
**Energy performance of buildings —
Calculation of energy use for space
heating and cooling**

*Performance énergétique des bâtiments — Calcul des besoins
d'énergie pour le chauffage et le refroidissement des locaux*

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13790 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*, in cooperation with CEN/TC 89, *Thermal performance of buildings and building components*.

This second edition cancels and replaces the first edition (ISO 13790:2004), which has been technically revised. A summary of the principal changes is given below.

- Throughout, statements and equations that were true only for the heating mode have been amplified to accommodate both heating and cooling modes.
- Throughout, all texts that applied only for monthly or seasonal calculations have been amplified to accommodate hourly as well as monthly and seasonal calculations.
- The structure has been adapted to maximize the common use of procedures, conditions and input data, irrespective of the calculation method.
- A monthly (and seasonal) method for cooling, similar to the method in the first edition for heating, has been added.
- A simple hourly method for heating and cooling, to facilitate direct introduction of hourly, daily or weekly patterns (e.g. controls, user behaviour), has been added.
- For dynamic simulation methods, procedures that are consistent with the boundary conditions and input data for the seasonal, monthly and simple hourly methods have been added for the boundary conditions and input data.
- The whole document has been scrutinized to check its applicability within the context of building regulations, which require a minimum of ambiguities and subjective choices; where needed, possibilities are offered for national choices as given in national annexes, national building codes or national standards referring to this document, depending on the purpose/application of the calculations as detailed in this list and on the type or complexity of the building.

Introduction

This standard provides the means (in part) to assess the contribution that building products and services make to energy conservation and to the overall energy performance of buildings.

This International Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/343), and supports essential requirements of EU Directive 2002/91/EC on the energy performance of buildings (EPBD^[26]). It forms part of a series of standards aimed at European harmonization of the methodology for the calculation of the energy performance of buildings. An overview of the whole set of standards to support the EPBD is given in CEN/TR 15615 ^[28]. See also Annex A.

This International Standard is one of a series of calculation methods for the design and evaluation of thermal and energy performance of buildings. It presents a coherent set of calculation methods at different levels of detail, for the energy use for the space heating and cooling of a building, and the influence of the recoverable thermal losses of technical buildings systems such as the heating and cooling system.

In combination with other energy performance-related standards (see Figure 1, which gives an outline of the calculation procedure and its links with other energy performance-related standards), this International Standard can be used for the following applications:

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- a) judging compliance with regulations expressed in terms of energy targets (via the design rating; see Annex A);
 - b) comparing the energy performance of various design alternatives for a planned building;
 - c) displaying a standardized level of energy performance of existing buildings (the standard calculated rating; see Annex A);
 - d) assessing the effect of possible energy conservation measures on an existing building, by calculation of the energy use with and without the energy conservation measure; see Annex A;
 - e) predicting future energy resource needs on a regional, national or international scale, by calculating the energy use of typical buildings representative of the building stock.

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

The main inputs needed for this International Standard are the following:

- transmission and ventilation properties;
- heat gains from internal heat sources, solar properties;
- climate data;
- description of building and building components, systems and use;
- comfort requirements (set-point temperatures and ventilation rates);
- data related to the heating, cooling, hot water, ventilation and lighting systems:
 - partition of building into different zones for the calculation (different systems may require different zones);
 - energy losses dissipated and recoverable or recovered in the building (internal heat gains, recovery of ventilation heat loss);
 - airflow rate and temperature of ventilation supply air (if centrally pre-heated or pre-cooled) and associated energy use for air circulation and pre-heating or pre-cooling;
 - controls.

The main outputs of this International Standard are the following:

- annual energy needs for space heating and cooling;
- annual energy use for space heating and cooling;
- length of heating and cooling season (for system running hours) affecting the energy use and auxiliary energy of season-length-dependent technical building systems for heating, cooling and ventilation.

Additional outputs are the following:

- monthly values of energy needs and energy use (informative);
- monthly values of main elements in the energy balance, e.g. transmission, ventilation, internal heat gains, solar heat;
- contribution of passive solar gains;
- system losses (from heating, cooling, hot water, ventilation and lighting systems), recovered in the building.

