



BSI Standards Publication

Energy performance of buildings - Method for calculation of the design heat load

Part 1: Space heating load, Module M3-3

National foreword

This British Standard is the UK implementation of EN 12831-1:2017. It supersedes BS EN 12831:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/24, Heating systems and water based cooling systems in buildings.

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

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of the design heat load - Part 1: Space heating load, Module
M3-3

Performance énergétique des bâtiments - Méthode de
calcul de la charge thermique nominale - Partie 1 :
Charge de chauffage des locaux, module M3-3

Energetische Bewertung von Gebäuden - Verfahren zur
Berechnung der Norm-Heizlast - Teil 1: Raumheizlast,
Modul M3-3

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European foreword

This document (EN 12831-1:2017) has been prepared by Technical Committee CEN/TC 228 “Heating systems and water based cooling systems in buildings”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2018, and conflicting national standards shall be withdrawn at the latest by January 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12831:2003.

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

EN 12831, *Energy performance of buildings — Method for the calculation of the design heat load*, is composed with the following parts:

- *Part 1: Space heating load, Module M3-3;*
- *Part 2: Explanation and justification of EN 12831-1, Module M3-3 [CEN/TR];*
- *Part 3: Domestic hot water systems heat load and characterisation of needs, Module M8-2, M8-3;*
- *Part 4: Explanation and justification of EN 12831-3, Module M8-2, M8-3 [CEN/TR].*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard is part of a series of standards aiming at international harmonization of the methodology for the assessment of the energy performance of buildings, called “set of EPB standards”.

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

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

For the correct use of this standard a normative template is given in Annex A to specify these choices. Informative default choices are provided in Annex B.

The EPB set of standards deals with energy performance calculation and other related aspects (like system sizing) to provide the building services considered in the EPBD.

The subjects covered by CEN/TC 228 are the following:

- design of heating systems (water based, electrical, etc.);
- installation of heating systems;
- commissioning of heating systems;
- instructions for operation, maintenance and use of heating systems;
- methods for calculation of the design heat loss and heat loads;
- methods for calculation of the energy performance of heating systems.

Heating systems also include the effect of attached systems such as hot water production systems.

All these standards are systems standards, i.e. they are based on requirements addressed to the system as a whole and not dealing with requirements to the products within the system.

Where possible, reference is made to other European or International Standards, a. o. product standards. However, use of products complying with relevant product standards is no guarantee of compliance with the system requirements.

The requirements are mainly expressed as functional requirements, i.e. requirements dealing with the function of the system and not specifying shape, material, dimensions or the like.

The guidelines describe ways to meet the requirements, but other ways to fulfil the functional requirements might be used if fulfilment can be proved.

Heating systems differ among the member countries due to climate, traditions and national regulations. In some cases requirements are given as classes so national or individual needs may be accommodated.

In cases where the standards contradict with national regulations, the latter should be followed.

Use by or for regulators: In case the standard is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications. These choices (either the informative default choices from Annex B or choices adapted to national / regional needs, but in any case following the template of this Annex A) can be made available as national annex or as separate (e.g. legal) document (national data sheet).

NOTE So in this case:

- the regulators will **specify** the choices;

- the individual user will apply the standard to assess the energy performance of a building, and thereby **use** the choices made by the regulators.

Topics addressed in this standard can be subject to public regulation. Public regulation on the same topics can override the default values in Annex B of this standard. Public regulation on the same topics can even, for certain applications, override the use of this standard. Legal requirements and choices are in general not published in standards but in legal documents. In order to avoid double publications and difficult updating of double documents, a national annex may refer to the legal texts where national choices have been made by public authorities. Different national annexes or national data sheets are possible, for different applications.

It is expected, if the default values, choices and references to other EPB standards in Annex B are not followed due to national regulations, policy or traditions, that:

- national or regional authorities prepare data sheets containing the choices and national or regional values, according to the model in Annex A. In this case the national annex (e.g. NA) refers to this text;
- or, by default, the national standards body will consider the possibility to add or include a national annex in agreement with the template of Annex A, in accordance to the legal documents that give national or regional values and choices.

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report accompanying this standard (CEN/TR 12831-2).

1 Scope

This European Standard covers methods for the calculation of the design heat load for single rooms, building entities and buildings, where the design heat load is defined as the heat supply (power) needed to maintain the required internal design temperature under design external conditions.

Table 1 shows the relative position of this standard within the set of EPB standards in the context of the modular structure as set out in EN ISO 52000-1.

NOTE 1 In CEN ISO/TR 52000-2 the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 2 The modules represent EPB standards, although one EPB standard may cover more than one module and one module may be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See also Clause 2 and Tables A.1 and B.1.

