Technical Report

ISO/TR 52016-4

First edition
2024-10

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

Part 4: Explanation and justification of ISO 52016-3

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

Partie 4: Explication et justification de l'ISO 52016-3

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
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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 document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

A list of all the parts in the ISO 52016 series can be found on the ISO website.

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

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Introduction

0.1 Set of EPB standards and supporting tools

This document gives guidance to a set of international standards that is used to collectively assess the overall energy performance of buildings (EPB). Throughout this document, this group of standards is referred to as the "set of EPB standards".

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency (see ISO 52000-1 , CEN/TS 16628 and CEN/TS 16629).

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

One of the main purposes of the set of EPB standards is to enable laws and regulations to 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 (see Annex B).

0.2 Rationale behind the set of 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 set of EPB standards.

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If this explanation were attempted in the standards themselves, the result is likely to be confusing, 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, e.g. this document, where all informative content is collected, to ensure a clear separation between normative and informative content (see CEN/TS 16629 for a more detailed explanation):

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— to underscore the difference between the normative and informative content;

— to reduce the page count of the actual standard;

— to facilitate understanding of the set of EPB standards.

0.3 This document

This document gives guidance on ISO 52016-3. The role and the positioning of ISO 52016-3 in the set of EPB standards is defined in the introduction of ISO 52016-3. A brief article on the subject can be found in the REHVA Journal [21].

To fully understand this document, it is intended to be read in close conjunction, clause by clause, with ISO 52016-3. Essential information provided in ISO 52016-3 is not repeated in this document. References to a clause can refer to the combined content of that clause in both ISO 52016-3 and this document.

0.4 Accompanying spreadsheet

An extensive spreadsheet [35] has been prepared to test and demonstrate ISO 52016-1. For the purpose of testing and demonstrating ISO 52016-3, this spreadsheet has been extended with an (optional) sheet to cover adaptive building envelope elements with different states and different control scenarios according to ISO 52016-3.

Examples of calculations with adaptive building envelope elements are found in this document.

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0.5 Background of this document and ISO 52016-3

ISO 52016-3 and the supporting technical report (this document) have been developed to respond to a strong need to include adaptive building envelope elements in the assessment of the energy performance of buildings. This inclusion aims to create a level playing field for conventional and promising techniques.

More extensive background information and history of the whole set of EPB standards is given in the introduction to ISO/TR 52000-2, the technical report accompanying the overarching EPB standard. Up-to-date information on the set of EPB standards can be found in the "public material" section of the ISO/TC 163 page on the ISO website.[1)]

0.6 Application area of ISO 52016-3

ISO 52016-3 specifies procedures for the calculation of the energy needs for heating and cooling, internal temperatures and sensible and latent heat loads of a building according to ISO 52016-1, with additions or modifications that are needed to incorporate adaptive building envelope elements in the calculation.

The main use of ISO 52016-3 is the assessment of the energy performance of buildings (energy performance labels and certificates), including comparison between buildings and for checking compliance with minimum energy performance criteria.

ISO 52016-3 is applicable to buildings at the design stage, to new buildings after construction and to existing buildings in the use phase.

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1) https://www.iso.org/committee/53476.html.

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

Part 4: Explanation and justification of ISO 52016-3

1 Scope

This document provides explanation and justification to support the correct understanding and use of ISO 52016-3.

2 Normative references

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

ISO 7345, *Thermal performance of buildings and building components — Physical quantities and definitions*

ISO 9488, *Solar energy — Vocabulary*

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

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

ISO 52016-3:2023, *Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 3: Calculation procedures regarding adaptive building envelope elements*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345, ISO 9488, ISO 52000-1, ISO 52016-1 and ISO 52016-3:2023 apply.

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

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

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

4 Symbols, subscripts and abbreviations

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52000-1, ISO 52016-1 and ISO 52016-3:2023 apply.

More information on key EPB symbols is given in ISO/TR 52000-2.

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4.2 Subscripts

For the purposes of this document, the subscripts given in ISO 52000-1, ISO 52016-1 and ISO 52016-3:2023 apply.

More information on key EPB subscripts is given in ISO/TR 52000-2.

