



BSI Standards Publication

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

Part 3: Domestic hot water systems heat load and
characterisation of needs, Module M8-2, M8-3

National foreword

This British Standard is the UK implementation of EN 12831-3:2017. It supersedes BS EN 15316-3-1:2007, which is withdrawn.

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

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M8-2, M8-3

Performance énergétique des bâtiments - Méthode de
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Charge thermique des systèmes de production d'eau
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Energetische Bewertung von Gebäuden - Verfahren zur
Berechnung der Energieanforderungen und
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European foreword

This document (EN 12831-3:2017) 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of an identical text or by endorsement, at the latest by January 2018, and conflicting national standards shall be withdrawn at the latest by January 2018.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 15316-3-1:2007.

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

The changes made to the previous edition are minor editorial corrections:

- a) minor improvement readability of Figure 4;
- b) correction of an incorrect term in Formula (14);
- c) correction of an incorrect symbol in Figure 14.

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

CEN/TC 228 deals with heating systems in buildings. Subjects covered by CEN/TC 228 are:

- energy performance calculation for heating systems;
- inspection of heating systems;
- design of heating systems;
- installation and commissioning of heating systems.

This European Standard was developed to cover hourly and minutely time-steps.

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.

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 (EN 12831-4).

1 Scope

This European Standard describes a method to calculate the power and the storage volume required for the dimensioning of domestic hot water systems (DHW). The applicability ranges from direct water heaters (no storage volume and a comparatively large effective heating power) to larger storage systems with a comparatively small heating power and large storage volumes.

This European Standard is applicable to the following water storage systems:

- storage systems characterized by a minimal mixing zone, (such as stratified charging storage tanks or storage tanks with external heat exchangers): these systems are nominated in this standard as “charging storage systems”;
- storage tank water heaters and warm water storage tanks with a pronounced mixing zone (such as DHW storage tanks with internal heat exchangers), nominated in this standard as “mixed storage systems”;

and for different uses.

The Scope also includes standardization methods for determining the energy need for domestic hot water. This European Standard covers the domestic hot water needs in buildings.

The calculation of the energy needs for DHW-Systems applies to residential and non-residential buildings, a building or a zone of a building.

Figure 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 shows the relative position of this standard within the EPB package of standards.

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

Overarching		Building (as such)	Technical Building Systems									
Sub module	Descriptions	Descriptions	Descriptions	Heating	Cooling	Ventilation	Humidif ication	Dehumidifi cation	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, and units and subscripts	Building Energy Needs							12831-3			
3	Applications	(Free) Indoor Conditions without Systems		12831-1					12831-3			
4	Ways to Express Energy Performance	Ways to Express Energy Performance		15316-1					15316-1			
5	Building categories and Building Boundaries	Heat Transfer by Transmission		15316-2	15316-2							
6	Building Occupancy and Operating Conditions	Heat Transfer by Infiltration and Ventilation		15316-3	15316-3				15316-3			
7	Aggregation of Energy Services and Energy Carriers	Internal Heat Gains		15316-5					15316-5 15316-4- 3			

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
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								
9	Calculated Energy Performance		Building Dynamics (thermal mass)		Load dispatching and operating conditions									
	Measured Energy Performance		Measured Energy Performance		Measured Energy Performance	15378-3					15378-3			

Overarching		Building (as such)		Technical Building Systems										
Sub module	Descriptions	M1	Descriptions	M2	Descriptions	Heating	Cooling	Ventilation	Humidif ication	Dehumidifi cation	Domestic Hot water	Lighting	Building automation and control	Electricity production
sub1		M1		M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
11	Inspection		Inspection		Inspection	15378-1					15378-1			
12	Ways 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 12897, *Water supply — Specification for indirectly heated unvented (closed) storage water heaters*

EN 50440, *Efficiency of domestic electrical storage water heaters and testing methods*

EN ISO 52000-1:2017, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures (ISO 52000-1:2017)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 52000-1:2017 and the following apply.

3.1

energy storage tank

storage tank for providing thermal energy amongst others for use in domestic hot water systems (DHW)

Note 1 to entry: The storage medium is not potable water.

3.2

centralized DHW system

DHW system where water for several building units is heated centrally and then distributed to each building unit

3.3

potable water, cold (PWC)

water that has not been heated by the DHW system

3.4

decentralized, individual DHW system

DHW System in which PWC is distributed to each draw-off point, dwelling or building unit and then individually heated (e.g. via a separate DHW module), in which case hot water is only distributed within individual building units)

Note 1 to entry: In this case, hot water is only distributed within individual building units.