Table 1 — Position of this standard, within the modular structure of the set of EPB standards

Technical Building Systems														
Overarching		Building (as such)												
Sub module	Descriptions		Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot water	Lighting	Building automation and control	Electricity production
sub1		M1		M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General		General		General	15316-1					15316-1			
2	Common terms and definitions; symbols, units and subscripts		Building Energy Needs		Needs						12831-3			
3	Applications		(Free) Indoor Conditions without Systems		Maximum Load and Power	12831-1					12831-3			
4	Ways to Express Energy Performance		Ways to Express Energy Performance		Ways to Express Energy Performance	15316-1					15316-1			
5	Building categories and Building Boundaries		Heat Transfer by Transmission		Emission and control	15316-2								
6	Building Occupancy and Operating Conditions		Heat Transfer by Infiltration and Ventilation		Distribution and control	15316-3					15316-3			

Sub module	Overarching		Building (as such)		Technical Building Systems										
	Descriptions	M1	Descriptions	M2	Descriptions	M3	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot water	Lighting	Building automation and control	Electricity production
sub1		M1		M2									M9	M10	M11
7	Aggregation of Energy Services and Energy Carriers		Internal Heat Gains		Storage and control	15316-5						15316-5 15316-4-3			
8	Building zoning		Solar Heat Gains		Generation										
8-1					Combustion boilers	15316-4-1						15316-4-1			
8-2					Heat pumps	15316-4-2		15316-4-2				15316-4-2			
8-3					Thermal solar Photovoltaics	15316-4-3						15316-4-3			15316-4-3
8-4					On-site cogeneration	15316-4-4						15316-4-4			15316-4-4
8-5					District heating and cooling	15316-4-5		15316-4-5							15316-4-5
8-6					Direct electrical heater	15316-4-8						15316-4-8			
8-7					Wind turbines										15316-4-10
8-8					Radiant heating, stoves	15316-4-8									

Overarching		Building (as such)		Technical Building Systems											
Sub module	Descriptions	M1	Descriptions	M2	Descriptions	M3	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot water	Lighting	Building automation and control	Electricity production
sub1		M1		M2		M3		M4	M5	M6	M7	M8	M9	M10	M11
9	Calculated Energy Performance		Building Dynamics (thermal mass)		Load dispatching and operating conditions										
10	Measured Energy Performance		Measured Energy Performance		Measured Energy Performance	15378-3						15378-3			
11	Inspection		Inspection		Inspection	15378-1						15378-1			
12	Ways to Express Indoor Comfort			-	BMS										
13	External Environment Conditions														
14	Economic Calculation	15459-1													
NOTE: The shaded modules are not applicable.															



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.

EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method (ISO 6946)*

EN ISO 7345, *Thermal insulation — Physical quantities and definitions (ISO 7345)*

EN ISO 9972, *Thermal performance of buildings — Determination of air permeability of buildings — Fan pressurization method (ISO 9972)*

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

EN ISO 13370, *Thermal performance of buildings — Heat transfer via the ground — Calculation methods (ISO 13370)*

EN ISO 13789, *Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method (ISO 13789)*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345 and EN ISO 52000-1, and the following apply.

3.1

ATD, air terminal device

air out-/inlets allowing air transfer between external and internal air (*external ATD*) or between separate rooms (*internal ATD*)

Note 1 to entry: In the field, the term *ATD* is used for a broad variety of air out- and inlets. Within this standard, the term refers only to passive devices allowing air flow through a building element (walls, etc.) in a defined manner. It does not include air out-/inlets of fan-assisted ventilation system.

Note 2 to entry: Within this standard, it is assumed that external ATDs are only applied in unbalanced ventilation.

3.2

annual mean external temperature

mean value of the external temperature during the year

3.3

balanced ventilation

fan-assisted ventilation where the sum of all supply air volume flows equals the sum of all exhausted air volume flows in quantity and over the course of time

3.4**building element**

internal or external component of the building structure and/or thermal envelope or a portion thereof with uniform thermal conditions on each side of the element

EXAMPLE Wall between two rooms of the same or different temperatures.

3.5**building entity**

certain portion of a building (one or more rooms) used as one unit by one party/occupant, such as:

- one apartment / flat;
- one office unit...

where the heat supply to that unit can be controlled individually by the occupant (usually by means of room temperature control devices)

Note 1 to entry: For the definition of *building entities* within application of this standard, it is not relevant if the heat supplied to *building entities* is generated centralized per building or separately in each *building entity*.

3.6**design heat load**

heat flow (power) required to achieve the specified internal design temperature under external design conditions

Note 1 to entry: The *design heat load* covers transmission and ventilation heat losses and, if any, an additional heating-up power.

3.7**design heat loss**

heat loss (power) leaving the building to the external environment under specified design conditions

3.8**design transmission heat loss**

heat loss to the exterior and between heated and other heated or unheated spaces inside a building as a result of thermal conduction through the surrounding surfaces

Note 1 to entry: The design transmission heat loss is a portion of the design heat loss.

3.9**design ventilation heat loss**

heat loss to the exterior by ventilation and infiltration through the building envelope and the heat transferred by ventilation from one heated space to another heated or unheated space

Note 1 to entry: The design ventilation heat loss is a portion of the design heat loss.

