation and justification of ISO 52000-1

*Performance énergétique des bâtiments — Évaluation globale de la PEB —*

*Partie 2: Explication et justification de l'ISO 52000-1*

Reference number
ISO/TR 52000-2:2017(E)

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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/TR 52000-2 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 371, *Energy Performance of Buildings project group*, in collaboration with ISO Technical Committees TC 163, *Thermal performance and energy use in the built environment*, and TC 205, *Building environment design*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 52000 series can be found on the ISO website.


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# Introduction

### The set of EPB standards, technical reports and supporting tools

In order to facilitate the necessary overall consistency and coherence, in terminology, approach, input/output relations and formats, for the whole set of EPB-standards, the following documents and tools are available:

a) a document with basic principles to be followed in drafting EPB-standards: CEN/TS 16628:2014, Energy Performance of Buildings - Basic Principles for the set of EPB standards[13];

b) a document with detailed technical rules to be followed in drafting EPB-standards; CEN/TS 16629:2014, Energy Performance of Buildings - Detailed Technical Rules for the set of EPB-standards[14];

The detailed technical rules are the basis for the following tools:

1) a common template for each EPB-standard, including specific drafting instructions for the relevant clauses;

2) a common template for each technical report that accompanies an EPB standard or a cluster of EPB standards, including specific drafting instructions for the relevant clauses;

3) a common template for the spreadsheet that accompanies each EPB standard, to demonstrate the correctness of the EPB calculation procedures.

Each EPB-standards follows the basic principles and the detailed technical rules and relates to the overarching EPB-standard, ISO 52000-1[1].

One of the main purposes of the revision of the EPB-standards is to enable that laws and regulations directly refer to the EPB-standards and make compliance with them compulsory. This requires that the set of EPB-standards consists of a systematic, clear, comprehensive and unambiguous set of energy performance procedures. The number of options provided is kept as low as possible, taking into account national and regional differences in climate, culture and building tradition, policy and legal frameworks (subsidiarity principle). For each option, an informative default option is provided (Annex B).

### Rationale behind the EPB technical reports

There is a risk that the purpose and limitations of the EPB standards will be misunderstood, unless the background and context to their contents – and the thinking behind them – is explained in some detail to readers of the standards. Consequently, various types of informative contents are recorded and made available for users to properly understand, apply and nationally or regionally implement the EPB standards.

If this explanation would have been attempted in the standards themselves, the result is likely to be confusing and cumbersome, especially if the standards are implemented or referenced in national or regional building codes.

Therefore each EPB standard is accompanied by an informative technical report, like this one, where all informative content is collected, to ensure a clear separation between normative and informative contents (see CEN/TS 16629[14]):

— to avoid flooding and confusing the actual normative part with informative content,

— to reduce the page count of the actual standard, and

— to facilitate understanding of the set of EPB standards.

This was also one of the main recommendations from the European CENSE project[5] that laid the foundation for the preparation of the set of EPB standards.

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## This document

This document accompanies the overarching EPB standard (ISO 52000-1) that addresses the overarching principles for EPB-standards. The overarching EPB standard, contains the common terms, definitions and overall energy performance assessment procedures, as a basis for a systematic, clear and comprehensive set of EPB standards. It forms part of a set of standards related to the evaluation of the energy performance of buildings (EPB).

The role and the positioning of ISO 52000-1 in the set of EPB standards is defined in the Introduction to the standard.

## Accompanying spreadsheets

Spreadsheets are produced through the implementation of ISO 52000-1. These spreadsheets (including possible updated versions) are available at www.epb.center. In this document, examples of each of these calculation sheets are included.

**Background and history of this document,** ISO 52000-1 **and the set of EPB standards**[1]:

### *Boosting energy efficiency of buildings*

Since buildings burn 40 % of all the energy consumed, designing better buildings and retrofitting existing ones will help to reduce the energy demand and to create significant job opportunities world-wide.

The building sector has a great potential to reduce the greenhouse gas emissions, in line with the climate targets set at the Paris climate conference (COP21) in December 2015. Helping to decarbonize the building sector is the goal of the new holistic approach, the set of EPB standards (ISO 52000-series; see below under "Road ahead") being developed for the energy performance of buildings (EPB).

### *Holistic approach*

| **The set of EPB standards ...** | |
|---|---|
| **take into account** | **and include:** |
| • indoor climate | • needs |
| • thermal properties (of walls, windows, etc.) | • use |
| • heating | • calculation |
| • cooling and air conditioning | • measurement |
| • domestic hot water | • inspection |
| • ventilation | • building design |
| • lighting | • new and existing buildings |
| • (de)humidification | • certification/labelling |
| • building automation and control (BAC/BMS) | • simple and complex buildings |
| • renewable energy sources | |

### *Why is the holistic approach important for the energy performance of buildings (EPB) ?*

In the past, energy performance requirements were set at component level – minimum thermal insulation levels and minimum efficiencies of products. This, however, leads to sub-optimal solutions and creates a barrier to the necessary technology transitions.

The holistic approach to assessing the overall energy performance of buildings and the built environment, provided by the set of EPB standards, is a key tool to overcome these barriers.

1) The references [26] to [43] (see bibliography) contain more extensive background information on the set of EPB standards.


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The set of EPB standards enable to assess the overall energy performance of a building. This means that any combination of technologies can be used to reach the intended energy performance level, at the lowest cost.

Due to this 'competition' between different technologies, the holistic approach is a key driver for technological innovation and change. Countries using the approach for several years – take, for instance, the Netherlands – have experienced large scale implementation and cost savings on a variety of new technologies.

And there is the economic benefit: Energy expenditures account for a substantial part of a building's total operating costs.

***Who are the potential users of the EPB set of standards, and what should they be aware of ?***

The energy assessment of buildings is carried out for various purposes, such as:

— judging compliance with building regulations expressed in terms of limited energy use or a related quantity,

— increasing transparency in real-estate transactions through an energy performance certification and/or display of the level of energy,

— monitoring the energy efficiency of the building and its technical building systems,

— helping to plan retrofit measures through predicting energy savings that would result from various actions.

In general, the holistic approach means that the energy performance is assessed as the total energy used for heating, cooling, lighting, ventilation, domestic hot water, and, in some cases, appliances. It ensures that all technologies are treated equally and balanced.

With the EPB set of standards**:**

— **Policy makers** acquire an instrumentation that enables them to take measures in the built environment and to quantify how much these measures would reduce the energy consumed in buildings.

— **Building industry, engineers and designers** can improve the energy-efficiency of their designs, building products and systems. The set of standards take these current and future products, systems and designs into account. Due to the holistic approach the risk of suboptimum solutions at component level is minimized. This way industry knows in what direction to innovate.

— **Building owners and occupants** can benchmark against other buildings and predict the energy saving potential of improvements.

***First editions: European standards***

The set of standards and accompanying technical reports on the energy performance of buildings have been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480[4])

Directive 2010/31/EU recasting the Directive 2002/91/EC on energy performance of buildings (EPBD[2]) promotes the improvement of the energy performance of buildings within the European Union, taking into account all types of energy uses (heating, lighting, cooling, air conditioning, ventilation) and outdoor climatic and local conditions, as well as indoor climate requirements and cost effectiveness (Article 1).

The first mandate to CEN to develop a set of CEN EPBD standards (M/343[3],), to support the first edition of the EPBD[2] resulted in the successful publication of all EPBD related CEN standards in 2007-2008.

The mandate M/480 was issued to review the previous mandate M/343 as the recast of the EPBD raised the need to revisit the standards and reformulate and add standards so that they become on the one

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hand unambiguous and compatible, and on the other hand a clear and explicit overview of the choices, boundary conditions and input data that need to be defined at national or regional level. Such national or regional choices remain necessary, due to differences in climate, culture & building tradition, policy and legal frameworks. Consequently, the set of CEN-EPBD standards published in 2007-2008 had to be improved and expanded on the basis of the recast of the EPBD.

***Road ahead: ISO 52000- series***

The numbers ISO 52000 through ISO 52150 are reserved for the EPB standards. So in the near future the term ISO 52000 series of standards will become equivalent to the term EPB set of standards.

Only standards that meet specific requirements, will be awarded such number. Currently, only 15 numbers are issued, mostly general EPB standards, or for building (thermal, solar) calculations. In 2017/2018 some 30 standards might become an ISO 52xxx standard, making use of the work already done in Europe.

The ISO 52000 series is modular and flexible, making it the perfect basis for future developments like innovations, new insights and new market demands.


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# Energy performance of buildings — Overarching EPB assessment —

# Part 2: Explanation and justification of ISO 52000-1

## 1 Scope

This document refers to the overarching EPB-standard, ISO 52000-1[1].

It contains information to support the correct understanding, use and national implementation of ISO 52000-1. This includes:

— explanation on the procedures and background information and justification of the choices that have been made;

— reporting on validation of calculation procedures given in the standard;

— explanation for the user and for national standards writers involved with implementation of the set of EPB standards, including detailed examples.

## 2 Normative references

There are no normative references in this document.

Some explanations regarding Clause 2 of the overarching EPB standard:

If a reference is made in the text of the standard to a specific part of another standard, only this specific part is referenced, not the entire other standard.

The following text in ISO 52000-1:2017, Clause 2 "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." is the standard phrasing for any ISO standard. As stated in the ISO/IEC Directives, Part 2:2016, Clause 15, the normative references clause is an informative element that lists, for information, those documents which are cited normatively in the document. Information on how these references apply is found in the place where they are cited in the document, and not in the normative references clause. The list of normative references is therefore given for the convenience of the user, who can then consult the place where they are cited in the document to understand and assess how they apply.

NOTE 1 EPB is regulated in some countries or regions: regulations do not necessarily endorse the complete set of EPB standards and might modify the content of the standard(s).

To keep flexibility in referencing standards, the references to EPB standards are placed in the national choices and input data sheet, see Annex A and Annex B.

The references to EPB standards are given as module code numbers instead of a simple list ([1], [2],.[3]), because with the EPB module code numbers the same module code numbering can be used for all EPB standards.

NOTE 2 This will facilitate the making of a consistent set of national annexes for each EPB standard and contribute to overall consistency and transparency.

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# 3 Terms and definitions

This clause provides an explanation of some of the terms and definitions given in ISO 52000-1. The numbers in brackets refer to the term-numbers in ISO 52000-1:2017, Clause 3.

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 Buildings

**Building (term 3.1.2)**

"Building" means the physical construction including the technical building systems.

"Building unit" has been defined separately (term 3.1.8).

The definition in EPBD: "'building' means a roofed construction having walls, for which energy is used to condition the indoor climate" is not usable in this context, e.g. because there are buildings without walls (only roof), or without roof (e.g. pyramid shaped, only inclined walls).

Building category (term 3.1.3)

The term "category" does not only relate to the type of use: also to size, to the period of use (e.g. temporary use) and to other qualifications (e.g. historic buildings).

See also the notes and examples in ISO 52000-1:2017 at this entry and at the definition of Space category (term 3.1.14).

**Reference floor area (term 3.1.12)**

The reference floor area should not be confused with the **useful floor area for EPB assessment** (3.1.18, see further on). The difference between useful floor area and reference area can be found in 9.3 and 9.4.

The **reference floor area** is one of the options is for the **reference size**.

**Reference size (term 3.1.13)**

The reference size is used for the normalization of the energy performance.

Extensive explanation on the reference size is given in 9.4.

**Space category (term 3.1.14)**

A building of a certain (use) category may contain spaces of different (use) categories. Therefore a separate definition at space level: "space category" is introduced.

The purposes of the building and space classifications may be different, which is expressed in the definitions. Moreover, the choice is given (see Clause 6) whether or not, in the EPB assessment, differentiation in space categories within a building of a specific building category is foreseen.

EXAMPLE Does an office building contain only office spaces or is there a distinction (in temperature set points, ventilation needs, lighting needs, domestic hot water needs, etc.) between e.g. office spaces, corridor, entrance hall, assembly spaces, toilets, kitchen, restaurant, …

See also the notes and examples in ISO 52000-1:2017 [1] at this entry and at the definition of Building category.


