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Environmental performance of buildings — Carbon metric of a building — Use stage

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/558, Sustainability of construction works.

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INTERNATIONAL STANDARD

ISO 16745

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Environmental performance of buildings — Carbon metric of a building — Use stage

Performance environnementale des bâtiments — Métrique du carbone des bâtiments — Phase opérationnelle

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 17, *Sustainability in buildings and civil engineering works*.

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Introduction

Buildings contribute approximately one-third of global greenhouse gas (GHG) emissions. With its high share of emissions, the building and construction sector has the responsibility to take the global lead in implementing strategies to reduce GHG emissions. The building and construction sector has more potential and opportunity to deliver quick, deep, and cost-effective GHG mitigation than any other sectors. Carbon dioxide (CO_2) emissions contribute to global warming, which is one of the most recognized environmental impacts attributable to buildings.

In this context, measurement and reporting of GHG emissions from existing buildings are critical for enabling significant and cost-effective GHG mitigation. Currently, there has not been a globally agreed method established to measure, report, and verify potential reductions of GHG emissions from existing buildings in a consistent and comparable way. If such a method existed, it could be used as a universal tool for measurement and reporting of GHG emissions, providing the foundation for accurate performance baselines of buildings to be drawn, national targets to be set, and carbon trading to occur on a level playing field.

In principle, accurate and precise reporting can only be achieved if GHG emissions (and removals) from all life cycle stages of buildings are measured and/or quantified. However, not all countries in the world have sufficient capacity or resources to use and apply life cycle assessment (LCA) methodologies.

Respecting the need for collaboration on a global scale, the need exists for a metric that is usable not only in countries with sufficient number of experts and a precise database, but also in those countries where experts' services are limited and databases have considerable gaps. For instance, with the potential for global scale carbon trading within building-related sectors, a method that is consistently usable in both the well-developed and developing world is needed.

Operational energy use in buildings typically accounts for 70 %–80 % of energy use over the building life cycle. Therefore, the operating stage of the building's life cycle is the focus of measurement and reporting of direct and indirect GHG emissions.

This International Standard aims to set out a globally applicable common method of measuring and reporting of associated GHG emissions (and removals) attributable to existing buildings, by providing requirements for the determining and reporting of a carbon metric(s) of a building.

The carbon metric is a measure (a partial carbon footprint) that is based on energy use data and related building information for an existing building in operation. It provides information related to the calculation of GHG emissions and can be used as an environmental indicator. Using this approach, the metric and its protocol can be applied by all stakeholders in both developing and well-developed countries, where building energy consumption and other relevant data can be retrieved or collected, making it useful and globally transferable.

This International Standard aims to be practical for many stakeholders (i.e. not only for the building profession), who are expected to use the carbon metric of a building as reference for decision making in their business activities, governmental policies, and as a baseline for benchmarking.

The simplicity of approach provides applicability at all scales, ranging from cities and building portfolios to individual buildings.

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INTERNATIONAL STANDARD ISO 16745:2015(E)

Environmental performance of buildings — Carbon metric of a building — Use stage

1 Scope

This International Standard provides requirements for determining and reporting a carbon metric of an existing building, associated with the operation of the building. It sets out methods for the calculation, reporting, communication, and verification of a set of carbon metrics for GHG emissions arising from the measured energy use during the operation of an existing building, the measured user-related energy use, and other relevant GHG emissions and removals. These carbon metrics are separated into three measures designated CM1, CM2, and CM3 (see 5.1.1).

This International Standard follows the principles set out in ISO 15392 and those described in Clause 4. Where deviations from the principles in ISO 15392 occur, or where more specific principles are stated, this International Standard takes precedence.

The carbon metrics CM1 and CM2 are not quantified based on life cycle assessment (LCA) methodology. Carbon metric CM3 may include partial quantification based on the results of LCA.

This International Standard does not include any method of modelling of the operational energy use of the building but follows the conventions provided by other International Standards, as given in relevant clauses.

This International Standard is not an assessment method for evaluating the overall environmental performance of a building or a building-rating tool and does not include value-based interpretation of the carbon metric(s) through weightings or benchmarking.

