



BSI Standards Publication

Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies

Part 1: General and Energy performance expression,
Module M3-1, M3-4, M3-9, M8-1, M8-4

National foreword

This British Standard is the UK implementation of EN 15316-1:2017. It supersedes BS EN 15316-1:2007, which is withdrawn.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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Energy performance of buildings - Method for calculation
of system energy requirements and system efficiencies -
Part 1: General and Energy performance expression,
Module M3-1, M3-4, M3-9, M8-1, M8-4

Performance énergétique des bâtiments - Méthode de
calcul des besoins énergétiques et des rendements des
systèmes - Partie 1 : Généralités et expression de la
performance, Modules M3-1, M3-4, M3-9, M8-1, M8-4

Energetische Bewertung von Gebäuden - Verfahren zur
Berechnung der Energieanforderungen und
Nutzungsgrade der Anlagen - Teil 1: Allgemeines und
Darstellung der Energieeffizienz, Module M3-1, M3-4,
M3-9, M8-1, M8-4

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European foreword

This document (EN 15316-1:2017) has been prepared by Technical Committee CEN/TC 228 “Heating systems and water based cooling systems”, the secretariat of which is held by DIN.

This document supersedes EN 15316-1:2007.

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of an identical text or by endorsement, at the latest by October 2017, and conflicting national standards shall be withdrawn at the latest by October 2017.

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

The main changes compared to EN 15316-1:2007 are:

- reference and coordination of all other modules (a module corresponds to a subsystem standard);
- inclusion of operating conditions calculation and load dispatching related to building automation control (BAC) and systems design (e.g. connection of distributions).
- inclusion of a monthly method based on BIN.

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.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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 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”.

EPB standards deal with energy performance calculation and other related aspects (like system sizing) to provide the building services considered in the EPB Directive.

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 (CEN/TR 15316-6-1).

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

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

The first version of this standard was developed during the first EPBD mandate and published in 2008.

The revision for inclusion in the second EPBD mandate package was performed in 2014.

Default references to EPB standards other than EN ISO 52000-1 are identified by the EPB module code number and given an Annex A (normative template) and Annex B (informative default choice).

Table 1 associates the title of the EN EPB standards to the numbers and modules. It also remembers the replaced standards.

Table 1 — List of EN EPB standards related to the calculation of space heating and domestic hot water systems

No.	Module	New EPBD numbering	Old standards replaced	Title of the new EPBD standard
1	M1-14	EN 15459-1	EN 15459	Energy performance of buildings - Heating systems and water based cooling systems in buildings - Part 1: Economic evaluation procedure for energy systems in buildings, Module M1-14
		CEN/TR 15459-2	New	Energy performance of buildings - Economic evaluation procedure for energy systems in buildings - Part 2: Explanation and justification of EN 15459-1, Module M1-14)
2	M3-11 M8-11	EN 15378-1	EN 15378	Energy performance of buildings - Heating systems and DHW in buildings - Part 1: Inspection of boilers, heating systems and DHW, Module M3-11, M8-11
		CEN/TR 15378-2	New	Energy performance of buildings - Heating systems and DHW in buildings - Part 2: Explanation and justification of EN 15378-1, Module M3-11 and M8-11)
3	M3-10 M8-10	EN 15378-3	New	Energy performance of buildings - Heating and DHW systems in buildings - Part 3: Measured energy performance, Module M3-10, M8-10
		CEN/TR 15378-4	New	Heating systems and water based cooling systems in buildings - Heating systems and DHW in buildings - Part 4: Accompanying TR to EN 15378-3 (Measured energy performance))
4	M3-3	EN 12831-1	EN 12831	Energy performance of buildings - Method for calculation of the design heat load - Part 1: Space heating load, Module M3-3
		CEN/TR 12831-2	New	Energy performance of buildings - Method for calculation of the design heat load - Part 2: Explanation and justification of EN 12831-1, Module M3-3)