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**Thermal envelope area (term 3.1.15)**

This term is only needed for the thermal part of the assessment, but still it is an overarching term, because it determines whether spaces are assumed to be thermally conditioned or not (e.g. staircases or attics) which subsequently may also affect e.g. the reference area and the zoning.

**Useful floor area (term 3.1.18)**

The terms 'conditioned (floor) area' and '(un)conditioned space' are obsolete. This is because in the context of the overall energy performance assessment these are ambiguous terms, leading to many misunderstandings, because:

— Each space belongs to a space category with specific conditions of use. Some spaces are thermally conditioned, some have domestic hot water needs, some have only lighting and ventilation needs.

— Other spaces are thermally unconditioned, but have only a specific influence (e.g. adjacent building with adiabatic boundary, adjacent unheated space with thermal influence, ..) or are thermally unconditioned but still with specific services taken into account (in some countries for instance: lighting and/or ventilation of indoor car park or common staircase).

Instead, the terms 'reference floor area' and 'useful floor area' are used.

Difference between the useful floor area and the reference floor area:

— The reference floor area is used for normalization of the energy performance.

— The useful floor area is used for various purposes, such as:

  — for conditions of use, if conditions of use are given per $m^2$ of floor area (e.g. hot water use, ventilation needs);

  — for weighting according to floor area, for instance for redistribution in case of zoning (see Clause 10).

For assessing the thermal envelope of the assessed building or building part and for the zoning, the term 'thermally conditioned space' is used.

Extensive explanation of the useful floor area is given in 9.3.

## 3.2 Indoor and outdoor conditions

**Conditions of use (term 3.2.1)**

This term is needed for the zoning and for the calculations. It means the set of conditions that is needed for the intended use of the space, such as temperature level, lighting level, domestic hot water needs, ventilation (IAQ) needs, …

The relation with operating conditions is: in order to achieve these conditions of use, and depending on the types of provisions (building, systems, controls), specific operating conditions are needed.

## 3.3 Technical building systems

**Cogeneration (term 3.3.5)**

"Energy is generated" is not really possible in a philosophical way. 'Transformed' or 'produced' could be better terms. But definition as used in other documents[2] is clear enough.

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## 3.4 Energy

**On-site (term 3.4.27)**

This definition is linked with those of “nearby” and “distant”. On-site is a larger perimeter then the building only. On-site is often linked to energy production or energy transformation that can be exported.

**Nearby the building site (term 3.4.24)**

The current definition for “nearby the building site” is not fitted for nearby electricity generation. It is intended to introduce also nearby electricity. A proposal could be: Connected to the same branch of the distribution grid (distribution grid meaning voltage level lower than 150 kV)”.

**Distant to the building site (term 3.4.7)**

“On-site” and “nearby” are defined in the EPBD related to NZEB. “Distant” is defined in this standard to cover all perimeters where energy can be produced or transformed.

## 3.5 Energy performance

**Energy rating (term 3.5.12)**

The terms EPB assessment and energy rating have been clearly distinguished. More information can be found in ISO 52003-1[8] and its accompanying report ISO/TR 52003-2[9].

**EPB standard (term 3.5.14)**

Special attention is drawn to the term EPB standard. This defined term is necessary to make clear which ISO standards belong to the set of EPB standards and which do not. A standard that does not fulfil the conditions is not called an EPB standard. Of course, it may still play an (possibly even essential) role. In that case it will be referenced in an EPB standard, typically to provide appropriate input data (e.g. on products or boundary conditions).

**Standard energy performance or energy performance (terms 3.5.23 and 3.5.7)**

The term ‘energy performance’ is used in the EPBD . However, the affix ‘standard’ emphasizes that it concerns the energy performance under standard use and climate, in contrast to ‘tailored energy performance’.

## 3.6 Energy calculation

No need for additional information.

## 3.7 General information on terms and definitions

### 3.7.1 General

Definitions, term, perimeters etc. are important as a common basis and for the understanding of the assessment of the energy performance. Care has been taken to draft the definitions in line with other relevant documents and to keep them as general as possible to match existing definitions. If in a country more precise definitions exist, then the advice is to give this information in a national annex.

### 3.7.2 Overarching terms and definitions

ISO 52000-1 provides terms and definitions that are needed at the overarching level. The terms of lower-level EPB-standards are defined there; otherwise the overarching EPB standard would be overloaded,


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the limit of the definitions to be considered would be difficult to define and the overview would be difficult to manage and keep up to date over time. However, ISO 52000-1 includes terms that are not used in the standard itself, but that are needed for overall consistency in the set of EPB standards.

Other terms and definitions seem overarching, but are only used in a certain area of EPB standards. For instance "expenditure factor" [ratio of the energy input (requested energy) to the useful energy output].

### 3.7.3 Difference between definition and specification

A clear difference should be made between a definition of a term and the procedure to specify (e.g. quantify) the term. The definition only identifies a term. Only in special cases this is enough to unambiguously specify the term. In other cases the actual assessment procedures in the standard contain appropriate procedures to unambiguously assess the value or otherwise specify the term. For instance the value for the energy need for heating or the specification of the energy performance assessment boundary.

### 3.7.4 Undefined and/or unspecified policy related terms

There are certain quantities, that are strongly related to national or regional policy, due to differences in culture and building tradition, building typologies (building use), policy and legal frameworks and administrative practices (including the type and level of quality control and enforcement and assessment cost expectations). It is impossible to fully harmonize these terms at the moment. Therefore they are not, or not completely, defined in the EPB standards or they are defined in a generic way, leaving room for further national or regional specification. Annex A of these EPB standards provides a template with tables for systematically specifying these specifications. Annex B gives informative default choices, that act as examples for the policy related quantities/terms.

Examples:

— useful floor area;

— the boundaries between "on-site", "nearby" and "distant";

— assignment of building and space categories (e.g. office space, shop, assembly room or hall, bed and breakfast, children day care, nursing home, …);

— subdivisions of building and space categories (e.g. residential buildings: single family house, student flat, senior homes, mobile home, house boat, holiday home, ..);

— assignment of category: designed building; new building after construction; existing building in the use phase; majorly renovated building.

Any (further) definition or specification of these terms would already be a too strong constraint for the required national or regional detailed specifications.

This does not lead to a problem in the form of an open end in the energy performance assessment, because such national or regional detailed specifications are done in the "pre-processing phase" of the energy performance assessment, so that it can be assumed that these have been assessed when starting the routing through the overarching EPB standard. For this reason, these issues are dealt with in the overarching EPB standard as "Overarching preparation steps" (see ISO 52000-1:2017, Clause 6).

## 4 Symbols, units, subscripts and abbreviations

### 4.1 Symbols

The list of symbols and units in ISO 52000-1:2017, 4.1 includes common symbols for the EPB standards. This list is normatively referenced in each subsequent EPB standard, but some of these may also be repeated in an individual EPB standard if convenient for the understanding. In particular if there is a need to give a systematic overview of specific subsets of symbols.

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The energy, time and power units are linked together. There are two set of quantities in use:

— Joule, second, Watt;

— kW·h, h, and kW.

Both can be used but care must be given to consistency with some other units involving energy such as;

— specific heat (J/kg or kW·h/kg);

— calorific value (MJ/kg or kW·h/kg).

The symbol for Celsius temperature is "$\vartheta$".

NOTE In the past "$\theta$" was used as well and could still appear in some standards until they are made all consistent.

For energy, the following rules apply for the use of symbols $Q$, $E$, and $W$:

— $Q$ is the symbol for heat within the building;

— $W$ is used for auxiliary energy within the building;

— $E$ is used for any other type of energy and for energy outside the building.

$E$ is used mostly for energy quantities related to exchanges across the assessment boundary. $E$ is also used as an amount of any energy carrier expressed as energy contents.

### 4.2 Subscripts

The list of subscripts given in ISO 52000-1:2017, 4.2 includes only subscripts used in that standard itself.

Common subscripts for all EPB standards are given in Annex C. This list is normatively referenced in each subsequent EPB standard, but some of these may also be repeated in an individual EPB standard if convenient for the understanding. In particular if there is a need to give a systematic overview of specific subsets of subscripts.

See ISO 52000-1:2017, Annex C and Annex Cof this document for further information on subscripts.

### 4.3 Abbreviations

For the purposes of this document, the abbreviations as mentioned and given in ISO 52000-1 apply.

The list of subscripts given in ISO 52000-1:2017, 4.3 includes abbreviations not used in that standard itself. They are given to ensure overall consistency between the set of EPB standards.

Where possible, the subscripts used for a certain term are the same as the abbreviation. Where possible the abbreviations used in connection with software are also the same.

## 5 Description of the overarching framework and procedures

### 5.1 Output of the method

The main output of this standard is

— the absolute values of the weighted total energy performance;

— the RER (renewable energy ratio).


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Additional output data, namely energy performance indicators per service and/or per part of the building or delivered energy per service and/or per part of the building, can be also calculated applying the additional procedures given in Annex E to ISO 52000-1:2017 [1].

The way of expression and the calculation of energy performance indexes is specified in ISO 52003-1[8].

## 5.2 General description of the procedures and routing

Annex K includes a calculation flow chart.

## 5.3 Selection criteria between the methods

The selection of method or methods may depend on the assessed object: object type, building category, application type and assessment type.

If the object type is a whole building, then a full method will usually be selected, if the object type is a building system, then a method for calculating/measuring a partial indicator is more likely, see 9.8.

If the building category is a residential building, then it is very possible that specific methods or requirements exist. For offices this is also possible, but for industrial sites or workshops a less detailed method might be enough.

If the application type is 'energy performance certificate', then this can be done by calculating from the design, but this does not include the changes that were made during construction, so calculation from the actual built situation is better. For the application type of 'energy audit' see also EN 16247-2, Energy audits - Part 2: Buildings.

If the assessment type is 'as built' then both calculation and measured methods can be applied. Measured is usually quicker, but due to some uncertainties in behaviour of the user of the building, it is less accurate.

## 5.4 The over-arching reference modular structure

### 5.4.1 Purpose

The overarching reference modular structure is used to identify:

— all required parts of the assessment procedure and provide an overview;

— the modules covered by the EPB standards and to support specifications given to standard writers of the EPB modules;

— the connection between the EPB standards (e.g.: calculation, expression of the energy performance).

This structure also enables and facilitates a step-by-step implementation in any national or regional context.

### 5.4.2 Systematic modular structure of the standards

The over-arching modular structure has four main areas as shown in Table 1:

**Table 1 — Modules main areas**

| Modules | Area |
|---|---|
| M1 | Overarching standards |
| M2 | Building (as such) |
| M3 - M11 | Technical Building Systems under EPB |
| M12 - M13 | Other systems or appliances (non-EPB) |

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Each main module is divided into sub-modules, in such a way that, where possible and feasible, some symmetry is retained.

The numbering of the systematic modular structure is shown in Table 1 in ISO 52000-1:2017.

EXAMPLE 1 M3-5 is the module on heating and cooling – the emission and control aspects.

EXAMPLE 2 M10-11 is the module on Building Automation and Control– the inspection aspects.

In the Introduction of each EPB Standard a table with the modular structure is provided. The number of the standard is placed in the module it refers to.

EXAMPLE 3 See the Introduction of ISO 52000-1:2017: the standard refers to modules M1-1, M1-2, M1-3, M1-5, M1-7, M1-8, M1-9 and M1-10.

### 5.4.3 The connection between the modules – step by step implementation

The connection between the different modules is illustrated by an example of the energy performance assessment of a building with heating and domestic hot water services.

Figure 1 shows an example of the needed calculation modules from the main modular structure.