3.10**external design temperature**

(minimal) external air temperature which is used for the calculation of the design heat losses

3.11

heated space

space which, per design, is heated to the specified internal design temperature and separated from other spaces by building elements such as walls, etc.

Note 1 to entry: Usually each single (heated) room is considered a heated space.

3.12

internal air temperature

temperature of the air inside the considered heated space

3.13

internal design temperature

temperature-value required for the intended use of a heated space and that is used to calculate the design heat loss

Note 1 to entry: The internal design temperature is an operative temperature and, therefore, depends, among other parameters, on the air temperature and the radiant temperature – usually defined in a simplified manner as arithmetic average between both.

Note 2 to entry: Default values for the internal design temperature are subject to national regulations.

3.14

large openings

openings of the enveloping surface of a room/building that are kept open for significant periods over the day on a regular basis; usually, but not necessarily, (large) doors or gates

EXAMPLE Gates in logistics and industrial halls.

3.15

mean internal air temperature

mean air temperature of a heated space

Note 1 to entry: With low room heights ($h < 4$ m), the *mean internal air temperature* can be assumed to equal the *internal design temperature*; with larger room heights, the *mean internal air temperature* is calculated based on the *internal design temperature*, specifically for the heating system to be used.

3.16

mean internal surface temperature

mean temperature of a building element's inner surface

Note 1 to entry: With low room heights ($h < 4$ m), the *mean internal surface temperature* can be assumed to equal the *internal design temperature*; with larger room heights, the *mean internal surface temperature* is calculated based on the *internal design temperature*, specifically for the heating system to be used.

3.17

minimum air change rate

number of air changes per hour that needs to be ensured in order to maintain an appropriate level of air hygiene (reduction of air pollutants, CO₂, moisture, etc.), which depends on type of the room (use); subject to national regulation

3.18**regularly unheated space**

space that, by design, is unheated; e.g. unheated attic, unheated corridor, unheated winter garden, etc.

Note 1 to entry: Within this standard, adjacent building entities (neighbouring apartment, etc.) are, for calculational purposes, assumed to be unheated – these, however, do not belong to *regularly unheated spaces*.

3.19**unbalanced ventilation**

fan-assisted ventilation where the sums of all supply air volume flows and all exhausted air volume flows differ significantly in quantity or over the course of time

3.20**ventilation**

entirety of all processes transporting air, including fan-assisted ventilation by ventilation systems, natural ventilation (“airing”), infiltration through leakages, etc.

3.21**zone (ventilation zone)**

group of rooms that are air-connected by design, either directly or indirectly (through other rooms there between); e.g. through internally mounted air transfer devices / shortened door leaves, etc.

Note 1 to entry: By design, there is no air transfer between *ventilation zones*. Usually, each *building entity* is considered a separate *zone*.

4 Symbols and abbreviations**4.1 Symbols**

For the purposes of this document, the symbols given in EN ISO 52000-1 and the specific symbols listed in Table 2 apply.

Table 2 — Symbols and units

Symbol	Name	Unit
Φ	Heat power (heat loss, heat load)	W
H	Heat transfer coefficient	W/K
θ	Temperature on the Celsius scale	°C
U	Thermal transmittance, U-value	W/(m ² ·K)
f	Adjustment/correction factor or term	-
Δ ...	Delta/difference	-
A	Area	m ²
a, b, c	Calculation parameters	-
B'	Geometric parameter of the floor slab	m
z	Depth of the floor slab below ground level	m
P	Exposed periphery of the floor slab	m
n _{1...3}	Calculation parameters (exponent)	-

Symbol	Name	Unit
n	Air change rate	1/h, h ⁻¹
ρ	Density (of air)	kg/m ³
c_p	Specific heat capacity of air (constant pressure)	Wh/(kg·K)
$q_{(v)}$	Air volume flow	m ³ /h
q	Specific air permeability of the building envelope	m ³ /(m ² ·h)
V	Volume	m ³
v	Pressure exponent for leakages	-
$a_{(ATD...)}$	ATD authority	-
ϕ	Specific heat power	W/m ²
τ	Building time constant	h
C	Thermal storage capacity	Wh/K
c	Volume-specific thermal storage capacity	Wh/(m ³ ·K)
G	Temperature gradient over height	K/m
k	Calculation parameter (factor)	-
h	Height	
d	Thickness	m
λ	Thermal conductivity	
R	Heat transmission resistance	m ² K/W
G_w	Ground water correction factor	—
l	Length (of a linear thermal bridge)	m
T	Thermodynamic temperature on the Kelvin scale	K
v	Wind velocity	m/s
η	efficiency	-
Ψ	Thermal transmittance of a linear thermal bridge	W/(m·K)

4.2 Subscripts

For the purposes of this document, the subscripts given in EN ISO 52000-1, *any TC LEVEL GENERAL DEFINITIONS STANDARD* and the specific subscripts listed in Table 3 apply.