NOTE 1 ISO 52016-1 uses input data from many technology fields. In the exceptional cases that subscripts in ISO 52016-1 are different from subscripts in other EPB standards that produce output needed as input to ISO 52016-1, these differences are reported in a special column in the tables with the overview of input data in 6.3. This can occur when the source documents use subscripts that are crucial for that specific technology field, but conflict with subscripts that are crucial for another specific technology field.

EXAMPLE Subscript g used for both "glazing" and for "ground".

NOTE 2 In ISO 52016-3 the subscript w (origin: “window”), used in ISO 52016-1 for transparent construction elements is also used for the adaptive building envelope element.

NOTE 3 For the solar and daylight properties the subscript gl (origin: “glazing”), is used as a rule to specifically refer to the projected area of the transparent part of the element.

4.3 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO 52016-1 and ISO 52016-3:2023 apply.

More information on key EPB abbreviated terms is given in ISO/TR 52000-2.

5 Description of the method

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5.1 Output of the method

The structure of ISO 52016-3:2023, Clause 5 conforms to the common template for the set of EPB standards. ISO 52016-3:2023, Clause 5 contains a brief (qualitative) description of the method, starting with the main output from the standard.

ISO 52016-3 covers the calculation of the energy need for heating and cooling and the internal temperature in case of a building or building zone with one or more adaptive building envelope elements.

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The method covers also, as product information, the calculation of some energy performance characteristics of adaptive building envelope elements, applied in a specific (e.g. reference) building.

NOTE Compare e.g. ISO 18292, that also uses a reference building for comparing the energy performance of windows.

This includes information on whether the building is smart ready in terms of adaptive building envelope elements.

5.2 General description of the method

5.2.1 General

The calculation procedures in ISO 52016-3 are an extension of the hourly calculation procedures specified in ISO 52016-1. ISO 52016-3 contains the additions and modifications that are needed to incorporate adaptive building envelope elements. Therefore, ISO 52016-1 is referenced accordingly throughout ISO 52016-3.

ISO 52016-1:2017 contains a normative Annex G that provides a framework for calculation procedures involving adaptive building envelope elements. ISO 52016-3 provides calculation procedures.

ISO 52016-3 fills a gap in the set of EPB standards.

The reasons for choosing an hourly calculation time interval are given in 6.2.

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5.2.2 Distinction between ISO 52016-3 and ISO 52016-1

The calculation procedures of ISO 52016-3 can be seen as an extension of the procedures given in ISO 52016-1. The reasons for providing these in two separate documents are:

— If ISO 52016-3 was combined into ISO 52016-1, it can harm the acceptance and roll-out of ISO 52016-1, e.g. if a legal authority wants to adopt the calculation procedures of the current ISO 52016-1, but has hesitations to adopt ISO 52016-3.

— Maintenance of ISO 52016-1 would be more difficult and costly if combined with the content of ISO 52016-3. With a separate ISO 52016-3 it is easier to plan revisions, e.g. based on experiences by users or developing technologies.

— ISO 52016-3 requires specific expertise on the technologies and control scenarios involved.

— The parties interested in the details of ISO 52016-3 are quite specific. Combining all in one document would not be efficient from the user perspective.

5.2.3 Successive steps in the calculation procedures

In ISO 52016-3:2023, the actual calculation procedures are given in 6.9. However, that subclause is just one sentence:

"Apply the hourly calculation procedures according to ISO 52016-1:2017, 6.5, with the additions and adaptations specified in the previous clauses of this document."

ISO 52016-3:2023, 6.4 to 6.8 contain the procedures needed to prepare the calculation. In ISO 52016-3:2023, 5.4, these preparatory steps are introduced as six successive steps.

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5.3 Technologies covered in ISO 52016-3

5.3.1 General

The technologies covered in ISO 52016-3 are selected on the basis of current or promising market share and distinction in functionality and control scenarios or passive response. Some technologies can be quite different in appearance but very similar in functionality and in options for control. For the purpose of ISO 52016-3 these are not categorized separately.

For example, for the purpose of ISO 52016-3 the physical model of a closed (unvented) cavity double skin façade is quite similar to a multiple glazing unit with integrated solar blinds.

Three main categories of technologies are covered in ISO 52016-3:

— Building envelope elements with dynamic solar shading (see 5.3.2).

— Building envelope elements with chromogenic glazing (see 5.3.3).

— Building envelope elements with an actively ventilated cavity (see 5.3.4).