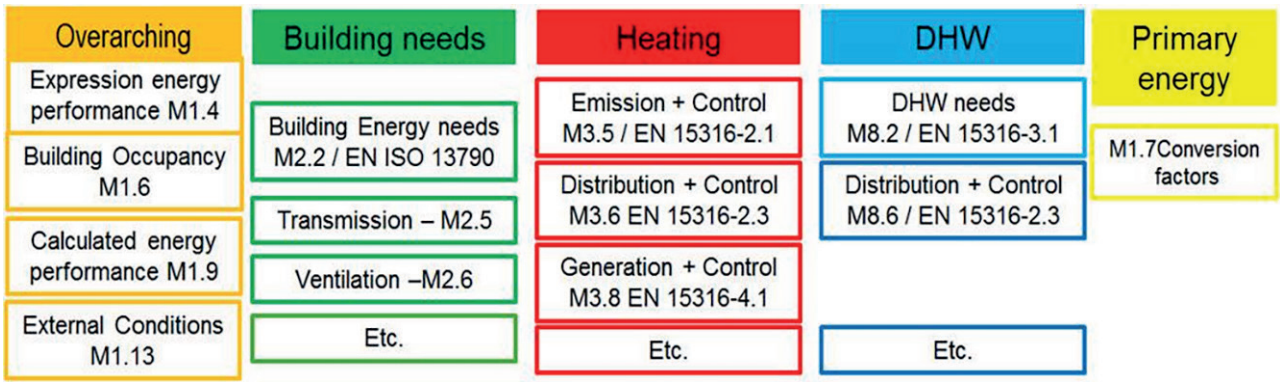


**Figure 1 — Example of modules for the energy performance assessment**

These different modules are connected in order to calculate the energy performance. The calculation goes from the needs to the primary energy. Figure 2 shows a simplified scheme of the connections.

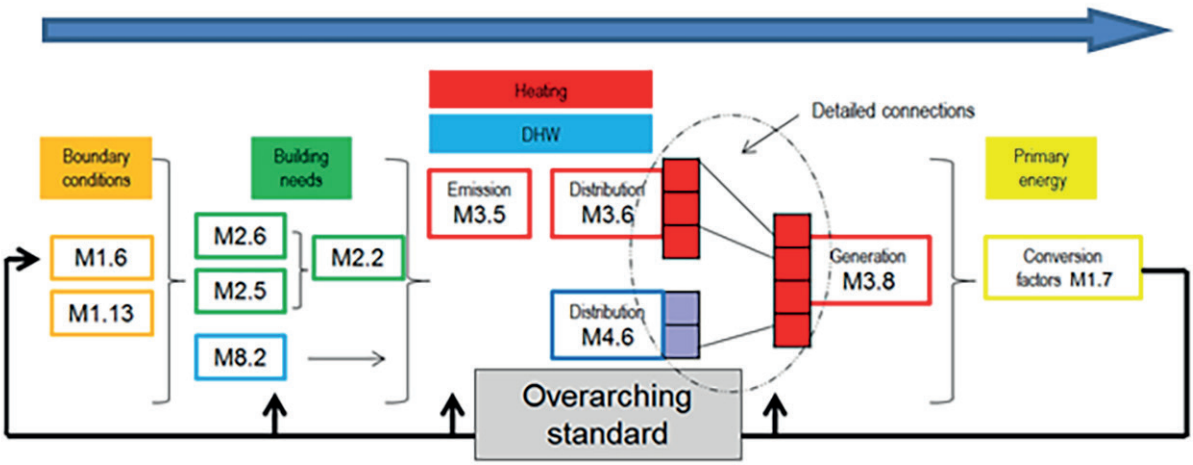


**Figure 2 — Connection scheme of the modules (Example).**


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The overall scheme, including the detailed connections, is indicated in the overarching EPB standard and worked out in cooperation between the overarching EPB standard and the development of the modules of the EPB standards.

The connection between the modules is organized in detail by defining the input and output of the modules.

The modules are integrated in the overall modular structure by the module input and module output.

The module input contains the needed system operation conditions to calculate the energy performance of the module (see Figure 3).

The module output (see Figure 3) contains, among others things:

— the systems operation conditions influenced by the module (e.g. distribution temperature);

— data needed in the overarching EPB standard to assess the energy performance and the interactions between modules (e.g. recoverable losses);

— data for compliance check and quality control.

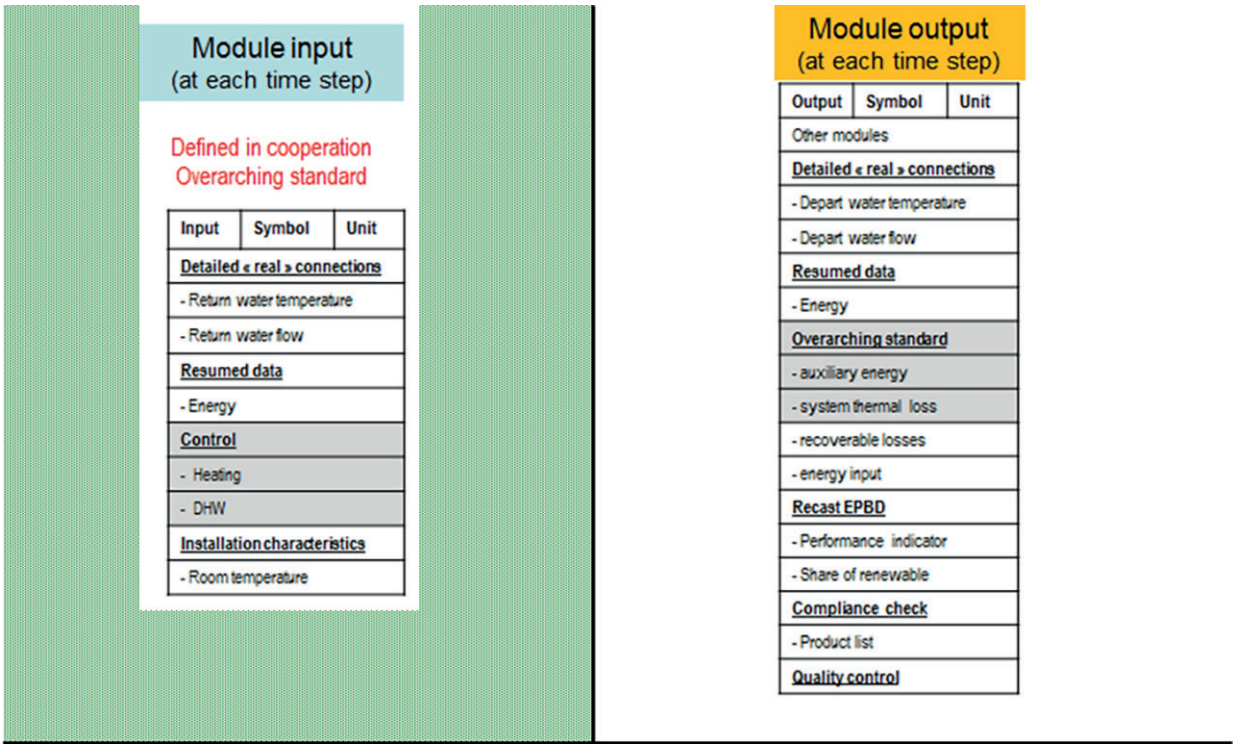


**Figure 3 — Input/output data of a module**

The input and output data are calculated at each calculation interval. There could be several modules dealing with the same topic (e.g. national or European boiler model) but each module fits the defined input and output data, otherwise it cannot be integrated in the overall structure.

In addition to input/output data defined in cooperation with the overarching structure, each module has also specific data, internal calculation procedures and links to databases (see Figure 4). The specific module input data is defined in a specific line of the user interface. The specific module input data are used only once at the beginning of the assessment.

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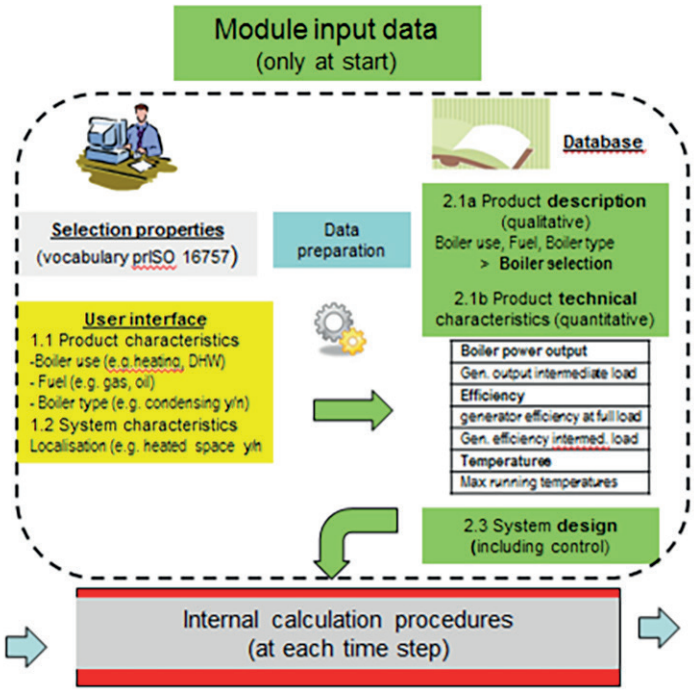


**Figure 4 — Specific module data**

### 5.4.4 Systematic consecutive numbering of the standards

The series of numbers between ISO 52000 and ISO 52150 have been reserved by the ISO Secretariat for the set of EPB standards.

Each number is intended for a specific module or part of it, with provisional titles to indicate the successive items. Per standard, different parts can be used for specific procedures. The parts with an odd number are intended for standards, while the parts with even number are intended for the accompanying technical report.

Examples are shown in Table 2:

**Table 2 — Examples of module numbers and the standards they refer to**

| Module | Number | Title (draft) |
|---|---|---|
| M1-4 | ISO 52003-1 | *Energy performance of buildings – Indicators, requirements, ratings and certificates– Part 1: General aspects and application to the overall energy performance* |
| | ISO/TR 52003-2 | *Energy performance of buildings – Indicators, requirements, ratings and certificates– Part 2: Explanation and justification of* ISO 52003-1 |
| M1-13 | ISO 52010-1 | *Energy performance of buildings –. External environment conditions – Part 1: Conversion of climatic data for energy calculations* |
| | ISO/TR 52010-2 | *Energy performance of buildings –. External environment conditions – Part 2: Explanation and justification of* ISO 52010-1 |
| M2-2 | 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 – Part 1: Calculation procedures* |
| | ISO/TR 52016-2 | *Energy performance of buildings – Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 1: Calculation procedures – Part 2: Explanation and justification of* ISO 52016-1 *and* ISO 52017-1 |


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**Table 2** *(continued)*

| Module | Number | Title (draft) |
|---|---|---|
| M2-5 | ISO/TR 52019-2 | *Energy performance of buildings (EPB) – Building and building elements – Hygrothermal performance of building components and building elements – Part 2: Explanation and justification* |
| M2-8 | ISO/TR 52022-2 | *Energy performance of buildings – Building and building elements – thermal, solar and daylight properties of building components and elements – Part 2: Explanation and justification* |
| | ISO 52022-1 | *Energy performance of buildings – Building and building elements – solar and visual characteristics – Simplified calculation method* |
| | ISO 52022-3 | *Energy performance of buildings – Building and building elements – solar and visual characteristics – Detailed calculation method* |

# 6 Overarching preparation steps

## 6.1 General

See the corresponding clause in ISO 52000-1 [1].

See also the discussion on policy related definitions and specifications in 3.7.3 of this document.

The reader should be aware that there are two different types of use of the overarching EPB standard (and other EPB standards) as illustrated in Figure 5:

**Step 1:** the use by private organizations or public institutes to make, for specific applications (e.g. for national energy performance certification and/or requirements) the input data, choices between options and choices in references to other EPB standards according to the template of Annex A: one or more (for different applications) National or Private Input and method selection data sheets.

**Step 2:** the use by the individual user to assess the energy performance of a specific object, using the appropriate National or Private Input and method selection data sheets from step 1.