No.	Module	New EPBD numbering	Old standards replaced	Title of the new EPBD standard
5	M8-3	EN 12831-3	EN 15316-3-1	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
		CEN/TR 12831-4	New	Energy performance of buildings - Method for the calculation of the design heat load - Part 4: Explanation and justification of EN 12831-3, Module M8-2, M8-3
6	M3-1 M8-1 M3-4 M8-4 M3-9 M8-9	EN 15316-1	EN 15316-1	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 1: General and Energy performance expression, Module M3-1, M3-4, M3-9, M8-1, M8-4
		CEN/TR 15316-6-1	New	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: Explanation and justification of EN 15316-1, Module M3-1, M3-4, M3-9, M8-1, M8-4
7	M3-5 M4-5	EN 15316-2	EN 15316-2-1	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 2: Space emission systems (heating and cooling), Module M3-5, M4-5
		CEN/TR 15316-6-2	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-2: Explanation and justification of EN 15316-2, Module M3-5, M4-5
8	M3-6 M4-6 M8-6	EN 15316-3	EN 15316-2-3 EN 15316-3-2	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 3: Space distribution systems (DHW, heating and cooling), Module M3-6, M4-6, M8-6
		CEN/TR 15316-6-3	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-3: Explanation and justification of 15316-3, Module M3-6, M4-6, M8-6
9	M3-8-1 M8-8-1	EN 15316-4-1	EN 15316-4-1 EN 15316-3-3 EN 15316-4-7	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-1: Space heating and DHW generation systems, combustion systems (boilers, biomass), Module M3-8-1, M8-8-1
		CEN/TR 15316-6-4	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-4: Explanation and justification of EN 15316-4-1, Module M3-8-1, M8-8-1
10	M3-8-2 M4-8-2 M8-8-2	EN 15316-4-2	EN 15316-4-2	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-2: Space heating generation systems, heat pump systems, Module M3-8-2, M8-8-2
		CEN/TR 15316-6-5	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-5: Explanation and justification of EN 15316-4-2, Module M3-8

No.	Module	New EPBD numbering	Old standards replaced	Title of the new EPBD standard
11	M3-8-3 M8-8-3 M11-8-3	EN 15316-4-3	EN 15316-4-3 EN 15316-4-6	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-3: Heat generation systems, thermal solar and photovoltaic systems, Module M3-8-3, M8-8-3, M11-8-3
		CEN/TR 15316-6-6	New	Energy performance of buildings - Method for calculation of system energy performance and system efficiencies - Part 6-6: Explanation and justification of EN 15316-4-3 Module M3-8-3 M8-8-3
12	M3-8-4 M8-8-4 M11-8-4 M3-7 / M8-7	EN 15316-4-4	EN 15316-4-4	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-4: Heat generation systems, building-integrated cogeneration systems, Module M8-3-4, M8-8-4, M8-11-4
		CEN/TR 15316-6-7	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-7: Explanation and justification of EN 15316-4-4, Module M8-3-4, M8-8-4, M8-11-4
13	M3-8-5 M4-8-5 M8-8-5 M11-8-5	EN 15316-4-5	EN 15316-4-5	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-5: District heating and cooling, Module M3-8-5, M4-8-5, M8-8-5, M11-8-5
		CEN/TR 15316-6-8	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-8: Explanation and justification of EN 15316-4-5 (District heating and cooling), Module M3-8-5, M4-8-5, M8-8-5, M11-8-5
14	M3-8-8	EN 15316-4-8	EN 15316-4-8	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-8: Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local), Module M3-8-8
		CEN/TR 15316-6-9	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-9: Explanation and justification of EN 15316-4-8, Module M3-8-8
15	M3-7 M8-7	EN 15316-5	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 5: Space heating and DHW storage systems (not cooling), M3-7, M8-7
		CEN/TR 15316-6-10	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 6-10: Explanation and justification of EN 15316-5, Module M3-7, M8-7
16	M3-8-6 M8-8-6	EN 15316-4-9	New	Heating systems and water based cooling systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-9: Direct electric generation systems
17	M11-8-7	EN 15316-4-10	New	Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-10: Wind power generation systems, Module M11-8-7

1 Scope

This European Standard is the general frame for the calculation of the energy use and the energy performance of heating and domestic hot water systems. This standard is only dealing with the heat, provided by water based systems, needed for heating, domestic hot water and cooling (e.g. absorption chiller).

It specifies how to perform the calculation of the entire installation using the calculation modules (see Table 2) corresponding to the methods defined in the respective standards.

It deals with common issues like operating conditions calculation and energy performance indicators.

It standardises the inputs and outputs in order to achieve a common European calculation method.

It allows the energy analysis of the heating and Domestic hot water systems and sub-systems including control (emission, distribution, storage, generation) by comparing the system losses and by defining energy performance indicators.

The performance analysis allows the comparison between systems and sub-systems and makes possible to evaluate the impact of each sub-system on the energy performance of a building.

The calculation of the system losses of each part of the heating sub-systems is defined in subsequent standards.

Ventilation systems are not included in this standard (e.g. balanced systems with heat recovery), but if the air is preheated or an air heating system is installed, the systems providing the heat to the AHU (Air Handling Unit) are covered by this standard.