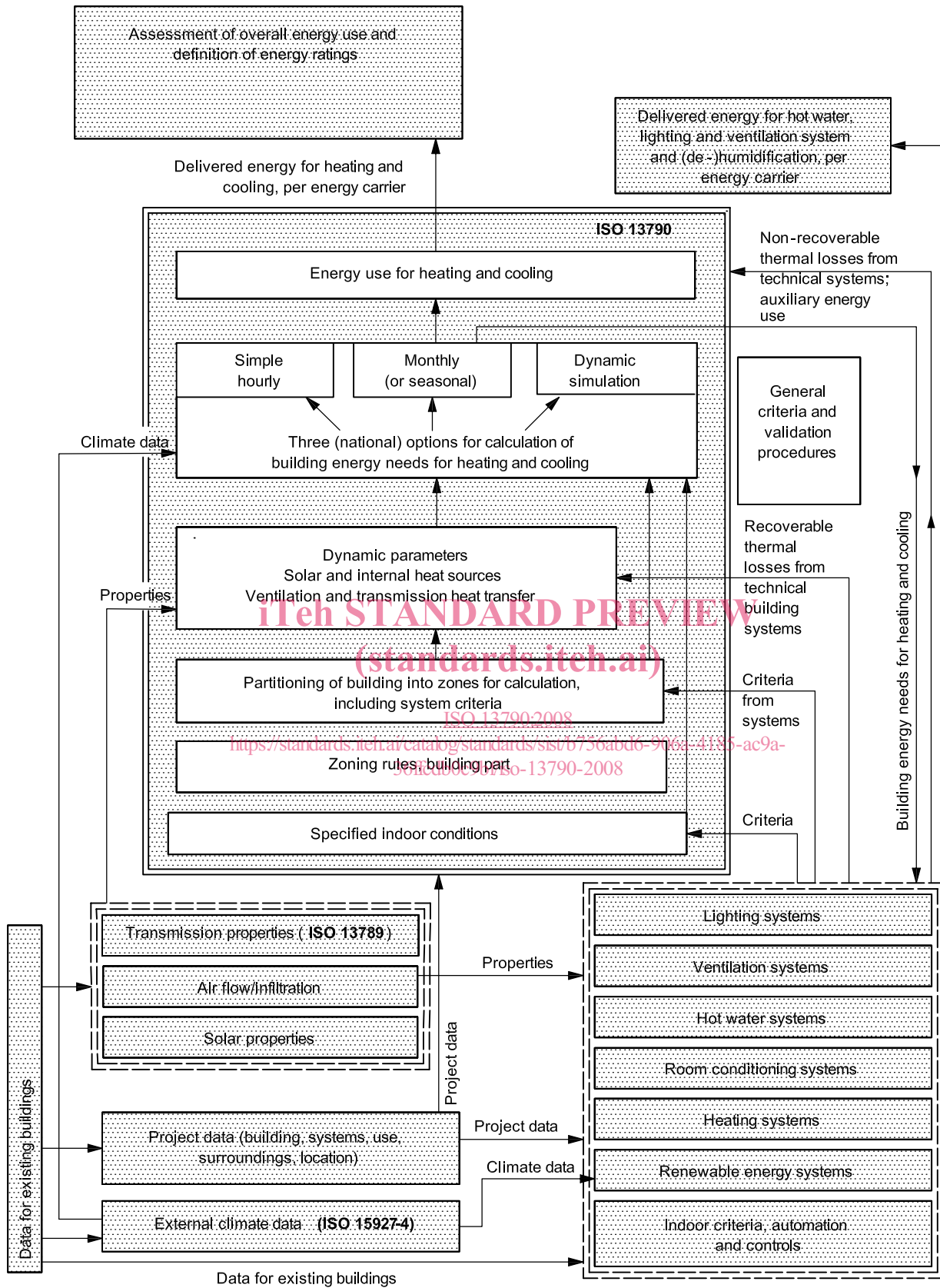


Figure 1 — Flow chart of calculation procedure and links with other standards

Energy performance of buildings — Calculation of energy use for space heating and cooling

1 Scope

This International Standard gives calculation methods for assessment of the annual energy use for space heating and cooling of a residential or a non-residential building, or a part of it, referred to as “the building”.

This method includes the calculation of:

- a) the heat transfer by transmission and ventilation of the building zone when heated or cooled to constant internal temperature;
- b) the contribution of internal and solar heat gains to the building heat balance;
- c) the annual energy needs for heating and cooling, to maintain the specified set-point temperatures in the building – latent heat not included;
- d) the annual energy use for heating and cooling of the building, using input from the relevant system standards referred to in this International Standard and specified in Annex A.