Table 3 — Indices

Index	Meaning/Use
50	Referring to a pressure difference of 50 Pa
a	Air
ann	Annual

Index	Meaning/Use
ATD	Air transfer device; refers to externally mounted air transfer devices unless otherwise specified
BE	Numbering index for building entities ^a
bottom	Referring to the underneath of the building or a portion hereof
build	Building
comb	Combustion
D	Discharge (coefficient)
design	Referring to a design condition or technical property
dir	Direction, orientation
du	Disuse
e	External air, exterior; usually refers to an external design condition
e,m	(Annual) mean external
eff	Effective
env	Envelope
equiv	Equivalent (U-value)
exh	Exhaust
f	Frame (of a window)
fac	Facade; vertical external walls
floor	Floor
g	Ground
g	Relative to ground level
g	Glazing (of a window)
gain	Heat gains
GW	Groundwater
HL	Heat load
hu	Heating-up
i, j	Numbering indices ^a for heated spaces; where (i) is normally used for heated spaces in consideration and (j) for other heated space interrelating to (i), such as a neighbouring room, etc.
ia	From the considered space (i) to an adjacent (heated) space (a)
iaBE	From the considered space (i) to an adjacent Building entity (aBE)
iae	From the considered space (i) to the exterior through an adjacent unheated space (ae)
ie	From the considered space (i) to the exterior (e)
ig	From the considered space (i) to the ground (g)

Index	Meaning/Use
inf	Infiltration
inf-add	Additional infiltration
inner	Inner/internal, Referring to internal dimensions
int	Internal; often refers to an internal design condition
ix	From the considered space (i) to another space; x being a placeholder for e, a, g, etc.
ju	From a space (j) to a space (u) that is looked upon as being unheated, although, design-wise, (u) may be heated or containing heated spaces
k	Numbering index ^a for building elements (walls, windows, ceilings, etc.)
l	Numbering index ^a for linear thermal bridges
leak	Leakage(s)
m	Numbering index ^a for punctiform thermal bridges
max	Maximum, upper limit
measure	Measured or obtained on the basis of a measurement
min	Minimum, lower limit
occup	Occupied; referring to the <i>occupied zone</i> as the height level that internal design conditions shall be achieved for
open	Openings (e.g. open gates)
p	Constant pressure
rad	Radiant
rec	Heat recovery
Ref	Reference site
sb	Setback
shield	Shielding
si, se	Internal and external heat transmission (e.g.: internal air to building element, building element to external air)
small_open	Small openings
sup	Supply air
surf	Surface
T	(Heat) Transmission
TB	Thermal bridge
techn	Technical, technically required or caused
th	Thermally induced
total	Total, overall
transfer	Referring to air volume flows between rooms

Index	Meaning/Use
u	Referring to a space (u) that is looked upon as being unheated although, design-wise, (u) may be a <i>heated space</i> or an entity containing heated spaces
U	Referring to a quality or condition regarding the thermal transmittance (U-value)
ue	From a space (u) that is looked upon as being unheated to the exterior (e)
v	Volume or volume flow
V	Ventilation
w	Wind-induced
z	Numbering index for (ventilation) zones
^a Note that, within this standard, the ranges of numbering indices (k, i, j, etc.) are not defined explicitly (e.g. $\sum_{i=1}^n [x_i]$ with $n = \dots$). They shall be defined depending on context, e.g.: — All building elements (k) that are walls to the exterior; — all building elements (k) that belong to the room (i); — all rooms (i) that are part of the building entity (BE); and so on.	

5 Description of the methods

This standard covers the calculation of the design heat load of single rooms, building entities and buildings. It contains a standard method and two simplified methods. Note that, while the standard method is a versatile approach, the simplified methods are restricted to certain cases of application and boundary conditions.

Table 4 — Calculation methods, overview

Method		Application	Restrictions within the overall scope of this standard
1	Standard method – Heat load of rooms, building entities and buildings (6)	— Versatile approach for any consideration on heat losses/load in accordance with Clause 1 (Scope) — Typically, dimensioning of components of heating systems in — new buildings — extensive reconstruction measures	-
2	Simplified method for the calculation of the design heat load of a heated space (single rooms) (7) ^a	Determination of room heat load prior to measures concerning the heat emission system in single rooms — exchange of heat emission (e.g. radiators) — hydraulic balancing	a) Only applicable to rooms in: 1) residential buildings or buildings of similar use 2) existing buildings / building stock 3) buildings with natural ventilation
3	Simplified method for the calculation of the building design heat load (8) ^a	Determination of building heat load prior to measures concerning the heat generation, e.g. — exchange of the heat generator	
^a The simplified methods (7, 8) are not suited to substitute the standard method (6) in case of extensive measures concerning heat generation AND emission.			