Table 2 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 2 — Position of this standard, within the modular structure of the set of EPB standards

Overarching			Building (as such)		Technical Building Systems										
	Descriptions			Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot water	Lighting	Building automation and control	Electricity production
sub1		M1	sub1	M2	sub1		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General		1	General	1	General	15316-1					15316-1			
2	Common terms and definitions; symbols, units and subscripts		2	Building Energy Needs	2	Needs						12831-3			
3	Applications		3	(Free) Indoor Conditions without Systems	3	Maximum Load and Power	12831-1					12831-3			
4	Ways to Express Energy Performance		4	Ways to Express Energy Performance	4	Ways to Express Energy Performance	15316-1					15316-1			
5	Building Functions and Building Boundaries		5	Heat Transfer by Transmission	5	Emission and control	15316-2	15316-2							
6	Building Occupancy and Operating Conditions		6	Heat Transfer by Infiltration and Ventilation	6	Distribution and control	15316-3	15316-3				15316-3			
7	Aggregation of Energy Services and Energy Carriers		7	Internal Heat Gains	7	Storage and control	15316-5					15316-5 15316-4-3			
8	Building Partitioning		8	Solar Heat Gains	8	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			15316-4-5
					8-6	Direct electrical heater	15316-4-9					15316-4-9			
					8-7	Wind turbines									15316-4-10
					8-8	Radiant heating, stoves	15316-4-8								
9	Calculated Energy Performance		9	Building Dynamics (thermal mass)	9	Load dispatching and operating conditions	15316-1								
10	Measured Energy Performance		10	Measured Energy Performance	10	Measured Energy Performance	15378-3					15378-3			
11	Inspection		11	Inspection	11	Inspection	15378-1					15378-1			
12	Ways to Express Indoor Comfort		12	-	12	BMS									
13	External Environment Conditions														
14	Economic Calculation	15459-1													

NOTE The shaded modules are not applicable

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 15316-3, *Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 3: Space distribution systems (DHW, heating and cooling), Module M3-6, M4-6, M8-6*

EN ISO 7345:1995, *Thermal insulation - Physical quantities and definitions (ISO 7345:1987)*

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 7345:1995, EN ISO 52000-1:2017 and the following specific definitions apply.

3.1

feeding distribution circuit

circuit providing the node with energy delivered by sources

3.2

load distribution circuit

circuit that draw energy from the node and distribute it to the demand side

3.3

node

connection point between one or several feeding circuits (sources) and one or more load circuits (demand side)

Note 1 to entry: The requested energy is dispatched among the sources (e.g. generators) at the node.

4 Symbols and abbreviations

4.1 Symbols

For the purposes of this Standard, the symbols given in EN ISO 52000-1, (M1-9): and the specific symbols listed in Table 3 apply.

Table 3 — Symbols and units

Symbol	Name of quantity	Unit
GEN_FUEL	Fuel type	-
HEAT_XXXX_XXXX_XXX	BAC function identifier	-

4.2 Subscripts

For the purposes of this European Standard, the subscripts given in EN ISO 52000-1, (M1-9) and the specific subscripts listed in Table 4 apply.

Table 4 — Subscripts

Sub	Description	Sub	Description	Sub	Description
nod	node	flw	flow	ret	return
fin	final distribution	loop	distribution loop		

5 Description of the methods

5.1 General description of the calculation method

5.1.1 Calculation direction

The calculation direction is from the energy needs to the source (e.g. from the building energy needs to the primary energy). The calculation direction is the opposite of the energy flow in the system.

If a priority is defined between services or sub-systems these services or sub-systems are calculated according to the priorities.

The calculation structure shall follow the actual structure of the heating systems.

Thermal energy and auxiliary energy used by the heating and DHW systems are calculated separately.

5.1.2 Operating conditions

For each sub-system the operating conditions (e.g. temperatures, mass flows) are calculated according to the related operating conditions modules (see Annex C). The calculation of operating conditions takes into account controls (control identifier).

Only if the sub-systems are separated by a node they can have different operating conditions.

The calculation in the heating, domestic hot water or other sub-system standards applies to a specific part of the technical system with its specific operating conditions (e.g. pipe length, temperatures, etc.).

In complex buildings with complex technical systems there are more specific parts because there are more than one heating system zone and therefore more than one emission, distribution and generation sub-systems. For a technical system with several load circuits it is necessary to know the specific operating conditions of each part (e.g. the demand in each load circuit and the corresponding temperatures) and to apply the sub-systems standards accordingly to each of them.

“Input” versus “output” naming is related to the energy flow.

The calculation direction is the opposite of the energy flow (an “energy flow” input is a “calculation” output).