For the sources used in the selection of technologies, see References 35, 28, 17, 18, 27, 34 and 38.

Examples of types of adaptive building envelope elements that are not covered in ISO 52016-3 are presented in 5.3.5.

5.3.2 Building envelope elements with dynamic solar shading

A building envelope element with dynamic solar shading can be described as a façade element (usually fitted to a window, door, curtain walling or façade, with one or more actively operated mobile parts) defined as the curtain that can (partially) obstruct solar radiation or sunlight. The aim of dynamic solar shading is to control solar radiation and daylight, to contribute to the thermal insulation, thermal comfort, cooling savings and visual comfort when combined to glazing.

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Dynamic solar shading can be positioned at the internal or external side of the façade element or integrated in between two or more façade elements. These façade elements may form a sealed multiple glazing unit, or consist of an assembly of multiple glazings, or assembly of partly transparent and partly opaque elements.

If a single façade is doubled inside or outside by a second, essentially glazed façade, it is usually defined as a double skin façade. The width of the cavity between these two skins can range from several centimetres at the narrowest to several metres for the widest accessible cavities. As long as such a façade has no intentional ventilation provisions ("closed cavity façade") it fits into the description of the dynamic solar shading.

This contrasts with the third category, building envelope elements with an actively ventilated cavity.

The main technologies for the dynamic solar shading elements are:

— Venetian blind: blind where the curtain consists of horizontal slats which can be tilted and where the curtain may be retracted by accumulating the slats. The slat angle can be tilted in various positions. They are usually opaque, but can also be partly transparent or translucent.

— Roller blind: blind where the curtain consists of material (e.g. fabric) which is retracted by rolling. The curtain can be semi-transparent, semi-translucent or opaque, and sometimes thermally insulated (multilayer).

— Roller shutter: shutter where the curtain is retracted by rolling and consists of interconnected horizontal laths, that can be tilted or not, which run inside channels.

Examples are shown in Figure 1:

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a) Windows with internal roller blinds

b) Windows with external venetian blinds. (Colour) photo by Samuel Zeller, CC0 1.0 DEED[2)]

c) Closed cavity façade with integrated venetian blinds

d) External folding-sliding shutters, Gerrit Rietveld Academie / Sandberg Instituut, Amsterdam

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Figure 1 — Four examples of building envelope elements with dynamic solar shading

For movable blinds or shutters, a specific terminology is used to avoid confusion between the blind or shutter movement and other movements, such as slats and louvers:

— Extended/retracted: movement of the blind resulting in an increase/decrease in the surface area covered (see EN 12216:2018, 5.1)

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— Open/closed: terms used to describe the increase in light (opening) or reduction of light (closing) in an extended position for products with laths, slats or louvres which can be tilted or adjusted (see EN 12216:2018, 5.1).

See also examples in EN 12216.

5.3.3 Building envelope elements with chromogenic glazing

Chromogenic glazing can be described as an adaptive technology directly integrated in the glazing itself. The physical properties can reversibly change according to a specific active or passive trigger, changing the appearance of the glazing itself: making it more or less transparent, absorbing or reflecting for solar radiation and daylight.

The main technologies currently available on the market are:

— Thermochromic and thermotropic glazing (passive; based on the glazing temperature changing);

— Photochromic glazing (passive; based on the level of incident solar irradiance changing);

— Electrochromic glazing (active; based on the level of electric power changing);

— Gasochromic glazing (active, based on changing gas mixture in cavity);

— Liquid crystal chromogenic glazing (active; based on the level of electric power changing);

— Suspended particle devices.

However, other smart glazing technologies are being, or may be developed, that can be simulated in the same way, e.g. electrophoretic, fluidic glass, microshades and micromirror arrays.

Examples are shown in Figure 2:

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a) High transmittance

b) Low transmittance

Key

SOURCE: Project Hamilton Bonaduz, Switzerland. Electrochromic Glass (SageGlass). Pictures by Ingo Rasp.

Figure 2 — Examples of building envelope with chromogenic glazing

5.3.4 Building envelope elements with an actively ventilated cavity

5.3.4.1 Distinctive feature

A building envelope element with an actively ventilated cavity is similar to a building envelope element with dynamic solar shading, except for the intentional and possibly controlled (i.e. natural, hybrid or mechanical) ventilation of the cavity or air circulation via the cavity.

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