This International Standard deals with the application of the carbon metric(s) for an existing building, either residential or commercial, or a building complex. It does not include provisions for regional and/or national building stock.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6707-1:2014, *Buildings and civil engineering works — Vocabulary — Part 1: General terms*

ISO 12655, *Energy performance of buildings — Presentation of measured energy use of buildings*

ISO 14050, *Environmental management — Vocabulary*

ISO 15392, *Sustainability in building construction — General principles*

ISO/TR 16344:2012, *Energy performance of buildings — Common terms, definitions and symbols for the overall energy performance rating and certification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6707-1, ISO 12655, ISO 14050, ISO 15392, ISO/TR 16344, and the following apply. Where differences or conflicts occur, the definitions given below shall take precedence.

NOTE A number of terms and definitions from these other sources have been repeated below, for ease of reference.

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3.1
building services
services provided by *technical building systems* (3.19) and by *appliances* (ISO 6707-1:2014, 5.4.7) to provide indoor climate conditions, domestic hot water, illumination levels, and other services related to the use of the *building* (ISO 6707-1:2014, 3.1.3)

[SOURCE: ISO/TR 16344:2012, 2.1.10]

3.2
carbon intensity
carbon metric (3.3) expressed in relation to a specific reference unit related to the *function* (ISO 15686-10:2010, 3.10) of the *building* (ISO 6707-1:2014, 3.1.3)

Note 1 to entry: Examples of reference units may include per unit area, per person, per kilobyte, per unit output, and per GDP.

3.3
carbon metric
sum of annual *greenhouse gas emissions* (ISO 14064-1:2006, 2.5) and *removals* (ISO 14064-1:2006, 2.6), expressed as CO_2 *equivalents* (ISO 14064-1:2006, 2.19), associated with the use stage of a *building* (ISO 6707-1:2014, 3.1.3)

3.4
cooling
removal of latent and/or sensible heat

[SOURCE: ISO 16818:2008, 3.47]

3.5
delivered energy
energy (3.6), expressed per *energy carrier* (3.7), supplied to the *technical building systems* (3.19) through the *system boundary* (3.18), to satisfy the uses taken into account [heating, *cooling* (3.4), *ventilation* (3.20), domestic hot water, lighting, *appliances* (ISO 6707-1:2014, 5.4.7), etc.], or to produce electricity

Note 1 to entry: Delivered energy can be calculated for defined energy uses or it can be measured.

[SOURCE: ISO/TR 16344:2012, 2.1.33, modified by deleting the Note 1 related to active solar and wind energy systems.]

3.6
energy
capacity for doing work; having several forms that may be transformed from one to another, such as thermal (heat), mechanical (work), electrical, or chemical

[SOURCE: ISO 16818:2008, 3.74]

3.7
energy carrier
substance or phenomenon that can be used to produce mechanical work or *heat* (ISO 16818:2008, 3.117) or to operate chemical or physical processes

Note 1 to entry: The *energy content* (ISO 13602-2:2006, 3.1) of *fuels* (3.10) is given by their *gross calorific value* (ISO/TR 16344:2012, 2.1.78).

[SOURCE: ISO/TR 16344:2012, 2.1.46]

3.8
energy source
source from which useful *energy* (3.6) can be extracted or recovered either directly or by means of a conversion or transformation process

Note 1 to entry: Examples include oil or gas fields, coal mines, sun, forests, etc.

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[SOURCE: ISO/TR 16344:2012, 2.1.62]

3.9
exported energy
energy (3.6), expressed per *energy carrier* (3.7), delivered by the *technical building systems* (3.19) through the *system boundary* (3.18) and used outside the system boundary

Note 1 to entry: It can be specified by generation types [e.g. combined heat and power (CHP), photovoltaic (PV)] in order to apply different weighting factors.

[SOURCE: ISO/TR 16344:2012, 2.1.72]

3.10
fuel
material that can be used to produce *heat* (ISO 16818:2008, 3.117) or generate power by combustion

[SOURCE: ISO/TR 16344:2012, 2.1.74]

3.11
functional equivalent
quantified functional requirements and/or technical requirements for a *building* (ISO 6707-1:2014, 3.1.3) or part thereof for use as a reference basis for comparison

[SOURCE: ISO 21931-1:2010, 3.7, modified to add reference to part of a building.]