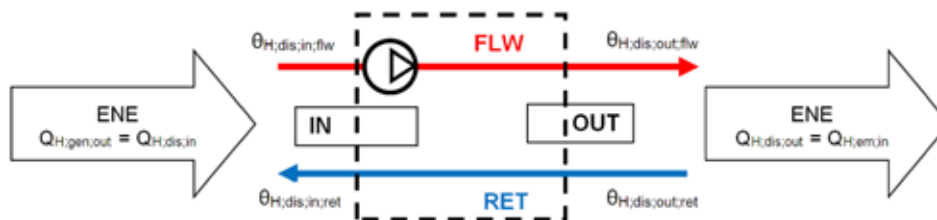
To make the distinction clear it is recommended to specify it (e.g. “flow” input, “calculation” output).

The operating conditions may for each sub-system include:

- the supply temperatures $\vartheta_{X;Y;in/out;sup}$
- the return temperatures $\vartheta_{X;Y;in/out;ret}$
- the average temperatures $\vartheta_{X;Y;in/out;avg}$
- the flow rates $V'_{X;Y;in/out}$

Additional operating conditions parameters may be defined depending on the sub-system characteristics.

Figure 1 illustrates the naming conventions of operating conditions parameters



Key

- FLW Supply (flow) pipe, hot water from generators to emitters
- RET Return pipe of colder water from emitters to generators
- IN Energy input (e.g. distribution input is generation output)
- OUT Energy output
- ENE Energy flow direction

Figure 1 — Naming conventions for energy flows and heating system operating temperatures

5.1.3 Maximum heat supply and power check

Often emitters are oversized whilst generation devices may be sized on average power. Therefore it is likely that the limitation of the power will not be on the emission sub-systems (an exception may be floor heating) but on the generation.

The maximum heat supply may also depend on the internal or external operating conditions (e.g. heat pumps).

For the monthly method and some special generators (like heat pumps) the bin method will be used to check if the generator is able to supply the requested heat. The needed running time to supply the heat will be compared to the effective bin time.

For the monthly method there should be a maximum average load (e.g. 70...80 %) because it is not likely that the installation may run full load for the whole month.

For the hourly method, the check of the heat supply is done for the emission and generation sub-system. Different possibilities are given to deal with a lack of energy supply:

- to add the missing energy production to the sub-system output (emission, generation) of the next time step. If the sub-system is not able to provide the requested energy after a defined number of time steps, then the calculation is stopped and the sizing of the generation sub-system should be reviewed by the designer,
- to calculate the variation of the internal temperature.

If there is lack of energy supply, the calculation will re-boucle at the emitter output calculation with the heat supply requested at the emitter output minus the difference of the requested energy supply and the maximum heat supply of the sub-system in the calculation interval.

5.1.4 Two emission sub-systems installed in the same heating system zone

In the same heating system zone different emission sub-systems may be installed (e.g. floor heating systems and radiators, both connected to the same heating system). One of the heat emitters can also be an independent heating device (e.g. electrical radiator, stove).

The operating conditions shall define if there is a priority (alternate mode) or if the emission subsystems work in parallel.

If a priority is defined between the emitters then the needed emission output is first calculated with the increased set point temperature related to the temperature increase of the priority emitter.

If no priority is defined, or if both emitter supply heat at the same time, then the increased set point temperature is the highest set point temperatures of both emitters.

The calculation procedure of these devices follows the general principles of the calculation procedure.

5.1.5 Multiservice and operating of multi generator systems (load dispatching)

A heat generator may provide heat for several services (e.g. heating, domestic hot water). The heat may be provided by one or several heat generators (e.g. several gas boilers).

The operating of multi service or multi generator systems is determined by the system design and are characterized by:

the operating mode (e.g.)

- alternate operation;
- parallel (simultaneous) operation;

the respective temperatures (e.g.);

- balance point temperature.

5.1.6 Heating and domestic hot water system thermal losses

The system thermal losses are calculated in the related sub-system modules (e.g. distribution, generation). Systems thermal losses are recoverable or non-recoverable.

A distinction is made between:

- parts of the “system thermal losses which are recoverable for space heating”;
- parts of the “system thermal losses which are recovered directly” in the sub-system and which are therefore subtracted from the sub-system thermal losses of the sub-system.

The “recoverable system thermal losses for space heating” are input values for M2-2 in which the recovered system thermal loss is calculated.

The “system thermal losses recovered directly” in the sub-system (heat recovery) improves the performance of the sub-system, e.g. recovered stack losses for preheating the combustion air, water cooled circulation pumps where the cooling water is the distribution medium.