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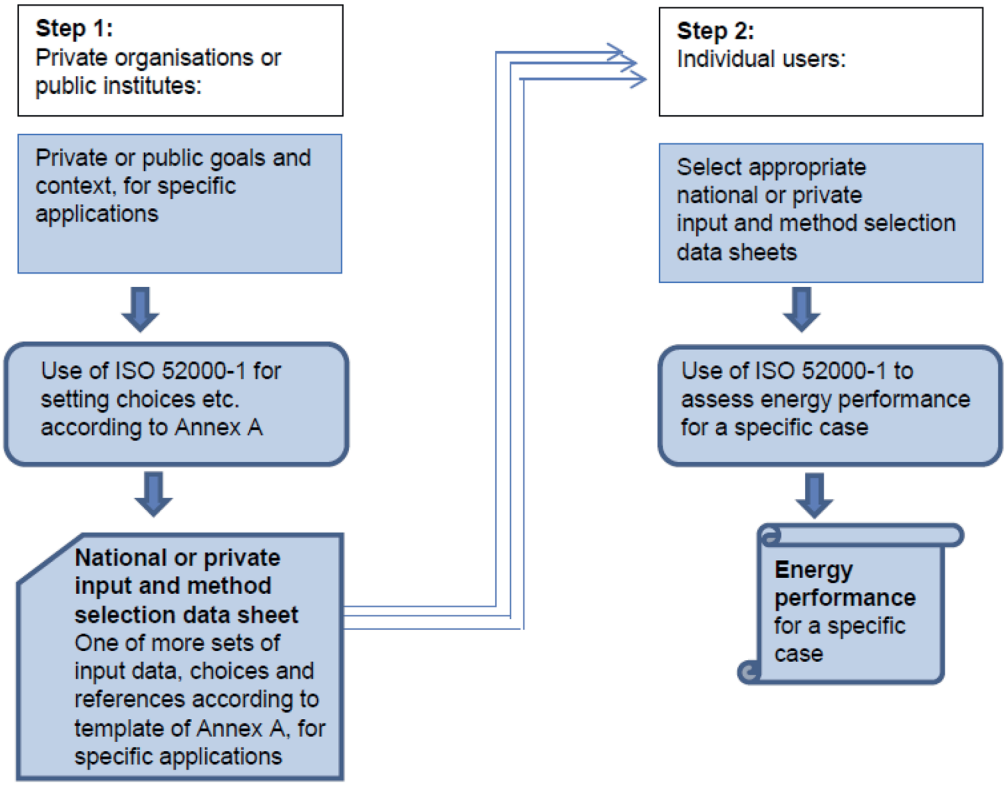


**Figure 5 — Illustration of the two different types of use of the EPB standards**

These two different types of use of the overarching EPB standard (or any other EPB standard) is explicitly visible in this Clause 6 that contains the preparation steps:

**Clause 6.2** covers the above mentioned "Step 1": for private organizations or public institutes (as part of the specification of the National or Private Input and method selection data sheets): to specify the list with types of object, building and space categories, types of applications, types of assessment and lists of EPB services

**Clause 6.3** covers the above mentioned "Step 2": for the individual users (after having made the appropriate selection of the National or Private Input and method selection data sheets) to select which type or types of object, building and space category or categories, type of applications, type of assessment and list of EPB services is applicable for his/her specific case.

Note that the choices in both 6.2 and 6.3 may have an effect on the choices in other EPB standards. These properties are therefore inherited by the other EPB standards, where relevant.

EXAMPLES:

— if, in a certain country, lighting is not included in the list of EPB services for residential buildings, then:

  — the fact that lighting is not included in the list of EPB services for residential buildings is taken into account in the National or Private Input and method selection data sheets of other EPB standards (e.g.: EPB standard on lighting, on indoor environment conditions, …).


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  — the fact that the specific object is a residential building or not is inherited by other EPB standards (e.g.: EPB standard on lighting, on indoor environment conditions, …).

— if the energy certificate for apartment buildings is based on measured energy performance, then this information may obviously be very relevant for several other EPB standards.

— if the energy certificate for public buildings is based on actual energy use of the building and if the certificate needs to be displayed, then this information may obviously be very relevant for several other EPB standards.

— if the energy performance of a partially renovated building needs to meet specific partial energy performance requirements, then this information may obviously be very relevant for several other EPB standards.

— The specification of different building categories, and/or space categories and the identification which building category and/or space categories is applicable in a given case, is directly linked to (possibly) different conditions of use (temperature settings, domestic hot water needs, lighting needs, etc.), to (possibly) different EP requirements, etc. Therefore this information is very relevant for several other EPB standards.

## 6.2 List of types and categories

### 6.2.1 Type of object

ISO 52000-1 [1] asks for the identification of the type of object.

Examples of object types are: whole building or part of the building or building unit, new or existing building, large public building.

Residential or non-residential buildings may require different choice of assessment method (e.g. measured versus calculated).

A specific country or region may have special building categories that require a deviating procedure. For instance in Europe: large public building according to the EPBD[2] art. 13 (plus art. 12.1b). Another distinction of types is according to the life cycle category, for example:

— designed building,

— new building after construction,

— existing building in the use phase,

— majorly renovated building.

The energy performance procedures and requirements may differentiate between new and existing buildings or building units.

For new buildings, for which no long term actual data (necessary to assess the energy use) are known or can be measured, the energy performance procedures and requirements are limited to calculated energy performance. Compare definition of existing building (unit).

For existing buildings, for which long term actual data (necessary to assess the energy use) are known or can be measured, the energy performance procedures and requirements may include measured energy performance.

‘Major renovation’ means for instance, according to the EPBD, the renovation of a building where:

(a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated; or

(b) more than 25 % of the surface of the building envelope undergoes renovation.

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If a so called "Representative building approach" is applicable, then the energy performance is taken from another, representative, building.

Another issue is the definition of a building: If a building category extends to two or more buildings on the same site, they can be regarded for the calculation as one building. But it is also possible to assess the energy performance of each of the buildings independent from each other, unless this conflicts with other parts of the procedures. For example if one or more residential functional units are located in another building (for example a bedroom or toilet in a separate building), the EP assessment of the building needs to be done for the buildings together.

### 6.2.2 Building category and space categories

#### 6.2.2.1 Building categories

The building category may have an influence on the energy performance, because of possibly different sets of conditions of use, possibly different EP requirements, etc..

EXAMPLE Historic monuments and/or religious buildings are sometimes excluded from the energy performance regulations.

For residential buildings a categorization could be: (a) single-family houses of different types and (b) apartment blocks.

For residential buildings, there may be a need for subcategories, because of possible differences in EP requirements or in the assessment type (measured or calculated EP). For example:

— Individual residence;

— Apartment building;

— Building unit in an apartment building with individual technical system(-s);

— Building unit in an apartment building with collective technical system(-s).

Again for residential buildings, there may be a need for special subcategories, because of possible differences in EP requirements and/or in the assessment type or conditions of use. For example:

— Residence for collective use;

— Mobile home;

— Holiday home.

A 'residence for collective use' is a residential building in which one or more spaces for a residential use are used collectively, with the result that the individual apartments are not independent building units, for example student-housing with kitchens and/or bathrooms or livings for collective use (see example cases in 6.4). In such cases the energy performance assessment of the building would typically be done for the total residence. But this is a choice that is linked to the choices of space categories and such.

But even more subcategories are feasible. For instance: a student flat, senior homes, house boat, bed and breakfast (residential?).

Another issue: What specific rules are needed for mixed buildings? A mixed residential/non-residential building is for example an apartment building comprising shops, office rooms, hotel rooms and/or for instance nursing rooms or an assembly hall. Are there any specific restrictions when dealing with mixed residential/non-residential buildings?


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#### 6.2.2.2 Space categories

A differentiation in space categories in a given building may be allowed or not (see Table A.6/B.6 of ISO 52000-1:2017 [1]). If so, the most likely reason is, that different categories of spaces have different conditions of use (to be specified in the EPB standards covering module M1-6).

The conditions of use imply which services are assumed to be present.

The space categories include unconditioned or partially conditioned spaces which have an influence on other spaces (e.g. thermal, daylight, additional energy use,..).

Examples of possible space categories: living space, (residential) kitchen, entrance hall, (indoor) stair case, (in)habitable attic, bed room, nursing room, education room, corridor, toilet, server room, storage room, kitchen of "industrial" type (e.g. in restaurant), undetermined space, etc.

For existing buildings: a space that is formally allocated as inhabitable spaces should, for the purpose of the assessment of the energy performance, be assumed to be a inhabitable area, and be assigned the corresponding space category, if this space is in practice regularly occupied. For instance an inhabited attic (even if legally uninhabitable e.g. due to insufficient daylight).

Consideration should be given to buildings that are not equipped with all services for which the energy performance should be assessed (e.g. building without cooling systems when cooling is part of the energy performance calculation). See discussion in 9.2 of this document.

### 6.2.3 Type of application

There are different types of application possible. For instance:

— To check compliance with energy performance requirements

— Energy performance certification

— To obtain building permit

— To obtain permit to use

— Energy audit (tailored)

— Energy performance inspection

Obviously the type of application may have an influence on the assessment and the routing through the EPB standards. Therefore also the type of application is inherited by the subsequent EPB standards.

### 6.2.4 Types of assessment

The assessments given in Table 3 of ISO 52000-1:2017 are derived from EPBD requirements. There are other possible assessments not in relation to the EPBD, but addressing "added value to the market". See also CEN/TS 16628:2014,[13] 7.8. The type or types of EPB assessment should be specified and, if depending on the application and/or building category, for which application and building categories.

Rationale for making the choice:

The selection of the relevant energy performance assessment type should take into account the following points. The procedure for building energy certification should describe how these points have been taken into account as part of the procedures in ISO 52003-1[8].

— For new buildings, the measured energy indicator is not available.

— Measured energy offers a means of adjusting recommendations to suit the actual building use rather than standardized assumptions.

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— For tracking year-on-year improvements (or otherwise) of operational performance, measurements need to be taken. (Public buildings are sometimes required to display annual measured ratings for several consecutive years).

— The utilities which collect data on energy consumption should not be authorized to disclose them for privacy reasons.

— A measured energy indicator will no longer be valid following a change of building occupier or of the pattern of use of the building. For existing buildings which are rented or sold, the way the building is managed could change and the measured energy indicator could change as a result.

— Defining a standard calculated energy indicator includes the collection of data on the building (insulation, heating system, etc.) which will be useful in giving advice on the improvement of its energy performance.

— In existing public buildings where there is no change in ownership, the measured energy indicator can be a measure of the quality of the management and can be used to motivate building operators and users.

— When the energy certificate is displayed in an existing public building, the operational indicator can be a measure of the quality of the management and can be used to motivate building operators and users.

— For managers of buildings, a measured energy indicator can be easily obtained from data often stored in their information systems (energy bills, areas, etc.).

— Measured energy indicator and standard calculated energy indicator do not necessarily include the same energy uses.

— For new buildings, a design indicator may be the only practical means of assigning an indicator.

EXAMPLE A mix of tailored and design assessment may be used for an optimization of the building and the technical systems during the design phase, if the use is better known and different from the standard use. A variant of this assessment using standard use data may then be used for the design assessment as a by-product.

### 6.2.5 Building services

The building category is linked to typical uses satisfied by building services. The definition of 'energy performance of a building'[2)] takes into account the following building services:

— heating;

— cooling;

— ventilation;

— domestic hot water;

— lighting;

— humidification;

— dehumidification.

Other energy services, for example "appliances", "transport" (e.g. lift, mechanical escalators) may be considered. If other appliances are considered, this should be indicated in the related table of the Input and method selection data sheet, according to Annex A of ISO 52000-1:2017.

2) Following definition 4 of the recast EPBD[2].


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The energy services for appliances will become more and more important in high performance buildings. The reasons for not selecting "appliances" in the default option are the following:

— only the energy services heating, cooling, ventilation, hot water and lighting are taken into account;

— only energy services characterising the performance of the building, linked to the building envelope and to "building integrated" technical systems, are considered;

— only energy services where it is possible and practical to verify the compliance with building regulations are considered (legal aspects).