3.12
greenhouse gas emission coefficient
coefficient that describes the amount of a specific *greenhouse gas* (ISO 14064-1:2006, 2.1) that is released from doing a certain activity, such as burning one tonne of *fuel* (3.10) in a furnace

Note 1 to entry: In general, GHG emission coefficients from specific *energy consumption* (ISO 50001:2011, 3.7) are quantified based on *GHG emission factors* (ISO 14064-1:2006, 2.7) for use of the *energy* (3.6).

Note 2 to entry: Greenhouse gas emission coefficients can differ by year.

3.13
greenhouse gas reservoir
physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a *GHG* (ISO 14064-1:2006, 2.1) removed from the atmosphere by a *greenhouse gas sink* (3.14) or a GHG captured from a *greenhouse gas source* (3.15)

Note 1 to entry: The total mass of carbon contained in a GHG reservoir at a specified point in time could be referred to as the carbon stock of the reservoir.

Note 2 to entry: A GHG reservoir can transfer greenhouse gases to another GHG reservoir.

Note 3 to entry: The collection of a GHG from a GHG source before it enters the atmosphere and storage of the collected GHG in a GHG reservoir could be referred to as GHG capture and storage.

[SOURCE: ISO 14064-1:2006, 2.4]

3.14
greenhouse gas sink
physical unit or process that removes a *GHG* (ISO 14064-1:2006, 2.1) from the atmosphere

[SOURCE: ISO 14064-1:2006, 2.3]

3.15
greenhouse gas source
physical unit or process that releases a *GHG* (ISO 14064-1:2006, 2.1) into the atmosphere

[SOURCE: ISO 14064-1:2006, 2.2]

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3.16
gross floor area
sum of the floor areas of the *conditioned spaces* (ISO 16818:2008, 3.38) within the *building* (ISO 6707-1:2014, 3.1.3), including basements, mezzanine and intermediate floor tiers, and penthouses, of headroom height 2,2 m or as specified in national or regional codes and standards

Note 1 to entry: It is measured from the exterior faces of exterior walls or from the centreline of walls separating buildings, but excluding covered walkways, open roofed-over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, chimneys, roof overhangs, and similar features.

[SOURCE: ISO/TR 16344:2012, 2.1.79]

3.17
renewable energy
energy (3.6) from an *energy source* (3.8) that is not depleted by extraction

[SOURCE: ISO/TR 16344:2012, 2.1.123, modified—specific reference to energy source added and the examples and explanatory note were removed.]

3.18
system boundary
boundary that includes within it all areas associated with a *building* (ISO 6707-1:2014, 3.1.3) (both inside and outside the building) where *energy* (3.6) is consumed or produced

Note 1 to entry: Inside the system boundary, the system losses are taken into account explicitly, while outside the system boundary, they are taken into account in the conversion factor.

[SOURCE: ISO/TR 16344:2012, 2.1.142]

3.19
technical building system
technical equipment for heating, *cooling* (3.4), *ventilation* (3.20), domestic hot water, lighting, and electricity production

Note 1 to entry: A technical building system can refer to one or to several *building services* (3.1) [e.g. heating system, heating, and domestic *hot water system* (ISO 6707-1:2014, 5.4.48)].

Note 2 to entry: A technical building system is composed of different sub-systems.

Note 3 to entry: Electricity production can include *cogeneration* (ISO/TR 16344:2012, 2.1.20) and photovoltaic (PV) systems.

[SOURCE: ISO/TR 16344:2012, 2.1.146]

3.20
ventilation
process of supplying or removing air by natural means or mechanical means to or from a space for the purpose of controlling air contaminant levels, humidity, odours, or temperature within the space

[SOURCE: ISO 16818:2008, 3.242]

3.21
verifier
party who makes sure or demonstrates that the process of measurement of a *carbon metric* (3.3) is true, accurate, and justified

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4 Principles

4.1 General

The application of the following principles is fundamental to ensuring that GHG-related information presented through the carbon metric represents a true and fair measure. These principles provide the basis for the application of the requirements in this International Standard by the organization or individual determining the carbon metric.

4.2 Completeness

Include all relevant GHG emissions and removals (see 5.1) that provide a significant contribution to the carbon metric.