The location of recoverable system thermal loss shall be identified according to the thermal zones or tagged as unallocated and then distributed,

As a minimum the system thermal losses should be calculated according the following locations: heated space, unheated space and outside.

In the monthly calculation the heat losses of the domestic hot water sub-systems or of the space heating sub-systems may be sent explicitly to the needs calculation module M 2.2 or subtract from needs with a recovery factor.

Non localized recoverable losses are distributed amongst heated space according to a building property specified according to the template given in Table A.2. A default specification is given in Table B.2.

5.1.7 Auxiliary energy

In heating and domestic hot water systems auxiliary energy is basically used for pumps, fans, controls, and other electrical components like transformers. To calculate the auxiliary energy, the respective power of the auxiliary components has to be given as input or calculated in the sub-systems.

A simplified approach to estimate auxiliary energy is to multiply the electrical power of the auxiliary by the relevant running or activation time of the respective auxiliary component.

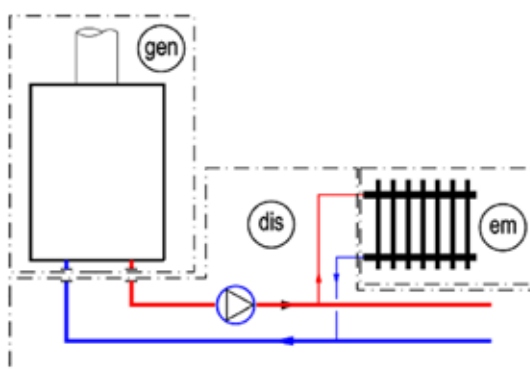
It has to be taken care, if the auxiliary energies is already included in the performance evaluations of the standard testing procedures or not (e.g. in heat pump standards auxiliary energy for control during the running time of the heat pump is taken into account in the COP value, the boiler standards do not consider auxiliaries in the boiler efficiency).

The running time of the auxiliary components depend on the control of each sub-system.

- Generation auxiliary running time is often linked to the running time of the generator which is a function of the power;
- Distribution pumps may be switched-on periodically or run all the time. The running time may also depend on the system configuration, e.g. linked to storage control in case of a heating buffer storage.

All devices using auxiliary energy shall be considered once and only once. Therefore the allocation of circulating pumps is defined according to the following principles.

If there is no pump within the generator, then the boundary between the generation and the distribution sub-systems is the hydraulic connection of the boiler, as shown in Figure 2 and the pump and its auxiliary energy use is attributed to the distribution sub-system.

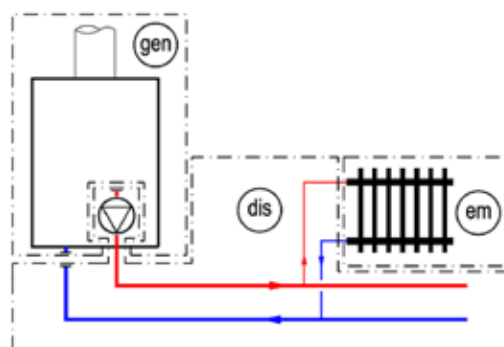


Key

- gen generation sub-system
- dis distribution sub-system
- em emission sub-system

Figure 2 — Sample sub-systems boundaries – example 1

A pump physically installed within the boiler may be considered either as part of the distribution sub-system or as part of the generation sub-system if it contributes directly to the flow of the heating medium to the emitters. An example is shown in Figure 3.

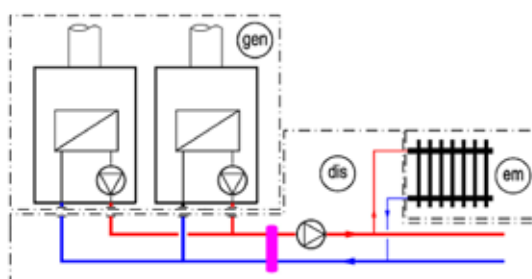


Key

gen generation subsystem
dis distribution subsystem
em emission subsystem

Figure 3 — Sample sub-systems boundaries - example 2

Pumps included in the generators and dedicated only to the circulation of water inside the generators are considered within the generation sub-system. An example is shown in Figure 4.



Key

gen generation subsystem
dis distribution subsystem
em emission subsystem

Figure 4 — Sample sub-systems boundaries -example 3

5.1.8 Sub-system energy balance

The calculation of each module for sub-system Y for the service X shall be based on the required energies $Q_{X,Y,out}$, $Q_{X,Y,in}$ and other specific relevant data (i.e. temperatures, flow rates, etc).

