



BSI Standards Publication

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

Part 6-1: Explanation and justification of EN 15316-1, Module M3-1, M3-4, M3-9, M8-1, M8-4

National foreword

This British Standard is the UK implementation of PD CEN/TR 15316-6-1:2017.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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**Energy performance of buildings- Method for calculation
of system energy requirements and system efficiencies -
Part 6-1: Explanation and justification of EN 15316-1,
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 : Explication et justification de l'EN
15316-1, Module M3-1, M3-4, M3-9, M8-1, M8-4

Heizungsanlagen und Wasserbasierte Kühlanlagen in
Gebäuden - Verfahren zur Berechnung der
Energieanforderungen und Nutzungsgrade der
Anlagen - Teil 6-1: Begleitende TR zur EN 15316-1
(Allgemeines und Darstellung der Energieeffizienz)

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European foreword

This document (CEN/TR 15316-6-1:2017) 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.

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

Introduction

The CENSE project, the discussions between CEN and the Concerted action highlighted the high page count of the entire package due to a lot of “textbook” information. This resulted in flooding and confusing the normative text.

In order to facilitate the necessary overall consistency and coherence, in terminology, approach, input/output relations and formats, for the whole set of EPB-standards, the following documents and tools are available:

- a) a document with basic principles to be followed in drafting EPB-standards: CEN/TS 16628:2014, Energy Performance of Buildings - Basic Principles for the set of EPB standards [1];
- b) a document with detailed technical rules to be followed in drafting EPB-standards; CEN/TS 16629:2014, Energy Performance of Buildings - Detailed Technical Rules for the set of EPB-standards [2];
- c) the detailed technical rules are the basis for the following tools:
 - 1) a common template for each EPB-standard, including specific drafting instructions for the relevant clauses;
 - 2) a common template for each technical report that accompanies an EPB standard or a cluster of EPB standards, including specific drafting instructions for the relevant clauses;
 - 3) a common template for the spreadsheet that accompanies each EPB standard, to demonstrate the correctness of the EPB calculation procedures.

Each EPB-standards follows the basic principles and the detailed technical rules and relates to the overarching EPB-standard, prEN ISO 52000-1:2015.

One of the main purposes of the revision of the EPB-standards is to enable that laws and regulations directly refer to the EPB-standards and make compliance with them compulsory. This requires that the set of EPB-standards consists of a systematic, clear, comprehensive and unambiguous set of energy performance procedures. The number of options provided is kept as low as possible, taking into account national and regional differences in climate, culture and building tradition, policy and legal frameworks (subsidiarity principle). For each option, an informative default option is provided (Annex B).

Rationale behind the EPB technical reports

There is a risk that the purpose and limitations of the EPB standards will be misunderstood, unless the background and context to their contents – and the thinking behind them – is explained in some detail to readers of the standards. Consequently, various types of informative contents are recorded and made available for users to properly understand, apply and nationally or regionally implement the EPB standards.

If this explanation would have been attempted in the standards themselves, the result is likely to be confusing and cumbersome, especially if the standards are implemented or referenced in national or regional building codes.

Therefore each EPB standard is accompanied by an informative technical report, like this one, where all informative content is collected, to ensure a clear separation between normative and informative contents (see CEN/TS 16629):

- to avoid flooding and confusing the actual normative part with informative content,

- to reduce the page count of the actual standard, and
- to facilitate understanding of the set of EPB standards.

This was also one of the main recommendations from the European CENSE project [1] that laid the foundation for the preparation of the set of EPB standards.

Figure 1 shows the relative position of the related standard within the EPB package of standards and the position of all the other EPB standards under the responsibility of CEN/TC 228.