NOTE 1 Assessment based on measured consumption (commonly used for public display certificates) can include these other energy uses.

The use of energy for the considered building services is linked to the occupancy patterns (e.g. tapping patterns for domestic hot water (DHW), internal air temperatures, occupancy, and scenarios).

NOTE 2 If verifiable construction specifications influence the "other energy services", then a possibility could be to take into account the other energy services by linking the construction specifications to different default values.

Another important part related to the building services are the recovered losses and the internal gains of an energy service, for example the heat gains related to appliances. A distortion of the energy balance can be created if the energy used is not considered in the energy balance and if only the internal gains are taken into account. In this case only the benefit related to the internal gains would be taken into account, without counting the needed energy use.

In order to be close to a realistic evaluation, especially of the indoor temperature and the load calculation, it has been decided to take into account internal gains even without the related energy service.

The value of these internal gains should be reported in the occupancy patterns and conditions of use.

Consideration should be given to buildings that are not equipped with all services for which the energy performance should be assessed (e.g. building without cooling systems when cooling is part of the energy performance calculation). Possible options are:

— provide specification of a default technical system for each missing service;

— accept a better assessment for buildings missing some service and possibly highlight the discomfort with a complementary indicator (example: hours of summer discomfort).

See discussion on this issue in 6.2.2 (Space categories) and 9.2 of this document.

## 6.3 Identification of types and categories for a specific case

See explanation in 6.1.

## 6.4 Example cases

### 6.4.1 General

The typical building services of the building, e.g. heating, cooling, ventilation, hot water and lighting seem related to the building category. However, the category is essentially a property of the individual space, because a building seldom consists of one space category only.

EXAMPLE A typical office building contains also a hall, toilets, corridors: spaces servicing the use as an office; a school building often has some office spaces: spaces with other use than education.

Consequently: Schematization of a building starts with the categorization of spaces.

Each space may have its own space category that needs to be specified since this determines the (assumed standard) conditions of use: temperature, lighting, ventilation and air quality, domestic hot

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water needs, use of (other) appliances, etc. So the categorization of spaces determines the **internal conditions** that influence the **energy use**.

The minimum energy performance **requirements** ("energy budget") and **benchmarking** are the mirror image of the energy performance assessment procedures: they should be based on the same assumptions to avoid that "apples are compared with oranges".

Consequently, one should be aware that choices that influence the energy use (e.g. which types of spaces and which energy services are included), also have an impact on the minimum energy performance requirements and the benchmarking. Setting legal requirements on energy performance should take into account the case of buildings including several space categories.

For administrative purposes, the prevailing space category may be attributed to the building.

In contrast to the categorization of spaces, the allocation of a building category seems to have no other impact on the energy performance assessment than certain legal implications (e.g. setting of minimum energy performance requirements, energy certificates, safety and health). The building categories apply either to the whole building or to a building unit.

It is up to the user of the standard to make simplifications in the differentiation and allocation of space categories, within the appropriate legal context of course. In this way it is even possible to allocate the prevailing space category to all the spaces of the building or building unit.

The following example cases (see Figures 6a to 6f) serve as catalyser for the discussion and better understanding of the specifications of the assessed building (part) and the allocation of space categories and conditions of use. Other exercises can be added easily.

### 6.4.2 Example case 1

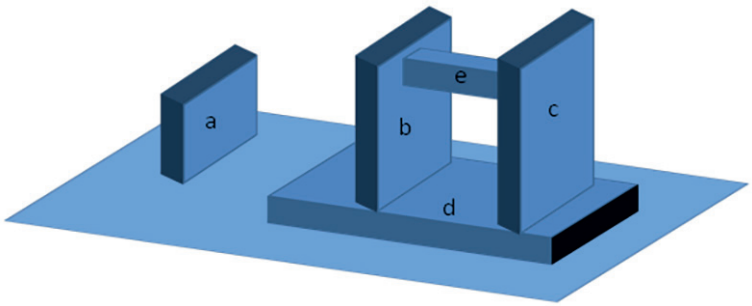


**Figure 6a — Example 1**

**Description:** More than one building on the same building site

**Exercises:**

— Is it possible to give a common EPB definition of a (separate) building? No, e.g. if (d) is an indoor car park and (e) is a sky bridge (as corridor): any definition is arbitrary whether (b) and (c) are separate buildings (connected via the sky bridge and indoor parking (d)) or (b) and (c) are a single building.

For the EP assessment this choice (two or one building) should not make a difference (but nevertheless probably will…).

— See 6.2: Situation may be for example:

  — Building (a) is a new building for which EP is to be assessed.

  — Building unit in building (a) needs to be assessed.

  — Building (b) is to be assessed; (including (some of?) common part (d) and sky bridge (e).


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— All buildings (a - e) are to be assessed.

— Building part (d) is renovated (including entrance hall for building parts (b) and (c); to be assessed, but large part is only entrance hall.

### 6.4.3 Example case 2

**Description:** A students flat.

Floor plan each floor:

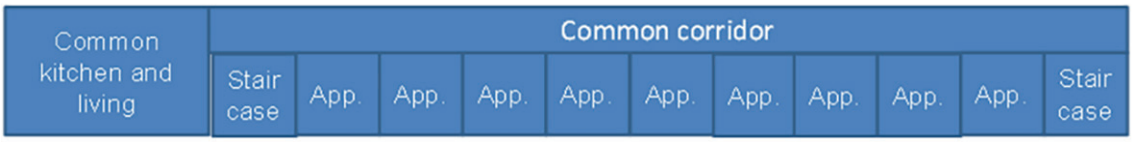


**Figure 6b — Example 2**

NOTE The apartments are not independent building units: each floor has a number of apartments with one common kitchen and living room (e.g. with also common showers per floor or an individual shower per apartment). This building type is also known as "Residence for collective use".

**Exercises:**

— See 6.2: Can the EP per apartment be assessed, as a building unit? No: each apartment is not an independent part of the building. An independent part of a residential building requires at least a living room, bed room, kitchen area, toilet and bath room, or combined toilet and bathroom. Therefore, the smallest building unit is one floor.

— See 6.2.2: What if the same building has, in addition to the common kitchen and living per floor, also a large common indoor space for the whole building, e.g. at the ground floor? Then it might depend on national building regulations whether this space is regarded as necessary common living space or as extra space.

### 6.4.4 Example case 3

**Description:** Mixed building with different space categories, common spaces (hall, toilets, escape route), spaces not for human occupation and spaces outside the considered building or building part.

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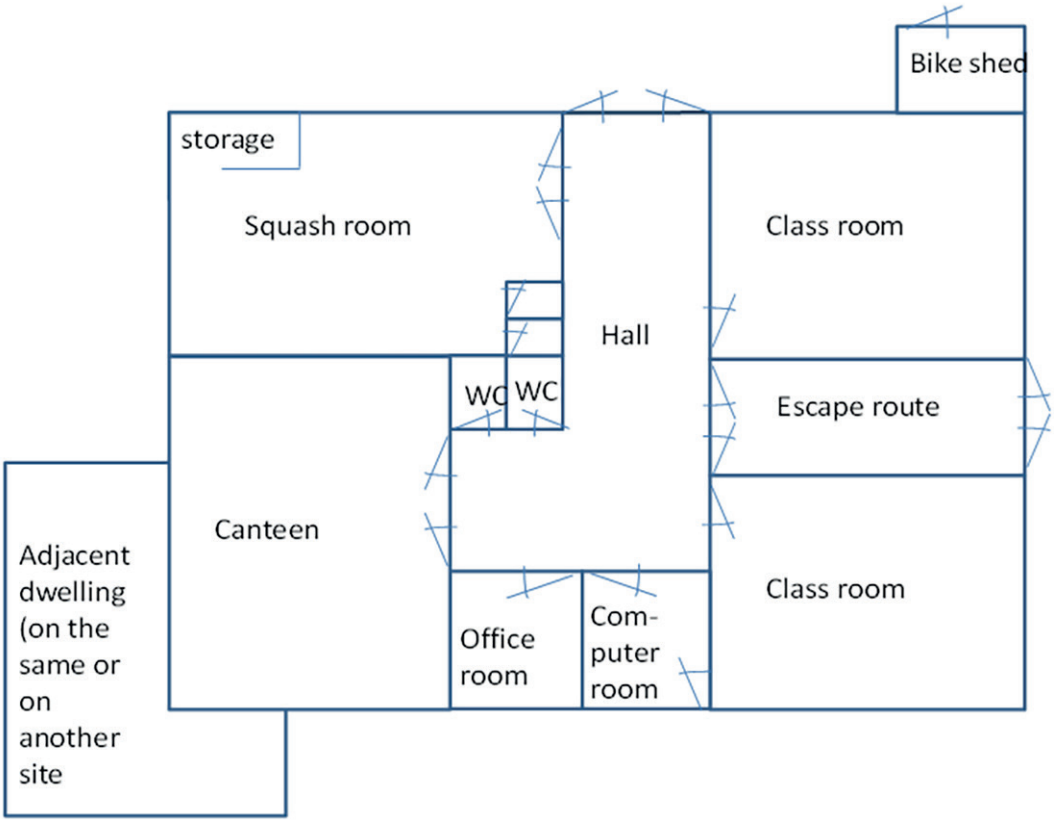


**Figure 6.c — Example 3**

**Exercises:**

— What is the space category of the common hall, escape route and the common toilets? See the three options with pro's and con's described above.

— Assume that the common hall, escape route and the common toilets have their own conditions of use. We would not like to calculate each space separately. What are the rules for allowing to combine spaces into building sections?

— Is the bike shed inside or outside the "thermal envelope"? This depends on rules, given in the standard under EPB module M2-2 (ISO 52016-1[10]). if inside: which (thermally conditioned) space category will be allocated to this space? But if there are adjacent spaces with different categories? The largest. But if they are equal size? Free choice?

— What is the link with the adjacent dwelling? Evidently: if on another site, or if not included in the object to be assessed, the adjacent dwelling is only a boundary condition. For what? A boundary condition for the calculation of the heating and cooling needs. Therefore, assumptions are needed for this boundary. But these can be specified in the specific standard dealing with energy needs for heating and cooling (ISO 52016-1[10]).

### 6.4.5 Example case 4

**Description:** Dwelling with (habitable) attic, sunspace, storage


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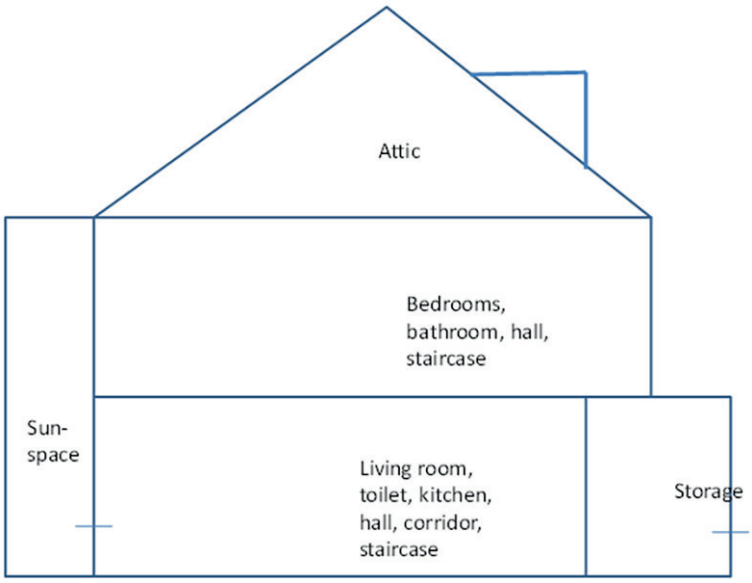


**Figure 6d — Example 4**

**Exercises:**

— What to do with attic if legally not habitable, but in practice habitable/habited?

— Storage included or excluded?