6 Standard method – Heat load of rooms, building entities and buildings

6.1 Output data

This method covers a steady-state calculation of the heat load for heated spaces, building entities or a building containing heated spaces under internal and external design conditions.

Table 5 — Output data

Description	Symbol	Unit	Intended use	Intended destination module
Design heat load of a heated space	$\Phi_{HL,i}$	W	— Dimensioning of components for heat emission and distribution	— application of the results in the field (see <i>Intended use</i>)
Design heat load of a building entity or building	$\Phi_{HL,BE}$ $\Phi_{HL,build}$	W	— Dimensioning of heat generators — Input value for the determination of heat generation losses	— application of the results in the field (see <i>Intended use</i>) — possible application in M3-2 (energy needs), M3-4 (energy efficiency) and where the power of a heat generation system may be required as input

6.2 Input data

The standard method requires the following input data that shall be obtained from the sources named. In case of multiple sources for one item, all sources are arranged in order of priority from highest to lowest.

Items relating to a single building element or a portion of the building (heated space, etc.) are indexed. Within Table 6, these indices (e.g. i and z) are given exemplarily – within the description of the calculation method and the referenced annexes, depending on context, numbering indexes might be represented by other terms than given here.

Table 6 — Input data

Symbol	Description	Unit	Source (highest to lowest priority)
$A_{env,i}$	Envelope of a heated space (i); surface area of all building elements (k) of a heated space (i) in contact with external air or unheated spaces A_{env} can be based on internal or external dimensions. If known, A_{env} shall refer to the same dimension specifications as the air permeability at 50 Pa that is determined by means of an air-tightness test or taken from national default values. Where dimension specifications are unknown, A_{env} shall refer to external dimensions. Reference to external dimensions is always acceptable (conservative estimate).	m ²	— Building data, measurement
$A_{env,build}$	Envelope of a building (build); surface area of all building elements (k) of a building (build) in contact with external air or unheated spaces A_{env} can be based on internal or external dimensions. If known, A_{env} shall refer to the same dimension specifications as the air permeability at 50 Pa that is determined by means of an air-tightness test or taken from national default values. Where dimension specifications are unknown, A_{env} shall refer to external dimensions. Reference to external dimensions is always acceptable (conservative estimate).	m ²	— Building data, measurement

Symbol	Description	Unit	Source (highest to lowest priority)
$A_{env,z}$	Envelope of the zone (z); surface area of all building elements (k) of a ventilation zone (z) in contact with external air or unheated spaces A_{env} can be based on internal or external dimensions. If known, A_{env} shall refer to the same dimension specifications as the air permeability at 50 Pa that is determined by means of an air-tightness test or taken from national default values. Where dimension specifications are unknown, A_{env} shall refer to external dimensions. Reference to external dimensions is always acceptable (conservative estimate).	m ²	— Building data, measurement
A_k	Area of the building element (k); can be based on internal or external dimensions depending on context, as follows — Calculation of transmission heat transfer coefficients: A_k shall refer to the same dimension specifications as the U-values applied — Calculation of envelope surfaces in the context of ventilation heat losses: A_k shall refer to the same dimension specifications as the air permeability at 50 Pa that is determined by means of an air-tightness test or taken from national default values Where dimension specifications are unknown, A_k shall refer to external dimensions. Reference to external dimensions is always acceptable (conservative estimate).	m ²	— Building data, measurement
C_{eff}	Volume-specific thermal storage capacity of the building	Wh/(m ³ ·K)	— Building data — National annex to this standard in accordance with Subclause A.2.7 — Subclause B.2.7
c_p	Specific heat capacity of air at constant pressure	Wh/(kg·K)	— Building data, design, ventilation concept — National annex to this standard in accordance with Subclause A.2.8 — Subclause B.2.8
$f_{u,k}$	Correction factor for the influence of building part properties and meteorological conditions not taken into account in the calculation of U-values	-	— National annex to this standard in accordance with Subclause A.2.2 — Subclause B.2.2