The building can have several zones with different set-point temperatures, and can have intermittent heating and cooling.

The calculation interval is either one month or one hour. For residential buildings, the calculation can also be performed on the basis of the heating and/or cooling season.

This International Standard also gives an alternative simple hourly method, using hourly user schedules (such as temperature set-points, ventilation modes or operation schedules of movable solar shading).

Procedures are given for the use of more detailed simulation methods to ensure compatibility and consistency between the application and results of the different types of method. This International Standard provides, for instance, common rules for the boundary conditions and physical input data, irrespective of the calculation approach chosen.

Special attention has been given to the suitability of this International Standard for use within the context of national or regional building regulations. This includes the calculation of an energy performance rating of a building, on the basis of standardized conditions, for an energy performance certificate. The result can have legal implications, in particular when it is used to judge compliance with minimum energy performance levels, which can, for instance, be required to obtain a building permit. For such applications, it is important that the calculation procedures be unambiguous, repeatable and verifiable. A special situation is the calculation of the energy performance in the case of old existing buildings, if gathering the full required input would be too labour-intensive for the purpose, relative to the cost-effectiveness of gathering the input. In this case, it is important that the calculation procedures provide the right balance between accuracy and data collection costs. To accommodate the application for these and other situations, this International Standard offers different choices. It is up to national bodies whether or not to choose a specific option for mandatory use, e.g. depending on the region in the country, the type of building and its use, and on the purpose of the assessment.

Annex H provides some information on the accuracy of the method.

This International Standard has been developed for buildings that are, or are assumed to be, heated and/or cooled for the thermal comfort of people, but can be used for other types of building or other types of use (e.g. industrial, agricultural, swimming pool), as long as appropriate input data are chosen and the impact of special physical conditions on the accuracy is taken into consideration.

NOTE 1 For instance, it can be used when a special model is needed but is missing.

Depending on the purpose of the calculation, it may be decided nationally to provide specific calculation rules for spaces that are dominated by process heat (e.g. indoor swimming pool, computer/server room or kitchen in a restaurant).

NOTE 2 For instance, in the case of a building energy certificate and/or building permit, e.g. by ignoring the process heat or using default process heat for certain processes (e.g. shops: freezers, lighting in shop window).

The calculation procedures in this International Standard are restricted to sensible heating and cooling. The energy use due to humidification is calculated in the relevant standard on the energy performance of ventilation systems, as specified in Annex A; similarly, the energy use due to dehumidification is calculated in the relevant standard on the energy performance of space cooling systems, as specified in Annex A.

The calculation is not used to decide whether mechanical cooling is needed.

This International Standard is applicable to buildings at the design stage and to existing buildings. The input data directly or indirectly called for by this International Standard should be available from the building files or the building itself. If this is not the case, it is explicitly stated at relevant places in this International Standard that it may be decided at national level to allow for other sources of information. In this case, the user reports which input data have been used and from which source. Normally, for the assessment of the energy performance for an energy performance certificate, a protocol is defined at national or regional level to specify the type of sources of information and the conditions when they may be applied instead of the full required input.

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2 Normative references

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The following referenced documents are indispensable for the application 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 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

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

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

ISO 13370:2007, *Thermal performance of buildings — Heat transfer via the ground — Calculation methods*

ISO 13786:2007, *Thermal performance of building components — Dynamic thermal characteristics — Calculation methods*

ISO 13789:2007, *Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method*

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

EN 15217, *Energy performance of buildings — Methods for expressing energy performance and for energy certification of buildings*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 7345 and the following apply.

3.1 Time steps, periods and seasons

3.1.1

calculation step

discrete time interval for the calculation of the energy needs and uses for heating, cooling, ventilation, humidification and dehumidification

NOTE Typical discrete time intervals are one hour, one month or one heating and/or cooling season, operating modes and bins.

3.1.2

calculation period

period of time over which the calculation is performed

NOTE The calculation period can be divided into a number of calculation steps.

3.1.3

heating or cooling season

period of the year during which a significant amount of energy for heating or cooling is needed

NOTE 1 The lengths of the heating and cooling seasons are determined in different ways, depending on the calculation method. The season lengths are used to determine the operation period of technical systems or season-dependent user behaviour, for instance on ventilation.

NOTE 2 This International Standard includes a seasonal method that requires as calculation step a fixed season length that has to be distinguished from the actual season length.