The output (direction of calculation) of each sub-system module shall include:

- the required energy input $Q_{X,Y,in}$;
- the required auxiliary energy $W_{X,Y,aux}$;
- the recoverable losses for heating or cooling $Q_{X,Y,ls,rbl,H}$;

— the localization (thermal zone specification) of recoverable losses $TZ_{X;Y;ls;rb;H}$

NOTE See also 6.3.3, Operating data and boundary conditions

Both auxiliary energy and heat losses may be recovered as a reduction of input or by contributing to recoverable losses for heating. This shall be calculated within the sub-system module.

NOTE 1 If the recovery of auxiliary energy and thermal losses is fully accounted in the sub-system, then $Q_{X;Y;ls;rb;H}$ will be 0.

NOTE 2 For domestic hot water, thermal losses cannot be recovered within the sub-system calculation. Only auxiliary energy can be recovered directly.

NOTE 3 Recoverable losses also include the losses of systems that are active in summer and that will contribute to the cooling needs instead of reducing heating needs.

The basic equations of sub-system modules are:

$$Q_{X;Y;in} = Q_{X;Y;out} + Q_{X;Y;ls} - W_{X;Y;aux} \cdot f_{X;Y;aux;rh} - Q_{X;Y;ls} \cdot f_{X;Y;ls;rh} \quad (1)$$

where:

- $Q_{X;Y;ls}$ are the subsystem losses;
- $f_{X;Y;aux;rh}$ is the recovery factor of auxiliary energy directly within the sub-system (heat to the heated space or to the heating medium);
- $f_{X;Y;ls;rh}$ is the recovery factor of heat losses directly within the sub-system.

$$Q_{X;Y;ls;rbl} = W_{X;Y;aux} \cdot f_{X;Y;aux;rbl;H} + Q_{X;Y;ls} \cdot f_{X;Y;ls;rbl;H} \quad (2)$$

where:

- $f_{X;Y;aux;rbl;H}$ is the recoverability factor of auxiliary energy (heat to the environment);
- $f_{X;Y;ls;rbl;H}$ is the recoverability factor of heat losses (heat to the environment not already accounted as heat recovery by $f_{X;Y;ls;rh}$).

NOTE These are typical equations (e.g. not general equations) because the input of generation sub-systems is not calculated via the sum of losses.

5.1.9 Interaction with other technical building systems

Also other technical building systems (e.g. AHU, absorption cooling) may be connected to the heating system. If the required heat of the other technical building systems will be provided by the heating system it has to be taken into account as a heating circuit connected to the relevant node.

5.2 Optional methods

Different methods to deal with operating conditions like temperatures may be used for hourly and monthly methods (bin method).

The differences are indicated in the related clauses.

5.3 Application data

Application data shall be specified according to the template given in normative Annex A.

Default data for the application of this standard are given in informative Annex B.

6 Calculation procedure

6.1 Output data

The output data of this method are listed in Table 5.

The input data related to the energy flow of each module are calculation output data. The calculation output data can be used by any other module.

Table 5 — Output data of method

Description	Symbol	Computed unit	Validity interval	Varying
Connection with Overarching standard M1-9				
Energy carrier i input for space heating and per zone	$E_{H;gen;in;cr,j}^b$	kWh	0...∞	YES
Energy carrier i identifier	GEN_FUEL,i	List	Not relevant	NO
Heating system auxiliary energy per zone	$W_{H;aux}$	kWh	0...∞	YES
Energy carrier j input for DHW system and per zone	$E_{W;gen;in;cr,j}$	kWh	0...∞	YES
Energy carrier j identifier	GEN_FUEL,j	List	Not relevant	NO
DHW system auxiliary energy per zone	$W_{W;aux}$	kWh	0...∞	YES
Connection with sub-systems				
Energy output required to sub-system Y for service X	$Q_{X;Y;out}^a$	kWh	0...∞	YES
Supply temperature at sub-system Y output for service X	$\vartheta_{X;Y;out;flw}$	°C	0...110	YES
Return temperature at sub-system Y output for service X	$\vartheta_{X;Y;out;ret}$	°C	0...110	YES
Connection with heating needs				
Actual heat supplied to each heating system zone	$Q_{H;sys;out;z}$	kWh	0...∞	YES
Recoverable losses to the conditioned space	$Q_{HW;sys;rbl;z}$	kWh	0...∞	YES
Location of losses to the conditioned space	TH_ZONE;z	List	Not relevant	NO
Connection with ventilation AHU				
Actual energy output to AHU	$Q_{H;sys;out;V}$	kWh	0...∞	YES
^a X can be "H" or "W" or "C" ("C" only if there are absorbers) Y can be any subsystem type ^b cr can be renewable and non-renewable energy carriers.				