3.5

domestic hot water

DHW

potable water, the temperature of which has been increased by means of heat transfer

Note 1 to entry: In this standard, the term domestic hot water (DHW) is equivalent to the term potable water hot (PWH). The usage of the term DHW also applies to non-domestic buildings and their systems.

3.6

DHW storage tank

tank for storage of domestic hot water (DHW)

3.7 mixed storage system

tank (energy storage or DHW storage tank) which is characterized by a pronounced mixing zone during the charging phase and a minimal mixing zone during the exclusive discharging phase

Note 1 to entry: E.g. storage systems with internal heat exchangers.

Note 2 to entry: As an example see Figure 1:



a) Charging phase of a mixed storage system b) Discharging phase of a mixed storage system

Figure 1 — Phases of a mixed storage system

3.8 charging storage system

tank (energy storage or DHW storage tank) which is characterized by a minimal mixing zone during charging and discharging phases

Note 1 to entry: Examples are: stratified charging tanks and tanks with external heat exchangers.

Note 2 to entry: As an example see Figure 2:



a) Charging phase of a charging storage system b) Discharging phase of a charging storage system

Figure 2 — Phases of a charging storage system

3.9 summation curve

cumulated course of a time-dependent element over time

Note 1 to entry: The *needs curve* and the *supply curve* are *summation curves*.

3.10**needs curve**

cumulated course of energy needs which is to be supplied by the DHW system

3.11**supply curve**

cumulated course of energy supplied by the DHW system including the losses thereof

3.12**residual capacity curve**

cumulated course of useful energy in the storage tank at the switch-ON point

3.13**distribution system**

pipings sections connecting the heat generator, storage system (energy- and DHW storage tanks) and tapping points

3.14**draw-off temperature**

temperature measured at the draw-off point (tapping point) of the DHW system

3.15**minimal useable draw-off temperature**

minimal withdrawal temperature at a draw-off point which can still be seen as a fulfilment of the specified temperature needs

Note 1 to entry: In systems with different temperature needs, the highest temperature needs to be applied.

4 Symbols and abbreviations**4.1 Symbols**

For the purposes of this document, the symbols given in EN ISO 52000-1:2017 and the specific symbols listed in Table 2 apply. Symbols and subscripts may have more than one denotation.

Table 2 — Symbols and units

Symbol	Name	Unit
Φ	Power/Wattage (Heat power)	W
ϑ	Temperature on the Celsius scale	°C
Q	Energy depending on context, absolute or time-specific	kWh or J/3,6x10 ⁶ also kWh/[unit of time]
q'	heat loss per unit length of pipe	W/m
$\dot{V}$	volume flow rate (water)	l/s
U	(Linear) Thermal transmittance of the piping	W/mK
l	Length of the piping	m
f	Adjustment/correction factor or term	-
ρ	Density	kg/m ³ or kg/l
c	Specific heat capacity	kJ/kgK
V	Volume	m ³
n	number	–
h	Height	m
x	Relative amount of water drawn within a certain period of time	-
t	Depending on context, a period of time or a time step (e.g. 1 min)	eg. min
S	standing loss value	[W]

4.2 Subscripts

For the purposes of this document, the subscripts given in EN ISO 52000-1:2017, and the specific subscripts listed in Table 3 apply. Subscripts may have several denotations.

Table 3 — Subscripts

Index	Meaning/Use
<i>W</i>	Water
<i>a</i>	Ambient
<i>b</i>	Building needs
<i>c</i>	Cold; referring to cold water
<i>ch</i>	Charging
<i>D</i>	Design
<i>A</i>	Draw-off flow rate
<i>sto</i>	Storage
<i>sb</i>	Standby
<i>dis</i>	Distribution
<i>d, day</i>	Per day, daily
<i>t</i>	Time; referring to a period of time or one time step within the calculation
<i>draw</i>	Drawn; referring to properties of the water drawn-off at the tap
<i>i</i>	General numbering index
<i>i</i>	Loop cycle / calculation step (one cycle per each minute of the period under consideration); referring to cumulated items
<i>t</i>	Time step, one minute; referring to non-cumulated items
<i>l</i>	Load, loading
<i>h</i>	Hourly, per hour, over the time of an hour
<i>sensor</i>	Temperature sensor of the storage tank
<i>sup</i>	Supply
<i>start</i>	Start; referring to (estimated) start values for iterative calculation approaches
<i>ON</i>	Switch on point; setting, at which the temperature sensor turns on the heat generator (reheat)
<i>OFF</i>	Switch off point; setting, at which the temperature sensor turns off the heat generator
<i>eff</i>	Effective
<i>HE</i>	Heat exchanger
<i>HG</i>	Heat generator
<i>min</i>	Minimum
<i>max</i>	Maximum
<i>m</i>	Mean
<i>N</i>	Net floor area
<i>N</i>	Nominal
<i>lag</i>	(Time) lag