Symbol	Description	Unit	Source (highest to lowest priority)
$f_{qv,z}$	Volume flow factor of the zone (z); optional: not required in naturally ventilated air-tight zones without ATDs	-	— National annex to this standard in accordance with Subclause A.2.12 — Subclause B.2.12
$f_{dir,z}$	Factor for the orientation of zone (z)	-	— National annex to this standard in accordance with Subclause x A.2.15 — Subclause B.2.15
f_{i-z}	Ratio between the minimum air volume flows of single rooms (i) being part of the zone (z) $q_{v,min,i}$ and the resulting air volume flow of the entire zone (z)	-	— National annex to this standard in accordance with Subclause A.2.9 — Subclause B.2.9
$f_{fac,z}$	Adjustment factor for the number of exposed facades of the zone (z) in accordance with EN ISO 13789; optional: only required in zones with unbalanced ventilation	-	— National annex to this standard in accordance with Subclause A.2.16 — Subclause B.2.16
$f_{\theta ann}$	Correction factor taking into account the annual variation of the external temperature	-	— National annex to this standard in accordance with Subclause A.2.3 — Subclause B.2.3
$G_{\theta,Ref}$	Temperature gradient of the reference site; a positive value stands for increasing temperature with increasing height	K/m	— National annex to this standard in accordance with Subclause A.4.1; no informative default values provided by this standard
h_{Build}	Mean height of the building above sea level	m	— Building data / data on building site
h_{Ref}	Mean height of the reference site (e.g. a state or a certain region) above sea level	m	— National annex to this standard in accordance with Subclause A.4.1; no informative default values provided by this standard
h_i	Mean internal height of the room (i); only required in with large ceiling heights (≥ 4 m)	m	— Building data, measurement
$h_{occup,i}$	Height of the occupied zone of the room (i); only required in with large ceiling heights (≥ 4 m)	m	— National annex to this standard in accordance with Subclause A.2.6 — Subclause B.2.6
k_T	Slope; parameter for the adjustment of the external design temperature taking into account the influence of the building time constant on heat loss	K/h	— National annex to this standard in accordance with Subclause A.4.1 — Subclause B.4.1
$n_{min,i}$	Minimum air change rate of the considered heated space (i), required for reasons of air quality / hygiene and comfort	h^{-1}	— Building data → design / ventilation concept — National annex to this standard in accordance with Subclause A.2.11 — Informative Subclause B.2.11

Symbol	Description	Unit	Source (highest to lowest priority)
$q_{\text{env},50}$ (n_{50})	Air permeability (alternatively, air change rate) at a pressure difference of 50 Pa (ATDs, if any, closed); considered a building property	$\text{m}^3/(\text{m}^2 \cdot \text{h})$ (h^{-1})	— Building data, design, ventilation concept, air-tightness measurement (EN ISO 9972) — National annex to this standard in accordance with Subclause A.2.10 — Subclause B.2.10
$q_{\text{v,ATD,design},i}$	Design air volume flow of the ATDs in room (i); optional: only required with ATDs	m^3/h	— Building data, design, ventilation concept — National annex to this standard in accordance with Subclause A.2.13 — Subclause B.2.13
$q_{\text{v,ATD,design},z}$	Design air volume flow of the ATDs in zone (z); optional: only required with ATDs	m^3/h	— Building data, design, ventilation concept — National annex to this standard in accordance with Subclause A.2.13 — Subclause B.2.13
$q_{\text{v,comb},i}$	Air volume flow exhausted from the heated space (i) that, in case of a ventilation system, has not been included in the exhaust air volume flow $q_{\text{v,exh},i}$ of the ventilation system – typically, but not necessarily for combustion air; optional: only required if there is such a technical system (e.g. open flue heaters)	m^3/h	— Building data, design, ventilation concept
$q_{\text{v,exh},i}$	Exhaust air volume flow from the heated space (i); optional: only required in ventilation systems with exhaust air	m^3/h	— Building data, design, ventilation concept
$q_{\text{v,open},i}$	External air volume flow into the heated space (i) through large openings; optional: only required if large openings are to be considered	m^3/h	— Building data, design, ventilation concept — National annex to this standard in accordance with Subclause A.2.17 — Subclause B.2.17
$q_{\text{v,sup},i}$	Supply air volume flow into the heated space (i); optional: only required in ventilation systems with supply air	m^3/h	— Building data, design, ventilation concept
$q_{\text{v,transfer},ij}$	Transfer air volume flow into the heated space (i); optional: only required in spaces with internal air transfer from one space to another	m^3/h	— Building data, design, ventilation concept
$U_{\text{equiv},k}$	Equivalent thermal transmittance of a building element (k) in contact with the ground (g)	$\text{W}/(\text{m}^2 \cdot \text{K})$	— National annex to this standard in accordance with Subclause A.2.3 — Subclause B.2.3 / Annex E