— See Clause 10: Service area for hot water needs? For a calculated EP, the amount of hot water needs (shower, kitchen) are (nationally) defined per person, with a given standard occupancy per m$^2$ floor area. In a residential building, the counting of persons is of course for the whole dwelling (evidently, because all the persons in the dwelling together determine the hot water needs of kitchen and bath room). Consequently: for the hot water needs of a dwelling the whole dwelling is a single "zone" (service area).

### 6.4.6 Example case 5

**Description:** Another mixed building with different space categories, common spaces (large entrance hall), spaces not for human occupation and (possibly) spaces outside the considered building or building part.

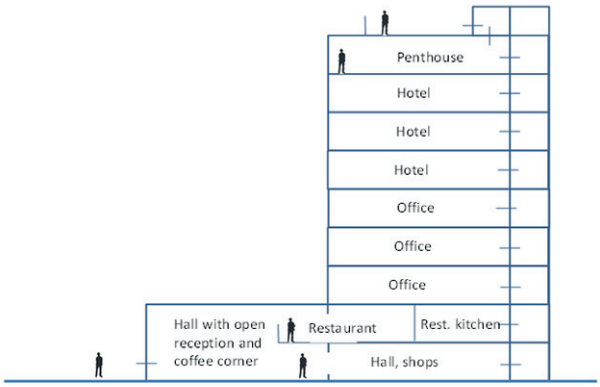


**Figure 6e — Example 5**

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**Exercises:**

— EP whole building: What conditions to assume for the large common entrance hall?

— EP of penthouse: what to do with attributing (part of) the hall?

— EP of restaurant (e.g. if renovated or changed ownership): What to do with attributing (part of) the hall? How to deal with the open connection to hall? What to do with kitchen (category: "industrial")? What to do with technical building systems (TBS) in case common TBS for whole building?

### 6.4.7 Example case 6

**Description:** Building with indoor car park

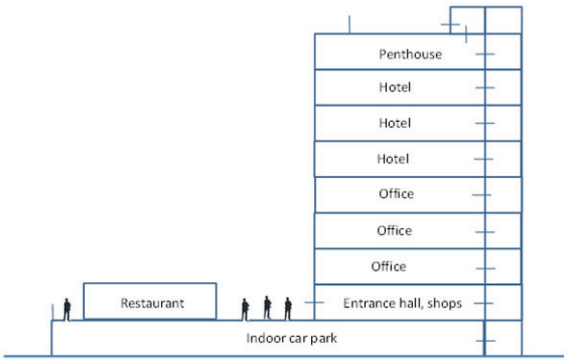


**Figure 6f — Example 6**

**Exercises:**

EP whole building: some countries include car park's energy for lighting and ventilation in EP, but not its size in the reference size (see discussion in 9.4).

# 7 Calculated energy performance of buildings

## 7.1 Output data

Obtaining data per service and per building zone can be done only at overarching levels because there can be many generation systems contributing to the same service and there are also common contributions of renewable energy produces on-site that is allocated to all the considered EPB services.

## 7.2 Calculation intervals and calculation period

### 7.2.1 Calculation interval

When defining the input and output variables between the individual modules in an unambiguous way, it is essential that it is clear which time interval is used for the variable being transferred from one module to the other. This could for instance be:

— Hourly;

— Monthly;

— Seasonal;

— Yearly;


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— Bin.

"Bin" refers to a statistical method, where the frequencies of occurrence of short time interval values for one or more boundary condition variables (e.g. hourly values for the outdoor air temperature) are allocated to defined intervals (the "bins"). The calculation is then done bin by bin, by using the value of the variable in the middle of the bin as a boundary condition and multiplied by the frequency of the respective bin.

This method is especially of value when calculations with longer time intervals for some parts (e.g. monthly or seasonal for the building) need to be combined with calculations of technologies where the influence of the variation of a driving force is essential and averaging is not acceptable (e.g. the outdoor temperature for air-to-water heat pumps).

The limitation of the bin method is that there is no 'memory' between the bins. In case of energy storage systems or in case of heat accumulation in building elements, a bin does not know how much heat was accumulated or released during the previous time interval, because the bins are not sequential in time as e.g. an hourly time interval.

The calculation interval is one of the key issues. to obtain a transparent and coherent overall structure, with all of the interactions at different levels and with a coherent set of input data.

For use in the context of building regulations it is essential that the procedures to calculate the energy performance of a building are not only **accurate**, but also **robust** (applicable to a wide range of cases). It is also essential that they are **reproducible** (unambiguous) as well as **transparent** and **verifiable** (e.g. for municipalities, to check compliance with national or regional minimum energy performance requirements) and **applicable/affordable** (e.g. for inspectors, assessing the energy performance assessment of an existing building).

In other words, it is important to find a balance between transparency, robustness and reproducibility of the calculation method, an affordable and reliable set of input data, and sufficient appreciation of the wide variety of available energy saving technologies.

Therefore, the accuracy of the model should always be in proportion with the limits and uncertainty in input data and with the required robustness and reproducibility of the method: a balanced accuracy.

Consequently, the most accurate, complete and state of the art method is not necessarily the most appropriate method for a specific calculation.

Annex L contains a list of technologies.

Many of these technologies, in particular for low energy buildings, are strongly and dynamically interacting with the hourly and daily variations in weather and operation (solar blinds, thermostats, needs, occupation, accumulation, mechanical ventilation, night time -free cooling- ventilation, weekend operation, etc.). This has a strong effect on the heating and cooling calculation.

In the monthly calculation method of the energy needs for heating and cooling, correction or adjustment factors are required to account for these effects in a kind of statistical way. A direct hourly calculation may not need such correction factors and is from that point of view a favourable method. But the challenge for an hourly method is to avoid the need for too many input data from the user, which would introduce uncertainties that could easily lead to a loss of overall accuracy.

Moreover, an accurate hourly calculation covers only one specific situation, with one specific set of conditions of use: one daily pattern of temperature settings, one pattern of occupancy presence, ventilation needs, weather, etc. The impact of variations is not taken into account (unless it would be prescribed to repeat the calculation for a given building with a prescribed variation of patterns).

The correlation factors in a monthly method may have been developed on the basis of a large series of building simulations with e.g. variations of daily weather and conditions of use, leading to statistically

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average correlation factors that could –for certain effects- give a more robust result than an hourly calculation based on only one specific pattern.

EXAMPLE the comparison of manually controlled solar blinds versus automated operation of blinds would require that the variation in user behaviour in case of manually controlled blinds is taken into account. In a monthly calculation a correlation factor can implicitly take into account these variations. In an hourly calculation there is only one type of user behaviour.

For an hourly method it is important to avoid that the result is just a black box. Therefore, where possible, monthly results are given that can be used to check the validity or feasibility of the result. In ISO 52016-1[10] the monthly and hourly calculation method are even directly linked: both methods use almost the same input and the hourly method also yields monthly results which can be compared with the monthly method or be a basis for the derivation of correlation factors for a monthly method.an hourly calculation method does not require that all output from each EPB standard are hourly varying. This depends on several factors, such as:

— The importance of the quantity (quantities with minor influence may be regarded more easily as 'static').

— The amount of variation of the output as function of certain conditions (e.g. the U-value of a wall can usually be regarded as constant over the year, despite the (small) temperature dependency; but the performance of a heat pump is usually strongly dependent on the temperature of the source and the required power and output temperature).

— The uncertainty in the process or in the input data: if there is a lack of reliable information, then a simplification may be more appropriate than a detailed calculation with many uncertainties (for instance: the accumulation of moisture in the building fabric; see ISO 52016-1[10]).

A balanced choice is to be made in each EPB standard accordingly (open for choices in Annex A/Annex B accordingly, if necessary).

The use of detailed building simulation tools is not covered by the set of EPB standards because that would be too much an open end. A detailed building simulation method with a standard list of input data (input variables) would solve the open end with respect to the input data, but would still not meet the criteria that a method to be standardized should be transparent for the standard writers, sufficiently stable and the availability of validation test cases, covering all elements in the calculation, and criteria with sufficiently narrow band width to ensure reproducibility and reliability.

A more detailed method only leads to an *apparent* higher accuracy and not to a *real* higher accuracy, because many details that would be equally important for a higher accuracy cannot (or are not) taken into account anyway; at least not without excessive extra input data.

Examples of typical differences between the model and the reality that in general are more or less "unavoidable":

— *Conditions:* typically, the calculation will be performed for one set of standard conditions climate, occupants, use, …). Even if this set represents the average situation in a country or region, the result will not be average due to non-linear effects.

— *Input:* there are practical limitations to the verification of the input data. Are the assumed products/components used? Are these products installed as assumed?

— *Modelling:* in particular, the redistribution of heat inside and between spaces in a building is ignored to some extent. For instance the thermal interaction by thermal transmission and air circulation between thermal zones in a building, the thermal stratification in a room, different heating or cooling needs in different parts of a room or thermal zone. In theory, a detailed model could be used, but this requires many assumptions on the use of the spaces, while the actual use of the spaces in practice will vary significantly.

— *Human factor:* uncertainty whether (on the average) the building is used as assumed; whether the building provisions are used and maintained as assumed.


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— *Peaks:* Even with detailed hourly simulations "peaks", if shorter than one hour, are not picked up. For example: peaks in heating or cooling load, peaks in glare.

These differences will lead to inaccuracies in the calculation results. The accuracy in other characteristics of the model needs to be in proportion with the "unavoidable" inaccuracies, to avoid a "fake accuracy". This is in particular the case if this would lead to a decrease in other important quality aspects such as transparency, robustness, reproducibility etc., as mentioned above.

### 7.2.2 Calculation period

The calculation period is, as a rule, one year.

The actual length of heating and cooling periods depends on the climate and conditions of use (such as temperature settings, ventilation needs, assumed internal; heat gains, etc.), but –obviously- also depends on the specific case (design). This actual length can be derived from the calculations. For instance, the output of ISO 52016-1[10] includes information on the actual heating and cooling period length. This can be used as input for other EPB standards (e.g. to calculate the operation time of pumps, fans, etc.).

However, there may also be a need to specify an 'overall' or 'maximum' length of the heating and cooling periods. E.g. to prevent that also short periods of heating/cooling outside the actual heating/cooling period are taken into account; or to account for certain building regulations. Or, e.g., to avoid that simultaneous heating and cooling is overlooked due to a simplification in the zoning of the building.

## 7.3 Input data

### 7.3.1 Product data

No additional information needed.

### 7.3.2 System design data

No additional information needed.

### 7.3.3 Operating conditions

#### 7.3.3.1 General

This standard assumes that auxiliary energy is electrical energy. Electricity may be also the main energy carrier that provides the input to a generation device, such as a heat pump or a blower. The distinction between "auxiliary energy" and "main electricity input" has no practical effect on the energy balance (e.g. it is electricity used for EPB purposes, indeed). In principle auxiliary energy may be of another type (it could be compressed air). In that case:

— either the auxiliary energy is produced by an electric device (it is often the case for compressed air) whose electricity use will be the real auxiliary energy;

— or it is treated just like another delivered energy carrier, using weighting factors based on the type of generation device that provide the auxiliary energy.

Each electric energy amount that is produced or used is associated with an identifier of the type of use or production. This feature has been introduced to allow features such as:

— priorities in using or exporting the electricity produced on site when multiple on-site generators are available;

— filtering of the type of uses that can be compensated by electricity produced on.

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#### 7.3.3.2 Electricity input to generators

Typically this is the input to electric heat pumps, chillers and blowers of ventilation systems.

If there is no such device, the value is zero.

#### 7.3.3.3 Auxiliary energy input

A system without auxiliary energy is possible but this happens very seldom.

#### 7.3.3.4 Electricity use type

The type of electricity use is recorded by an identifier to manage any condition on which type of source can be used to cover electricity use.

EXAMPLE In some countries it is not allowed to compensate electricity use for direct heating with electricity produced by PV panels. This can be done in a software only if the specification of type of use is attached to any used energy amount.

The identifier EL_USE_DEFAULT can be assumed if no specification is given.