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3.1.4

unoccupied period

period of several days or weeks without heating or cooling, e.g. due to holidays

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3.2 Spaces, zones and areas

3.2.1

heated space

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

3.2.2

cooled space

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

3.2.3

conditioned space

heated and/or cooled space

NOTE The heated and/or cooled spaces are used to define the boundaries of the thermal zones and the thermal envelope.

3.2.4

unconditioned space

room or enclosure that is not part of a conditioned space

3.2.5

conditioned zone

part of a conditioned space with a given set-point temperature or set-point temperatures, throughout which the same occupancy pattern is assumed and the internal temperature is assumed to have negligible spatial variations, and which is controlled by a single heating system, cooling system and/or ventilation system, or by different systems with equal energy performance

3.2.6

conditioned area

floor area of conditioned spaces excluding non-habitable cellars or non-habitable parts of a space, including the floor area on all storeys if more than one

NOTE 1 Internal, overall internal or external dimensions can be used. This leads to different areas for the same building.

NOTE 2 Some services, such as lighting or ventilation, might be provided to areas not included in this definition (e.g. a car park).

NOTE 3 The precise definition of the conditioned area is given by national authorities.

NOTE 4 "Conditioned area" can be taken as the useful area mentioned in the Clauses 5, 6 and 7 of the EPBD [26] unless it is otherwise defined in national regulations.

3.2.7

calculation with coupled zones

multi-zone calculation with thermal coupling between zones, taking into account any heat transfer by thermal transmission and/or by ventilation and/or by air infiltration between zones

3.2.8

calculation with uncoupled zones

multi-zone calculation without thermal coupling between zones, not taking into account any heat transfer by thermal transmission or by ventilation or by air infiltration between zones

3.2.9

projected area of solar collecting elements

area of the projection of the surface of the element on to a plane parallel to the transparent or translucent part of the element

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

EXAMPLE Windows.

3.2.10

projected area of frame elements

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

EXAMPLE Window frames.

3.3 Temperatures

3.3.1

external temperature

temperature of external air

NOTE 1 For transmission heat transfer calculations, the radiant temperature of the external environment is supposed equal to the external air temperature; long-wave radiation to the sky, from building elements facing the sky, is calculated separately (see 11.3.5 and/or 11.4.6).

NOTE 2 The measurement of external air temperature is defined in ISO 15927-1.

3.3.2**internal temperature**

arithmetic average of the air temperature and the mean radiant temperature at the centre of a zone or space

NOTE This is the approximate operative temperature according to ISO 7726.

3.3.3**set-point (of the internal) temperature**

internal (minimum intended) temperature as fixed by the control system in normal heating mode, or internal (maximum intended) temperature as fixed by the control system in normal cooling mode

NOTE The values are specified at national level, depending on the type of space and purpose of the calculation. See also definition of conditioned space (3.2.3). For monthly and seasonal methods, the value of the set-point can include adjustment for intermittency, as specified in 13.2.2.

3.3.4**set-back temperature**

minimum internal temperature to be maintained during reduced heating periods, or maximum internal temperature to be maintained during reduced cooling periods

3.3.5**intermittent heating or cooling**

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

3.4 Energy

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3.4.1**energy need for heating or cooling**

heat to be delivered to, or extracted from, a conditioned space to maintain the intended temperature conditions during a given period of time

NOTE 1 The energy need is calculated and cannot easily be measured.

NOTE 2 The energy need can include additional heat transfer resulting from non-uniform temperature distribution and non-ideal temperature control, if they are taken into account by increasing (decreasing) the effective temperature for heating (cooling) and not included in the heat transfer due to the heating (cooling) system.

3.4.2**auxiliary energy**

electrical energy used by technical building systems for heating, cooling, ventilation and/or domestic water to support energy transformation to satisfy energy needs

NOTE 1 This includes energy for fans, pumps, electronics, etc. Electrical energy input to a ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy use for ventilation (3.4.11).

NOTE 2 In ISO 9488, the energy used for pumps and valves is called "parasitic energy".

3.4.3**technical building system**

technical equipment for heating, cooling, ventilation, domestic hot water, lighting and electricity production

NOTE 1 A technical building system can refer to one or to several building services (e.g. heating system, heating and domestic hot water system).

NOTE 2 A technical building system is composed of different subsystems.