Symbol	Description	Unit	Source (highest to lowest priority)
U_k	Thermal transmittance of the building element (k), determined in accordance with: EN ISO 6946 (opaque elements) EN ISO 10077-1 (doors and windows) information given in European Technical Approvals	$W/(m^2 \cdot K)$	— Building data — National annex to this standard in accordance with Subclause A.4.3 — Subclause B.4.3
V_i	Internal volume of the considered heated space (i)	m^3	— Building data / Measurement
V_e	External building volume	m^3	— Building data / Measurement
$V_{leak,z}$	Pressure exponent of zone (z); optional: only required in zones with ATDs	-	— National annex to this standard in accordance with Subclause A.2.14 — Subclause B.2.14
$\Delta p_{ATD,design,z}$	Design pressure difference of the ATDs in zone (z); optional: only required in zones with ATDs	Pa	— Building data, design, ventilation concept — National annex to this standard in accordance with Subclause A.2.13 — Subclause B.2.13
ΔU_{TB}	Blanket additional thermal transmittance for thermal bridges. ΔU_{TB} incorporates thermal bridges in a simplified manner; where a more detailed consideration of thermal bridges is required, the method described in Annex E may be used instead if not overridden by national specifications to this standard	$W/(m^2 \cdot K)$	— National annex to this standard in accordance with Subclause A.2.1 — Subclause B.2.1
$\Delta \theta_{e,T,0}$	Basic value; parameter for the adjustment of the external design temperature taking into account the influence of the building time constant on heat loss	K	— National annex to this standard in accordance with Subclause A.4.1 — Subclause B.4.1
$\Delta \theta_{e,T,max}$	Upper limit; parameter for the adjustment of the external design temperature taking into account the influence of the building time constant on heat loss	K	— National annex to this standard in accordance with Subclause A.4.1 — Subclause B.4.1
$\Delta \theta_{e,T,min}$	Lower limit; parameter for the adjustment of the external design temperature taking into account the influence of the building time constant on heat loss	K	— National annex to this standard in accordance with Subclause A.4.1 — Subclause B.4.1
$\eta_{rec,z}$	Efficiency of the heat recovery assigned to zone (z); refers to design external conditions*; optional: only required in case of ventilation systems with heat recovery * Example: If, for a given ventilation system, heat recovery is typically bypassed under design external conditions, $\eta_{rec,z} = 0$	-	— Building data, design, ventilation concept

Symbol	Description	Unit	Source (highest to lowest priority)	
$\Phi_{\text{gain},i}$	Heat gains (power) for the room (i) that occur under design external conditions	W	— National annex to this standard in accordance with Subclause A.2.19 — Subclause B.2.19	
$\phi_{\text{hu},i}$	Specific additional power for heating up after temperature setback for the room (i)	W/m ²	— National annex to this standard in accordance with Subclause A.2.18 — Subclause B.2.18 / Annex F	
$\theta_{\text{e},m}$	Annual mean external temperature	°C	— National annex to this standard in accordance with Subclause A.4.1; no informative default values provided by this standard	
$\theta_{\text{e,Ref}}$	External design temperature of the reference site	°C	— National annex to this standard in accordance with Subclause A.4.1; no informative default values provided by this standard	
$\theta_{\text{exh},z}$	Temperature of the exhaust volume air flow from the zone (z); optional: only required in ventilation systems with exhaust air	°C	— Building data, design, ventilation concept — Estimation based on per-room values (Subclause 6.3.3.7, Formula (38))	
$\theta_{\text{int},i}$	Internal design temperature of the considered heated space (i). Depending on context, other numbering indices than (i) may be used	°C	— Building data, design — National annex to this standard in accordance with Subclause A.4.2 — Subclause B.4.2	
$\theta_{\text{transfer},ij}$	Temperature of the transfer air volume flow into the heated space (i) from another space (j); optional: only required in spaces with internal air transfer from one space to another.	°C	Room height < 4 m	Room height ≥ 4 m
			— $\theta_{\text{transfer},ij} = \theta_{\text{int},j}$ see $\theta_{\text{int},i}$	— $\theta_{\text{transfer},ij} = \theta_{\text{int},j}^*$ see $\theta_{\text{int},i}^*$
$\theta_{\text{rec},z}$	Temperature of the supply air volume flow into zone (z) after passing heat recovery, but without “active” preheating; optional: only required in ventilation systems with exhaust and supply air Any temperature-rise through “active” preheating (requiring power from the heat generation) shall not be taken into account. Only heat recovery and “passive” preheating (e.g. ground heat exchanger) shall be taken into account. In case of actively preheated supply air, $\theta_{\text{rec},z}$ is not the actual supply air temperature but the temperature that the supply air would have if it had not been preheated.	°C	— Building data, design, ventilation concept — Subclause 6.3.3.7, Formula (37)	
$\theta_{\text{int},k}^*$	Mean internal surface temperature of a building element (k)	°C	Room height < 4 m	Room height ≥ 4 m
			— $\theta_{\text{int},k}^* = \theta_{\text{int},i}$ see $\theta_{\text{int},i}$	— Subclause 6.3.8.2

Symbol	Description	Unit	Source (highest to lowest priority)	
$\theta_{int,i}^*$	Mean internal air temperature of a room (i).	°C	Room height < 4 m	Room height ≥ 4 m
			— $\theta_{int,i}^* = \theta_{int,i}$ see $\theta_{int,i}$	— Subclause 6.3.8.3
θ_u	Temperature of an adjacent building entity that is looked upon as being unheated although it may contain rooms that, by design, are heated	°C	— National annex to this standard in accordance with Subclause A.2.5 — Subclause B.2.5 / Annex D	
ρ	Density of air	m ³ /kg	— Building data, design, ventilation concept — National annex to this standard in accordance with Subclause A.2.8 — Subclause B.2.8	

6.3 Calculation procedure

6.3.1 Design heat load

6.3.1.1 Building (build)

The design heat load for a whole building is calculated from all transmission heat losses to the exterior (direct and indirect), the ventilation heat loss of the building and, if any, an additional heating-up power. Heat gains (Φ_{gain}) may be taken into account in accordance with national regulation.