The value of Table B.11 in ISO 52000-1:2017 can be EL_USE_DEFAULT only if no special condition in the default values is used.

A consequence of this approach is that electric energy uses are not summed in the low level standards unless they have the same use type.

#### 7.3.3.5 On-site produced electricity

No additional information needed.

#### 7.3.3.6 Electricity production type

The electricity production type is an identifier that is used to keep track of the origin of the electricity produced on-site. This is relevant for the following steps:

— calculating step A weighting factors;

— specifying and taking into account any priority in the use of electricity produced on-site.

Contributions from several on-site generation devices should be kept separate if a priority criteria for exportation or on-site use is considered. If they are not kept separate, then there is no priority applied and the on-site use is implicitly considered as proportional to the electricity generated by each generation device.

#### 7.3.3.7 Electricity use for non EPB uses

It is possible to take into account the electricity used on site for non EPB uses. This option is not handled by “energy use type” because an independent weighting factor can be specified for this type of exported energy.

#### 7.3.3.8 Delivered energy other than electricity

These are amounts of energy carriers that are not exported. Usually these are all other energy carriers than electricity.


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#### 7.3.3.9 Energy carrier specification

The coding of this identifier should be as far as possible uniform in the various national implementations of the EPB standards.

EXAMPLE GEN_CR_EL for electricity, GEN_CR_GAS for natural gas or GEN_CR_LPG for LPG.

On a broader level, there might be additional energy carriers such as special fuels, nuclear power, municipal waste, etc.

This list of energy carriers allows unambiguous and unique specification of weighting factors and physical properties (e.g. density, calorific values) of energy carriers in all EPB standards.

### 7.3.4 Constants and physical data

No additional information needed.

### 7.3.5 Other data

#### 7.3.5.1 Primary energy weighting factors

Non-renewable, renewable and total primary energy and the corresponding weighting factors are not independent. For any energy carrier cr, the following relationships holds:

$$E_{P;tot;cr} = E_{P;nren;cr} + E_{P;ren;cr} \quad (29)$$

$$f_{P;tot;cr} = f_{P;nren;cr} + f_{P;ren;cr} \quad (30)$$

#### 7.3.5.2 Time dependent weighting factors

The calculation model of ISO 52000-1 has been designed to support time-dependent weighting factors. In the past primary energy factors have been always considered constants. Time dependent primary energy factors might be used for electricity if the varying generation combination is taken into account. Cost of electricity is already very often a time dependent weighting factor.

This does not mean that time dependent weighting factors are required. Weighting factors are usually time-independent. This means only that should anybody desire to use time dependent weighting factors, this is possible with ISO 52000-1.

#### 7.3.5.3 The $k_{exp}$ factor

The weighting of the exported energy is done in a two-step approach:

— first weight exported energy according to the resources used to produce it (first step, step A),

— then possibly add the benefit for the external world of exporting that energy (second step, step B).

The exported energy evaluation factor $k_{exp}$ controls how much of the second step in weighting the exported energy is taken into account.

The effect of the choice of $k_{exp}$ is the following:

— setting the value of $k_{exp}$ to 0 has the effect to take into account into the energy performance of the building only energy that is used in the building;

— setting the value of $k_{exp}$ to 1 has the effect to take into account into the energy performance of the building also the energy that is produced on-site and used outside of the building.

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### 7.4 Description of the calculation procedure

When ISO 52000-1 is applied, the calculation of all the energy flows within the building at all calculation intervals is already completed. All the energy exchanges with the external world are known in quality (which energy carriers are crossing the assessment boundary) and quantity (how many kW·h of each energy carrier are physically crossing the assessment boundary).

ISO 52000-1:2017, 9.6.1, Formula (2) only states that the energy performance balance is made of two components: delivered minus exported. Weighting factors and other indicators are defined in other parts of the standard.

The data and calculation procedure about electric energy is separated from other energy carriers because it is the energy carrier that can be produced on-site from renewable or non-renewable sources and it can be both delivered and exported. If other energy carriers are exported (e.g. biogas) then the same procedure as for electricity is followed.

## 8 Measured overall energy performance and comparison with calculations

### 8.1 General

ISO 52000-1 covers the final weighting of delivered and exported energy after the building and the technical systems have been taken into account in the other modules.

Table 3 shows a non-exhaustive comparison between calculated and measured data.

**Table 3 — Comparison between calculated and measured data**

| Feature | Calculated | Measured |
|---|---|---|
| Time interval of data | Any desired time interval is possible.<br>Data are naturally synchronous per calculation interval. Different calculation intervals can be combined. | Imposed by actual rate and time of measurements. Specific hardware is required to get a predefined time resolution.<br>Even if metered data is available with a good time resolution, synchronicity of measurements is not guaranteed unless specific provisions are in place. |
| Availability of detailed data | Any desired detailed quantity can be evaluated (e.g. auxiliary energy for a single pump, fuel for a single generator, etc.) In existing buildings the information is not always visible and might need to be determined from the age and type of the building/system. | The only available data is the metered data, usually at the level of energy carrier.<br>Sometimes heat or electricity to a building part or service is measured |
| Other uses than EPB | Other uses than EPB are naturally ignored unless intentionally included | Other uses are often included in the raw measured data. Separation procedures required |


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**Table 3** *(continued)*

| Feature | Calculated | Measured |
|---|---|---|
| Use and weather influence | Any use or weather, standard or custom, can be taken into account | Use and weather influence are included in the measured data.<br>Normalization techniques and procedures are required |
| Reliability of data | Data are well defined but there is often uncertainty on their value for concealed materials and installations. New product data are defined in dedicated standards. Some product standards do not define the exact data to evaluate the performance of products within any system and possible operating condition. | The source of data needs to be checked, depending on the source (invoices, user readings, etc.). A validation information is needed. |
| Auxiliary energy data | Auxiliary energy is easily included in the calculation | Auxiliary energy is seldom measured independently |

The measurement, filtering (e.g. separation non EPB uses), normalization, separation of services and validation of the delivered and exported energy amounts are covered by the specific modules MX-10.

ISO 52000-1:2017, Clause 8 gives specific definitions, consideration and instruction required when the delivered and exported energy amounts are measured. It gives also common definitions needed by the specific modules MX-10.

Sometimes a mix of measured and calculated data can be specified by the underlying modules to complete the measured data set for consistency with calculated data.

EXAMPLE Measuring the main fuel input and estimating (e.g. calculating) the auxiliary energy

## 8.2 Output of the method

The output of the measured energy performance is in principle the same as the output from the calculated energy performance (see 7.1).

However there are limitations when using measured data because usually only seasonal or yearly delivered and exported energy amounts are known, per energy carrier. Intermediate readings are seldom available. The break-out of an energy carrier use amongst several generators and/or services is seldom known.

To get reliable and useful results, a monitoring system and procedure should be planned from the design phase, based on the desired output and on the objective of the measured energy performance assessment.

## 8.3 Measurement intervals and measurement period

The calculated energy performance requires the concepts of “calculation period” and “calculation interval”:

— the calculation is repeated for each calculation interval (month, hour, …)

— the results for the calculation intervals are combined to get the final result for the calculation period (year, season).

The measured energy performance assessment requires an extra concept: measurements are often extended on a time span which is a multiple of the “calculation period”, typically to average out climate influence and any other random influence.

A comparison of time intervals for measured and calculated data is given in Table 4.

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**Table 4 — Comparison between time intervals for calculated and measured energy performance**

| Calculated | Measured |
|---|---|
| **Calculation interval**<br>It has a well-defined duration. | **Measurement interval**<br>The duration depends on the actual date of each measurement. The duration may be random and is not guaranteed unless a measurement procedure was designed and implemented in the use phase.<br>Synchronicity of data from several measurement points is an issue as well. |
| **Assessment interval**<br>Not relevant. | **Assessment interval**<br>This is the time span covered by measurement intervals taken into account.<br>The assessment interval may be longer than the calculation period when interpolation techniques are used.<br>The assessment interval may be shorter than the calculation period when extrapolation techniques are used. |
| **Calculation period**<br>It is the time span for which the final result is desired.<br>The result for a calculation period is a combination (usually sum) of results for shorter calculation intervals. | **Calculation period**<br>This is the same as for calculated energy performance.<br>The result for a calculation period is a combination of results (interpolation or extrapolation) for the assessment interval. |

The concept of "assessment interval" is distinguished from the concept of "measurement interval" and measurement procedures can have requirements on the assessment interval duration.

EXAMPLE A possible requirement is that an yearly measurement is repeated for at least three years and then averaged to reduce the influence of climate which is mostly a random deviation.

NOTE Averaging over years will not reduce (or will reduce less) the user behaviour influence which is more of a systematic nature and that can change with building use and users.

Another example of the need for a distinction between "calculation period" and "assessment interval" for measured energy performance is the following: The assessment interval of heating should be one season (e.g. autumn to spring) and not one year (e.g. calendar year) because there can be very significant differences in degree days within a heating season (e.g. warm autumn and cold spring or vice-versa). Fluctuations in seasonal degree-days are usually less significant.

## 8.4 Input data

### 8.4.1 Product data

No additional information.

### 8.4.2 System design data

At measured energy performance module level (MX.10), the system design data define:

— the services provided by each generator;

— the generators supplied by each metered energy carrier.

Specific data on system design are defined in the relevant modules.

### 8.4.3 Operating conditions data

ISO 52000-1:2017, Table 8 (for measured energy performance) is the equivalent of Table 6 in the same standard (for calculated energy performance). In principle there is no difference between getting the delivered and exported energy by meter (measured energy performance) or by generator (calculated


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energy performance). It is indeed the amount of delivered energy per carrier which is allocated to a defined EPB service(s).

### 8.4.4 Constants and physical data

No additional information needed.

### 8.4.5 Other data

No additional information needed.

## 8.5 Measurement procedures

This clause gives general information on the measurement procedures that are specified and detailed by the specific modules MX-10.

One separate module should be available for each EPB service. However the separation of energy use for each EPB service is often difficult with measured energy.

The listed corrections and/or extrapolations as well as specific validation criteria are given in the specific modules MX-10.

## 8.6 Calculation of the energy performance based on measured energy

Once the delivered energy carrier amounts are known, the weighting procedure is in principle the same as for calculated energy performance.

However the (usually low) number of measurement intervals can strongly limit the validity of features like the evaluation of the interactions of produced, used and exported electricity.

## 8.7 Comparison between calculated energy performance and measured energy performance

Comparison between calculated and measured energy performance is not a trivial topic, because:

— corrections and extrapolations to convert the measured energy use under actual conditions to energy use under standard environment and operational conditions for the energy performance assessment;

— or calculating a tailored energy performance;

requires expert knowledge and/or a large amount of operational data (actual conditions of use of the building, climatic data, etc.).

Corrections and/or extrapolations and/or additional data are needed for:

— taking into account only the desired energy services (e.g.: filter out appliances, including lighting in case of residential buildings);

— determining the amount of fuels and energy carriers (e.g. weighting wood or coal or estimating the stock at the end of the assessment period);

— calorific value of fuels (e.g. taking into account humidity of wood);

— aligning to a common assessment period (e.g.: interpolate or extrapolate to a full year) which is different for heating, cooling, domestic hot water, solar or wind power, lighting, ventilation etc.;

— taking into account weather and outdoor environment (e.g.: correct to a standard year) which is again different for heating, cooling, domestic hot water, solar or wind power, lighting, ventilation etc.;

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— taking into account occupancy and operation (e.g.: number of occupants different from standard assumptions, different occupancy behaviour (set points, ventilation, control of solar blinds, ...), system control settings different from assumed control, etc.).

These correction procedures are detailed in the specific modules MX-10.

As an example, EN 15378-3 '*Energy performance of buildings - Heating and DHW systems in buildings - Part 3: Measured energy performance, Module M3-10, M8-10*' deals with heating and domestic hot water which are often combined and produced by the same technical system. Also, the fuel counter may take into account also non EPB uses (e.g. cooking when using natural gas). EN 15378-3 includes procedures to separate any non-heating use.