4.3 Consistency

Apply assumptions, methods, and data in the same way throughout the carbon metric determination to arrive at conclusions in accordance with the needs of the intended user and intended use (see 5.1).

4.4 Relevance

Select the GHG sources, GHG sinks, GHG reservoirs, data, and methodologies appropriate to the needs of the intended user and the intended use (see 5.3.4).

4.5 Coherence

Select methodologies, standards, and guidance documents already recognized and adopted for energy measurement and consumption to enhance comparability between common carbon metrics (see 5.3.2)

4.6 Accuracy

Ensure that the carbon metric quantification and communication are accurate, verifiable, relevant, and not misleading and that bias is avoided and uncertainties are minimised (see 5.3.4).

4.7 Transparency

Address and document all relevant issues in an open, comprehensive, and understandable presentation of information.

Disclose any relevant assumptions and make appropriate references to the methodologies and data sources used. Clearly explain any estimates and avoid bias so that the carbon metric faithfully represents what it purports to represent.

Ensure that the carbon metric communication is available to the intended audience and its intended meaning is presented in a way that is clear, meaningful, and understandable. Include information on the functional equivalent, data assumptions, calculation methods, and other characteristics to make the limitations in the comparisons of carbon metrics transparent and clear to the target group (see 6).

4.8 Avoidance of Double Counting

Avoid counting of greenhouse gas emissions and removals that have already been allocated within other carbon metrics (see 5.3).

NOTE This list of principles has been adapted based on the principles described in ISO/TS 14067, 5.

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5 Protocol of measuring the carbon metric of a building in the use stage

5.1 System boundary

5.1.1 Types of carbon metrics of a building

A carbon metric shall be measured by quantifying the direct and indirect GHG emissions and removals associated with a building in-use.

The three types of carbon metrics of a building are defined as follows:

a) Carbon metric 1 (CM1) is the sum of annual GHG emissions, expressed as CO_2 equivalents, from building-related energy use (see 5.3.4.1);

b) Carbon metric 2 (CM2) is the sum of annual GHG emissions, expressed as CO_2 equivalents, from building- and user-related energy use (see 5.3.4.2);

c) Carbon metric 3 (CM3) is the sum of annual GHG emissions and removals, expressed as CO_2 equivalents, from building- and user-related energy use, plus other building-related sources of GHG emissions and removals.

5.1.2 System boundary for the carbon metrics of a building

5.1.2.1 System boundary for the carbon metrics CM1 and CM2

The system boundary for the CM1 and CM2 of a building is shown in Figure 1. It consists of the equipment to operate the building fulfilling the demand as energy end use and the technical building system(s) to deliver, convert, and generate energy for the energy end use.

CM1 and CM2 of a building are determined based on the following:

a) delivered energy for the building and for other energy use within the building's site (curtilage);

NOTE Delivered energy includes energy provided by the local or national utility supplier and any remotely generated energy [e.g. from photovoltaic (PV), wind power, or combined heat and power (CHP) etc.] that is directly connected to the building.

b) total on-site energy generated and used in the building and for other energy use within the building's site (curtilage).

NOTE Examples of sources of on-site energy generation can be solar power [photovoltaic (PV) panel], wind turbine power, biomass fuel, combined heat and power (CHP), fuel cell, and others.

The system boundary shall include all the energy consuming and generating systems that are within the building's site (curtilage) and that support operation of the building.

All building-related energy end use (as indicated in the pale grey boxes in Figure 1) shall be taken into account for the carbon metric (CM1), even when energy for these services is separately measured through sub-metering.

Lighting (including plug-in lighting necessary for the basic function of the building) and controls (including systems for daylight control) shall be included in the CM1. (see 5.3.4.1).

User-related energy use (as indicated in the dotted box in Figure 1) shall be included in the CM2, including energy for supplementary lighting installed by building users (see 5.3.4.2).