In order to prevent oversizing of the heat generator for ecological and economic reasons, only those heating-up powers may be taken into account that can be assumed to occur at the same time and under external design conditions – it is strongly recommended that the consideration of heating-up power in the sizing of heat generators is explicitly agreed upon between the customer and the contractor sizing/installing the heat generator:

$$\Phi_{HL,build} = \sum_i \langle \Phi_{T,ie} + \Phi_{T,iae} + \Phi_{T,ig} \rangle + \Phi_{V,build} + \sum_i \langle \Phi_{hu,i} \rangle - \sum_i \langle \Phi_{gain,i} \rangle \quad (1)$$

where

$\Phi_{HL,build}$	design heat load of the building (build)	W
$\sum_i \langle \Phi_{T,ie} + \Phi_{T,iae} + \Phi_{T,ig} \rangle$	sum of the transmission heat losses directly or indirectly to the exterior for all contained heated spaces (i), in accordance with 6.3.2	W
$\Phi_{V,build}$	ventilation heat loss of the entire building in accordance with 6.3.3	W
$\sum_i \langle \Phi_{hu,i} \rangle$	sum of the heating-up powers that occur simultaneously under design external conditions; optional item	W
$\sum_i \langle \Phi_{gain,i} \rangle$	sum of the heat gains that occur simultaneously under design external conditions; optional item	W

6.3.1.2 Building entity (BE)

The design heat load for a building entity is calculated from all transmission heat losses to the exterior (direct/indirect) and to other building entities, the ventilation heat loss of the building entity and, if any, an

additional heating-up power. Heat gains (Φ_{gain}) may be taken into account in accordance with national regulation.

In order to prevent oversizing of the heat generator for ecological and economic reasons, only those heating-up powers may be taken into account that can be assumed to occur at the same time and under external design conditions – it is strongly recommended that the consideration of heating-up power in the sizing of heat generators is explicitly agreed upon between the customer and the contractor sizing/installing the heat generator:

$$\Phi_{\text{HL, BE}} = \sum_i \langle \Phi_{\text{T, ie}} + \Phi_{\text{T, iae}} + \Phi_{\text{T, iaBE}} + \Phi_{\text{T, ig}} \rangle + \Phi_{\text{V, BE}} + \sum_i \langle \Phi_{\text{hu, i}} \rangle - \sum_i \langle \Phi_{\text{gain, i}} \rangle \quad (2)$$

where

$\Phi_{\text{HL, BE}}$	design heat load of the building entity (BE)	W
$\sum_i \langle \Phi_{\text{T, ie}} + \Phi_{\text{T, iae}} + \Phi_{\text{T, iaBE}} + \Phi_{\text{T, ig}} \rangle$	sum of the transmission heat losses directly or indirectly to the exterior for all contained heated spaces (i), in accordance with 6.3.2	W
$\Phi_{\text{V, BE}}$	ventilation heat loss of the building entity in accordance with 6.3.3	W
	Note that a building entity (BE) usually equals a ventilation zone (z); here, $\Phi_{\text{V, BE}} = \Phi_{\text{V, z}}$. If the building entity (BE) contains more than one zone (z), $\Phi_{\text{V, BE}} = \sum_z \langle \Phi_{\text{V, z}} \rangle$ for all contained zones (z).	
$\sum_i \langle \Phi_{\text{hu, i}} \rangle$	sum of the heating-up powers for the contained heated spaces (i) that occur simultaneously under design external conditions; optional item; usually only required with per-flat heat generation	W
$\sum_i \langle \Phi_{\text{gain, i}} \rangle$	sum of the heat gains for the contained heated spaces (i) that occur simultaneously under design external conditions; optional item	W

6.3.1.3 Heated space (i)

The design heat load of a heated space is calculated as sum of the transmission and ventilation heat loss and, if any, an additional heating-up power. Heat gains (Φ_{gain}) may be taken into account in accordance with national regulation:

$$\Phi_{\text{HL, i}} = \Phi_{\text{T, i}} + \Phi_{\text{V, i}} + \Phi_{\text{hu, i}} - \Phi_{\text{gain, i}} \quad (3)$$

where

$\Phi_{\text{HL, i}}$	design heat load of the heated space (i)	W
$\Phi_{\text{T, i}}$	design transmission heat loss of the heated space (i) – sum of all transmission heat losses in accordance with 6.3.2	W
$\Phi_{\text{V, i}}$	design ventilation heat loss for the heated space (i) in accordance with 6.3.3	W
$\Phi_{\text{hu, i}}$	optional additional heating-up power for the heated space (i) in case of intermittent heating	W
$\Phi_{\text{gain, i}}$	optional heat gains for the heated space (i) that occur under design external conditions	W