These outputs shall be defined monthly and yearly.

Table 6 — Partial indicators

Partial performance indicators				
Heating system expenditure factor	ε_H	-	0–10	NO
Heating system efficiency	$\eta_{H,m,y}$	-	0–10	
DHW system expenditure factor	ε_W	-	0–10	NO
DHW system efficiency	$\eta_{W,sys}$	-	0–10	NO

The partial performance indicators can be expressed by calculation interval (e.g. monthly, seasonal or yearly), by service, etc.

6.2 Calculation interval and calculation period

6.2.1 Calculation interval

The methods described are suitable for the following calculation intervals t_{ci} :

- month;
- hour;
- bin.

The same calculation interval shall be used for the calculation of all subsystems. Calculation intervals are indicated in Table A5. Informative default values are provided in Table B5.

6.2.2 Calculation period

The length of the calculation period, also depending on the calculation interval (e.g. month, hour, etc), is given in EN ISO 52000-1, (M1-9). There are two calculation periods: heating and domestic hot water. The calculation period is indicated in Table A5. Informative default values are provided in Table B5.

6.3 Input data

6.3.1 Product data

6.3.1.1 Product description data

No product description data are required by this standard.

6.3.1.2 Product technical data

If values from the manufacturer are not available, then default values shall be specified according to the template given in Table A14. Default product technical data are given Table B.14.

6.3.2 System design data

6.3.2.1 General

System zone areas should be put here:

$A_{H,SZ,i}$ Heating system zone i

$A_{DHW;SZ;i}$ DHW system zone i

6.3.2.2 Process design

6.3.2.2.1 Type of emitter circuit

The identifier of the type of emitter circuit is specified according to the template given in Table A.11.

Default identifiers corresponding to circuits in Annex C are given in Table B.11

6.3.2.2.2 Type of generation circuit

The identifier of the type of generation circuit is specified according to the template given in Table A.12.

Default identifiers corresponding to circuits in Annex D are given in Table B.12

6.3.2.3 Control

The process control options are given by BACS identifiers, see Table 7.

Table 7 — BACS identifiers

Code	Meaning
HEAT_EM_CTRL_DEF	Heating emission control
HEAT_EM_CTRL_TABS	Heating emission control for TABS (heating mode)
HEAT_DIS_CTRL_TMP	Heating distribution control
HEAT_DIS_CTRL_PMP	Control of distribution pumps in networks
HEAT_DIS_CTRL	Intermittent control of emission and/or distribution
HEAT_GEN_CTRL_CD	Heating generator control for combustion and district heating
HEAT_GEN_CTRL_HP	Heat generator control heat pump
HEAT_GEN_CTRL_OU	Heat generator control outdoor unit
HEAT_GEN_CTRL_SEQ	Sequencing of different heat generators
HEAT_TES_CTRL	Thermal Energy Storage (TES)

6.3.3 Operating data and boundary conditions

The required energy input is a calculation output of the sub-system.

$$Q_{X;Y;in} = Q_{X;Y;out} + Q_{X;Y;ls} - Q_{X;Y;ls,rvd} \quad (3)$$

where

$Q_{X;Y;out}$ is the energy output

$Q_{X;Y;ls}$ is the thermal losses

$Q_{X;Y;ls,rvd}$ is the recovered losses in the sub-system

This calculation shall be made within each sub-system.

The recoverable losses are collected in this standard. Then the values are passed to the building module (M2-2).