5 Description of the methods

5.1 General description of the method for sizing domestic hot water systems

This standard describes a method to determine the power and the storage volume required for designing and dimensioning DHW systems. The method is based on a comparison of the curves of the energy needs for domestic hot water and the energy supply from the hot water system as a function of time.

The sizing of DHW systems can be depicted graphically. The graphical approach is called *summation curve method*. Here, the energy need for DHW (*needs curve*) as well as the energy supply from the hot water system (*supply curve*) are depicted in the form of cumulative curves for a certain time period (usually 24 h). The hot water system is adequately designed as long as:

- the supply curve does not intersect with or fall below the needs curve in systems with a minimal mixing zone (charging storage systems) or
- the supply curve always lies above the needs curve while maintaining a minimal distance in systems with a distinct mixing zone (mixed storage systems).

Both curves are determined with a time step of 1 min. The input data for the needs curve can also be given on a different time basis, such as an hourly basis. In this case, the data are broken down into equal minutely values.

The design steps are as follows:

- a) determination of the hot water needs:
 - 1) by measuring the volume flow rate of hot water on a minutely basis and considering the hot and cold water temperatures;
 - 2) on the basis of statistical methods (characteristic needs);
 - 3) on the basis of published and accepted characteristic load profiles (to be determined on a national basis. In the absence of national values default profiles are given in Annex B);
- b) calculation and depiction of the needs curve;
- c) definition of the design parameters of the hot water system:
 - 1) selection of the hot water system;
 - 2) type and power of the available heat source and other required data such as thermal losses of the storage and distribution systems;
- d) dimensioning of the hot water system. Calculate and depict the supply curve, starting alternatively by either:
 - 1) defining the power on the basis of the available power of the heat generator;
 - 2) defining the storage volume (storing the peaks in the hot water needs or via daily, half-daily or hourly energy needs);

- 3) using a starting value for either the power of the heat generator or the storage volume by evaluating the mean slope of the needs curve in cases where no distinct data on heat generator power or storage volume is available;
- e) determination of the missing parameter (volume or power) by modification of the supply curve;
- f) optimization of the system by using manufacturers' data and by considering further boundary conditions (e.g. restricted periods, work cycles and hygienically aspects).

5.2 General description of the methods for calculating the energy needs for domestic hot water

This clause describes several methods for calculating the energy needs of domestic hot water. The methods differ as to the level of detail assumed for the domestic hot water demand; for example whether the conditions relating to the different uses of the hot water are taken into account. The energy needs per day may also be used to size the DHW system according to Clause 5, provided an appropriate load profile is used. When using this approach it should be considered that the energy needs and the load profile do not necessarily reflect a worst-case scenario.

A National Annex may specify which method should be used for different building categories. A national Annex may also specify which method is acceptable for the purpose of energy labelling or any other specific use.

The calculations are based on a daily domestic hot water requirement.

6 Calculation procedures

6.1 Output data

This standard provides a method or (default) values to determine the following items. Note that the method presented here may require first estimates (start values) of some items considered output data. Therefore, some items may be both output and input data (see Table 4).

Table 4 — Output data

Description	Symbol	Unit	Intended use	Intended destination module
Effective power required for DHW	$\Phi_{W,eff}$	W	Dimensioning of components for DHW, as heat generators hot water tanks	M8-8, M3-8
Storage volume of the hot water tank	V_{sto}	m ³		M8-7
Energy needs for DHW in time step	$Q_{W;nd;i}$	kWh/t	Energy demand calculation	M8-1
Volume of water drawn at the current time step	V_t	m ³ /ti		M8-6

6.2 Calculation time steps

The calculation time step for the purpose of sizing the DHW system is one minute. The input data for the energy needs can however also be given on a different time basis (usually an hourly basis) and can then be converted.