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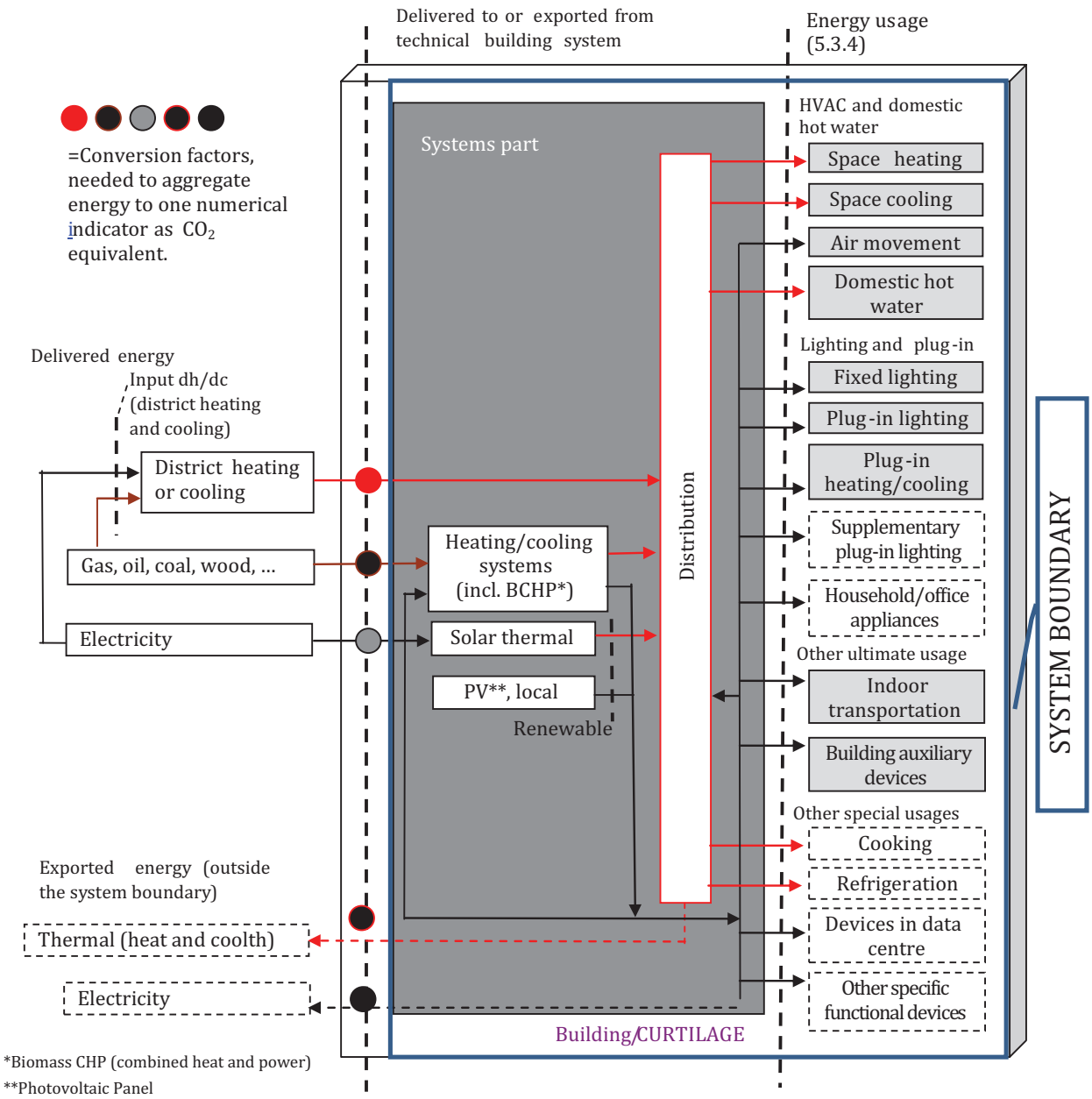

Figure 1 — Boundary and energy flows —
Main energy flows within and crossing the boundaries for energy use of a building

It is NOT necessary to separately measure the amount of energy generated, converted, or consumed within the system boundary by each individual system, piece of equipment, or machine.

Exported energy is outside the system boundary but may be reported as additional information where appropriate (see 6.2.2).

Figures 2, 3, and 4 show examples of the system boundary for CM1.

EXAMPLE 1 Only the energy carrier for the delivered energy and energy generated by the PV panels and used within the system boundary are required to be measured for CM1.

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