NOTE 3 Electricity production can include cogeneration and photovoltaic systems.

3.4.4

technical building subsystem

part of a technical building system that performs a specific function (e.g. heat generation, heat distribution, heat emission)

3.4.5

building services

services provided by the technical building systems and by appliances to provide the indoor climate conditions, domestic hot water, illumination and other services related to the use of the building

3.4.6

system thermal loss

thermal loss from a technical building system for heating, cooling, domestic hot water, humidification, dehumidification or ventilation that does not contribute to the useful output of the system

NOTE 1 A system loss can become an internal heat gain for the building if it is recoverable.

NOTE 2 Thermal energy recovered directly in the subsystem is not considered as a system thermal loss but as heat recovery and directly treated in the related system standard.

NOTE 3 Heat dissipated by the lighting system or by other services (e.g. appliances of computer equipment) is not part of the system thermal losses, but part of the internal heat gains.

3.4.7

recoverable system thermal loss

part of a technical system thermal loss which can be recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

NOTE 1 This depends whether or not the recoverable system thermal losses are directly taken into account as a reduction to the system losses.

NOTE 2 In this International Standard, if not directly taken into account as a reduction to the system losses, the recoverable system thermal losses are calculated as part of the internal heat gains. It may be decided at national level to report the recoverable system thermal losses separately from the other internal heat gains.

3.4.8

recovered system thermal loss

part of a recoverable system thermal loss which has been recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

NOTE This depends whether or not the recoverable system thermal losses are directly taken into account as a reduction to the system losses.

3.4.9

energy use for space heating or cooling

energy input to the heating or cooling system to satisfy the energy need for heating or cooling, respectively

NOTE If the technical building system serves several purposes (e.g. heating and domestic hot water), it can be difficult to split the energy use into that used for each purpose. It can be indicated as a combined quantity (e.g. energy use for space heating and domestic hot water).

3.4.10

delivered energy for space heating or cooling

energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances, etc.) or to produce electricity

NOTE 1 For active solar and wind energy systems the incident solar radiation on solar panels or on solar collectors, or the kinetic energy of wind is not part of the energy balance of the building.

NOTE 2 Delivered energy can be calculated or it can be measured.

3.4.11**energy use for ventilation**

electrical energy input to a ventilation system for air transport and heat recovery (not including energy input for pre-heating or pre-cooling the air) and energy input to a humidification system to satisfy the need for humidification

3.4.12**energy need for humidification and dehumidification**

latent heat in the water vapour to be delivered to, or extracted from, a conditioned space by a technical building system to maintain a specified minimum or maximum humidity within the space

3.4.13**energy use for other services**

electrical energy input to the appliances providing other services

NOTE This refers to services other than heating, cooling, domestic hot water, ventilation and lighting.

3.4.14**ventilation-heat recovery**

heat recovered from exhaust air to reduce the ventilation heat transfer

3.5 Building heat transfer**3.5.1****heat transfer coefficient**

heat flow rate divided by the temperature difference between two environments; specifically used for heat transfer coefficient by transmission or ventilation

NOTE In contrast with a heat gain, the driving force for heat transfer is the difference between the temperature in the considered space and the temperature of the environment at the other side (in the case of transmission) or the supply air temperature (in the case of ventilation).

3.5.2**transmission heat transfer coefficient**

heat flow rate due to thermal transmission through the fabric of a building, divided by the difference between the environment temperatures on either side of the construction

NOTE By convention, the sign is positive if the heat flow is going out of the space considered (heat loss).

3.5.3**ventilation heat transfer coefficient**

heat flow rate due to air entering an enclosed space, either by infiltration or ventilation, divided by the difference between the internal air temperature and the supply air temperature

NOTE The sign of the coefficient is always positive. By convention, the sign of the heat flow is positive if the supply air temperature is lower than the internal air temperature (heat loss).

3.6 Building heat gains and recoverable system thermal losses**3.6.1****heat gains**

heat generated within, or entering into, the conditioned space from heat sources other than energy intentionally utilized for heating, cooling or domestic hot water preparation

NOTE 1 These include internal heat gains and solar heat gains. Sinks that extract heat from the building are included as gains with a negative sign. In contrast with heat transfer, for a heat source (or sink) the difference between the temperature of the considered space and the temperature of the source is not the driving force for the heat flow.

NOTE 2 For summer conditions heat gains with a positive sign constitute extra heat load on the space.