Table 8 — Operating conditions input data

Name	Symbol	Unit	Range	Origin	Varying
Domestic hot water energy needs	$Q_{W,nd}$	kWh	$0 \dots \infty$	M8-2	YES
Heating generator input i	E or $Q_{H,gen;in,i}$	kWh	$0 \dots \infty$	M3-8	YES
Heating generator Fuel type i	H_GEN_FUEL_i	List	Not relevant	M3-8	NO
DHW generator input i	E or $Q_{W,gen;in,i}$	kWh	$0 \dots \infty$	M8-8	YES
DHW generator Fuel type i	W_GEN_FUEL_i	List	Not relevant	M8-8	NO
Heating storage input i	$Q_{H;sto;in,i}$	kWh	$0 \dots \infty$	M3-7	YES
Heating distribution input i	$Q_{H;dis;in,i}$	kWh	$0 \dots \infty$	M3-6	YES
Heating emission input i	$Q_{H;em;in,i}$	kWh	$0 \dots \infty$	M3-6	YES
DHW storage input i	$Q_{W;sto;in,i}$	kWh	$0 \dots \infty$	M3-7	YES
DHW distribution input i	$Q_{W;dis;in,i}$	kWh	$0 \dots \infty$	M3-5	YES
Maximum generator output i	$Q_{X;gen;out,max,i}$	kWh	$0 \dots \infty$	M3-8, M8-8	YES
Recoverable heating emission system losses with localization	$Q_{H;em;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M3-5	YES
Recoverable heating distribution system losses with localization	$Q_{H;dis;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M3-6	YES
Recoverable heating storage system losses with localization	$Q_{H;sto;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M3-7	YES
Recoverable heating generation system losses with localization	$Q_{H;gen;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M3-8	YES
Recoverable DHW emission system losses with localization	$Q_{W;em;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M8-5	YES
Recoverable DHW distribution system losses with localization	$Q_{W;dis;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M8-6	YES
Recoverable DHW storage system losses with localization	$Q_{W;sto;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M8-7	YES
Recoverable DHW generation system losses with localization	$Q_{W;gen;ls;rbl;z,i}$	kWh	$0 \dots \infty$	M8-8	YES
Auxiliary energy of the heating emission sub-system	$W_{H;em;aux,i}$	kWh	$0 \dots \infty$	M3-5	YES
Auxiliary energy of the heating distribution sub-system	$W_{H;dis;aux,i}$	kWh	$0 \dots \infty$	M3-6	YES
Auxiliary energy of the heating storage sub-system	$W_{H;sto;aux,i}$	kWh	$0 \dots \infty$	M3-7	YES
Auxiliary energy of the heating generation sub-system	$W_{H;gen;aux,i}$	kWh	$0 \dots \infty$	M3-8	YES
Auxiliary energy of the DHW emission sub-system	$W_{W;em;aux,i}$	kWh	$0 \dots \infty$	M3-5	YES
Auxiliary energy of the DHW distribution sub-system	$W_{W;dis;aux,i}$	kWh	$0 \dots \infty$	M8-6	YES
Auxiliary energy of the DHW storage subsystem	$W_{W;sto;aux,i}$	kWh	$0 \dots \infty$	M8-7	YES
Auxiliary energy of the DHW generation sub-system	$W_{W;gen;aux,i}$	kWh	$0 \dots \infty$	M8-8	YES

The control modules, in which the operating conditions (e.g. temperatures, mass flow rates) for the emission – distribution and generation sub-systems are calculated, are treated as independent modules in Annex C and Annex D of this standard. The operating conditions input data are detailed there.

Table 9 — Specific data

Name	Symbol	Unit	Value
Water specific heat	c_W	J/(kg•K)	4 186
Water specific heat	c_W	Wh/(kg•K)	1,16

6.3.4 Other data

Simplified data input, if any, shall consist of correlations that provide the detailed input.

6.4 Domestic hot water energy use calculation

6.4.1 Domestic hot water needs per domestic hot water system zone

6.4.1.1 General

The DHW emission output (needs) per DHW needs zone $Q_{W;exp;Dzn,i}$ is calculated according to M8-2.

The parameter t_{atap} specifying time after a tapping before next tapping shall also be calculated with the data from M8.2 because this value is used in M8.6 to calculate the stub losses (final distribution).

The required hot water temperature $\theta_{W;em}$ is a system design data.

6.4.1.2 Simplification if DHW need zones (WZN) and DHW system zones (WSZ) are different

As a simplification, the DHW emission output is obtained by dividing the DHW needs per DHW system zone according to the DHW system design. Subdivision rules are indicated in Table A.2. Informative default values are provided in Table B.2. For example dispatch the domestic hot water needs to each DHW system zone according to the useful area.

If a domestic hot water needs zone is served by several domestic hot water system zones, then the needs per each domestic hot water system zone $Q_{W;nd;wzs,i}$ is given by

$$Q_{W;nd;wzs,i} = Q_{W;nd;wzn,j} \cdot \frac{X_{wzs,i}}{\sum_k X_{wzs,k}} \quad (4)$$

where

- $Q_{W;nd;wzn,j}$ are the calculated needs for the domestic hot water needs zone j;
- $X_{wzs,i}$ is the distribution property for domestic hot water system zone i;
- $X_{wzs,k}$ are the distribution property for each domestic hot water system zone k belonging to the domestic hot water needs zone j.

Property X shall be specified according to the template given in Table A.2. A default specification is given in Table B.2

If a domestic hot water system zone serves several domestic hot water needs zones, then the needs of domestic hot water system zone $Q_{W;nd;wzs,i}$ is given by

$$Q_{W;nd;wzs,i} = \sum_k Q_{W;nd;wzn,j} \quad (5)$$