### 8.8 Measured energy performance reporting

No additional information needed.

## 9 Overall assessment of the energy performance of buildings

### 9.1 Categorization of building and/or spaces

See discussion in Clause 6.

### 9.2 Combination of building services included in EPB in each space

'Combination of services' means the list of which services are taken into account in the energy performance assessment.

Because this list may be different for different building (or space) categories (see also discussion in Clause 6), there may be different lists. For instance:

— Residential buildings: excluding lighting.

— Office buildings: excluding domestic hot water.

Obviously, there is a direct link with the assumed conditions of use per building or space category, to be specified in the standard covering EPB module M1-6.

Consideration should be given to buildings that are not equipped with all services for which the energy performance is assessed (e.g. building without cooling systems when cooling is part of the energy performance calculation).

More information can also be found in ISO/TR 52003-2[9] and ISO/TR 52018-2,[12] the technical reports accompanying the EPB standards on Energy performance of buildings – Indicators, requirements, ratings and certification (On general aspects and on building fabric respectively).

### 9.3 Useful floor area and air volume

Useful floor area is important in the possibility to reconcile the needs for harmonization, transparency and flexibility.

A complete separation has been made between reference floor area and useful floor area.

The **useful floor area** is used for various purposes, such as:

— for conditions of use, if **conditions of use** are given **per m$^2$ of floor area** (e.g. hot water use, ventilation needs),

— for weighting according to floor area, e.g. for subdivision and recombination in case of **zoning** (see Clause 10).


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The **reference floor area** is one of the options for a reference size. It *can* be *based on* the useful floor area. The **reference size** is used for **normalization of the energy performance**, as explained in 9.4.

The **useful floor area** should not be confused with the **thermal transmission loss area**. The latter is specified in ISO 13789.

The **thermal transmission loss area** can be specified using e.g. internal dimensions or external dimensions (see ISO 13789). The use of internal or external dimensions and the value of linear thermal bridges due to connections between constructions are communicating vessels. If internal dimensions are used, the value of the areal thermal transmittance of the construction is smaller, but the value of the thermal bridge by the connection with an adjacent construction is larger than in case of external dimensions; and vice versa.

The **thermal transmission loss area** is relevant for any (heat loss giving) construction.

The **useful floor area** is something completely different: it includes for instance the area of intermediate floors without any heat loss. It may exclude for instance parts of a heat loss giving floor area if the space above it is not useful: e.g. if it is taken by a load-bearing construction, or if it has a height (below ceiling) that is smaller than for instance 1,5 m. These specifications are open for choice (see ISO 52000-1:2017, Table A.20/B.20).

ISO 52000-1:2017, Table B.20 gives an informative default specification.

The specification of the useful floor area does not intend to replace any national definition of useful floor area for economic and legal purposes:

— The useful floor area is explicitly defined as the useful floor area **for the EPB assessment** (which is further precised in the definition).

— The given specification in the standard is only an informative default option (in Table B.20).

It is important that whatever is the specification of the useful floor area, it **must** be **independent** of the choice of the elementary spaces, as stated in the standard. The useful floor area of a thermal zone or a service area must be the same as the sum of the useful floor areas of the elementary spaces. This condition is met with the informative default specification in ISO 52000-1:2017, Table B.20.

The air volume may be needed in different parts of the energy performance calculation, for instance to calculate the moisture (or contaminant) content resulting from the moisture supply and extraction due to ventilation, absorption and / or production in a space.

The air volume is in principle also an important parameter for the thermal balance in a space (heating up and cooling down). However, in a real situation the amount of furniture in a space will be more important than the shear air volume.

Also the air volume *can* be used as the basis for the **reference size** (see 9.4).

## 9.4 Normalization to building size

### 9.4.1 Reference size

The reference size is used for the normalization of the energy performance. For example: the non-renewable primary energy use, in kW·h per square metre.

NOTE 1 The European directive EPBD[2] refers in several articles to the size of a building in terms of square metres. And in the context of nearly zero energy buildings (art. 9) it asks for "… including a numerical indicator of primary energy use expressed in kW·h/m$^2$ per year."

The reference size can for instance be based on the useful floor area or net volume. If it is based on the useful floor area, it is called reference floor area. The choice is given in ISO 52000-1:2017, Annexes A and B.

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Assessing the size of a building or part of a building implies the choice which spaces are considered to be included. This choice is related to the space category. For specific space categories a fraction (between 0 and 1) of the size may be appropriate. ISO 52000-1:2017, 9.4.1.

EXAMPLE A basement, attic, indoor parking.

It is evident that the reference size has a large effect on the value of the normalized energy performance.

NOTE 2 And subsequently on the energy performance requirements if these are also normalized.

Obviously the conditions of use in the different spaces (such as temperature set points, etc.) have a strong influence on the (e.g. calculated) energy use in those spaces.

Therefore it is very important that the choice of the boundary of the building with respect to the reference size is consistent with the assumed conditions of use for the different spaces. More information can be found in ISO/TR 52003-2[9] and ISO/TR 52018-2,[12] the technical reports accompanying the EPB standards on Energy performance of buildings – Indicators, requirements, ratings and certificates (on general aspects and on building fabric respectively).

The minimum energy performance requirement levels of space types, such as office spaces, educational spaces and restaurant spaces, differ for a large extent due to the different internal conditions that are typical for every activity. For instance, in the bedrooms of a hospital the indoor temperature is much higher than in an office. The higher energy use of the hospital space due to this higher internal temperature is reflected in a higher maximum allowed energy performance requirement (a higher "**energy budget**") in the hospital space.

The energy budget (maximum allowed energy use) is typically, in one way or another, made proportional to the size of the spaces involved: the reference size (but see also discussion in 9.4.2 on normalization versus smart EP requirements).

Service spaces (**not** to be confused with service areas, term 3.3.4 in ISO 52000-1) will probably have no own energy performance requirement level. So, the energy use of a hall, corridor or toilet isn't automatically balanced by an "energy budget".

If the size of these service spaces is included in the reference size of the building, the energy budget is compensated for the extra energy use for the service spaces.

By excluding the size of the service space from the reference size of the building (no compensation), the energy performance of a building is **penalized** if it has shared energy using service spaces.

But allocation of the full size of the service space might lead to **overcompensation**; because the internal conditions of a service space often lead to less energy use per $m^2$ compared to the main spaces they service, while, by taking into account their full size, they receive the full energy budget.

A typical example in this context is the energy use versus the energy budget of an indoor parking. What is found in some countries is that the (assumed) internal condition of the indoor parking requires energy for ventilation and/or lighting, which is taken into account in the calculation of the energy use of the building.

If, for the energy budget, the size of the "indoor parking" isn't added, at least partly, to the reference size of the building, the energy budget isn't compensated for this additional energy use and the energy performance is penalized. This could be a very rational national choice, aiming at minimizing the energy use in such servicing spaces.

What is clear from the examples above is that the specification of the assumed standard indoor conditions per space category, for the *energy use* calculation, needs a matching specification of the assumed reference size, per space category, for the calculation of the *energy budget*.

So, assessing the size of the building or building part implies the choice which spaces are considered to be included. This choice is related to the space category. For specific space categories a fraction (between 0 and 1) of the size may be appropriate. E.g. for a basement, attic, indoor parking, etc., for reasons explained above.


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### 9.4.2 Normalization

Since large buildings usually use more energy than comparable small buildings, the total amount of energy used is not very informative. If the total amount is divided by the reference size of the building, the outcome is normalized. This normalized outcome makes it possible to compare the energy performance of buildings of different sizes.

However, using the normalized energy performance as the basis for energy performance requirements may result in too crude energy performance requirements: the methods for assessing the energy performance of a building are very detailed. One of the purposes of creating such elaborate methods is to achieve a reasonably fine evaluation of the energetic quality of the building, taking into account the benefits that many different design and technological variants and improvements may offer. They thus create a stimulating context for the construction sector to invest in a comprehensive energy efficient planning and a careful execution. And the component supply industry is stimulated to ever further develop more energy efficient systems. Crudely expressed requirements may to a large extent annihilate this achievement.

This can be solved by requirements in which also other aspects of the building are taken into account. This subject is discussed in more detail in ISO/TR 52003-2.

### 9.4.3 Reference floor area

The reference floor area is used for the reference size of the assessed object. See also 3.3 of this document.

Since there are many different ways to calculate a floor area used all over the wold, the EPB standards cannot prescribe which is the best way. In particular because the choice may have several legal or practical implications. In the input and method selection data sheet the type of floor area used can be specified. This could be (based on) the useful floor area, but it could also be (based on) the net floor area.

On the other hand: the specification of the useful floor area itself is also left open via the input and method selection data sheet, with a default choice given in ISO 52000-1:2017,Table B.20.

## 9.5 Assessment boundary and perimeters

### 9.5.1 General principles

The assessment boundary is the boundary where the delivered and exported energies are measured or calculated.

All energy flows are counted and weighted at the same assessment boundary (energy use assessment boundary). To accommodate different accounting criteria, the overarching EPB standard allows to specify which energy performance components should be taken into account when calculating:

— the RER: it is possible to take into account all contributions to renewable energy, or to exclude the renewable energy included in energy carriers coming from distant and so on.

— the “total” primary energy: it is possible to take into account all contributions to the total primary energy, or to exclude on site renewable energy from the total.

This makes it possible to use the calculation procedure of the overarching EPB standard (one assessment boundary) for all possible choices, and also to express the system performance by using the total primary energy factor as indicated in Annex H. The assessment boundary is also the boundary where the delivered and exported energy are weighted in the energy balance (see Formula (2) in ISO 52000-1:2017, 9.6.1)

The assessment boundary is different from the geographical perimeters, like on-site or nearby.

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The definition of the assessment boundary impacts the following conventions:

— inside the assessment boundary, the system losses and energy flows are taken into account explicitly in the energy balance;

— outside the assessment boundary energy losses are taken into account in the weighting factor applied to each energy carrier;

— energy can be delivered (imported) or exported through the assessment boundary;

— "energy plus buildings" are only possible if the effect of the exported energy is included in the energy performance of the building and the energy balance becomes negative, see ISO 52000-1:2017, 11.6.2.3 and the $k_{exp}$ factor.

The definition of recast EPBD[2] related to Nearly Zero Energy Buildings (NZEB) 3) in Europe includes energy from renewable sources produced on-site or nearby.

The localization of the technical building systems situated either on-site or nearby impacts the energy balance. Primary energy conversion factors are defined for on-site and nearby. Different buildings can be on-site (e.g. school building, office building) and located on the same parcel of land. Rules are provided in ISO 52000-1 to take into account the different situations in the energy assessment of each building.

### 9.5.2 Assessment boundary for multiple buildings

If a site comprises several buildings connected to a common technical system (e.g. a common boiler house for several apartment blocks), then:

— first, the energy performance is calculated for the whole site, including all buildings connected to the same systems;

— second, the energy performance for the individual buildings is obtained with the calculation procedure of the energy performance per part of a building (see ISO 52000-1:2017, Annex E).

## 9.6 Overall energy performance

### 9.6.1 Weighted overall energy balance

The different types of energy carriers delivered to the building are never summed directly with each other. They can be summed only taking into account a conversion factors into an homogeneous quantity (weighting).

The weighting criteria considered in ISO 52000-1 are the following:

— non-renewable primary energy;

— renewable primary energy;

— total primary energy;

— costs, which is an essential weighting criterion for cost-benefits evaluations;

— $CO_2$ or GHG emissions.

For each energy carrier and weighting property, an additional distinction can be made according to the "perimeter" (e.g. the origin of the energy carrier) that can be on-site, nearby and distant.

Weighting factors are the ratio of the amount of the weighting property (energy, cost) to the actual delivered or exported energy. Therefore the units of the weighting factors are kW·h/kW·h or $MCO_2$/kW·h or €/kW·h and so on.

3) See definition 2 of the EPBD recast.


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