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	sub 1	M2	sub1		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General		1	General	1	General	EN 15316-1					EN 15316-1			
2	Common terms and definitions; symbols, units and subscripts		2	Building Energy Needs	2	Needs						EN 12831-3			
3	Applications		3	(Free) Indoor Conditions without Systems	3	Maximum Load and Power	EN 12831-1					EN 12831-3			
4	Ways to Express Energy Performance		4	Ways to Express Energy Performance	4	Ways to Express Energy Performance	EN 15316-1					EN 15316-1			
5	Building Functions and Building Boundaries		5	Heat Transfer by Transmission	5	Emission and control	EN 15316-2	EN 15316-2							
6	Building Occupancy and Operating Conditions		6	Heat Transfer by Infiltration and Ventilation	6	Distribution and control	EN 15316-3	EN 15316-3				EN 15316-3			
7	Aggregation of Energy Services and Energy Carriers		7	Internal Heat Gains	7	Storage and control	EN 15316-5					EN 15316-5 EN 15316-4-3			

Overarching			Building (as such)	Technical Building Systems											
	Descriptions			Descriptions		Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot water	Lighting	Building automation and control	Electricity production	
sub1		M1	sub 1	M2	sub1	M3	M4	M5	M6	M7	M8	M9	M10	M11	
8	Building Partitioning		8	Solar Heat Gains	8	Generation									
					8-1	Combustion boilers	EN 15316-4-1				EN 15316-4-1				
					8-2	Heat pumps	EN 15316-4-2	EN 15316-4-2			EN 15316-4-2				
					8-3	Thermal solar Photovoltaics	EN 15316-4-3				EN 15316-4-3			EN 15316-4-3	
					8-4	On-site cogeneration	EN 15316-4-4				EN 15316-4-4			EN 15316-4-4	
					8-5	District heating and cooling	EN 15316-4-5	EN 15316-4-5			EN 15316-4-5			EN 15316-4-5	
					8-6	Direct electrical heater	EN 15316-4-9				EN 15316-4-9				
					8-7	Wind turbines								EN 15316-4-10	
					8-8	Radiant heating, stoves	EN 15316-4-8								

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	sub 1	M2	sub1		M3	M4	M5	M6	M7	M8	M9	M10	M11
9	Calculated Energy Performance		9	Building Dynamics (thermal mass)	9	Load dispatching and operating conditions	EN 15316-1								
10	Measured Energy Performance		10	Measured Energy Performance	10	Measured Energy Performance	EN 15378-3					EN 15378-3			
11	Inspection		11	Inspection	11	Inspection	EN 15378-1					EN 15378-1			
12	Ways to Express Indoor Comfort		12	-	12	BMS									
13	External Environment Conditions														
14	Economic Calculation	EN 15459-1													

Figure 1 — Position of EN 15316-1 within the EPB set of standards

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	Heating systems and water based cooling systems in buildings — Energy performance of buildings — Part 1: Economic evaluation procedure for energy systems in buildings
		TR 15459-2	New	Accompanying TR to EN 15459-1 (Economic evaluation procedure for energy systems in buildings)
2	M3-11 M8-11	EN 15378-1	EN 15378	Heating systems and water based cooling systems in buildings — Heating systems and DHW in buildings — Part 1: Inspection of boilers, heating systems and DHW
		TR 15378-2	New	Accompanying TR to EN 15378-1 (Inspection of boilers, heating systems and DHW)
3	M3-10 M8-10	EN 15378-3	New	Heating systems and water based cooling systems in buildings — Heating systems and DHW in buildings — Part 3: Measured energy performance
		TR 15378-4	New	Accompanying TR to EN 15378-3 (Measured energy performance)
4	M3-3	EN 12831-1	EN 12831	Heating systems and water based cooling systems in buildings — Method for calculation of the design heat load — Part 1: Space heating load
		TR 12831-2	New	Accompanying TR for EN 12831-1 (Space heating load)
5	M8-3	EN 12831-3	EN 15316-3-1	Heating systems and water based cooling systems in buildings — Method for calculation of the design heat load — Part 3: Domestic hot water systems heat load and characterization of needs
		TR 12831-4	New	Accompanying TR to EN 12831-3 (Domestic hot water systems heat load and characterization of needs)
6	M3-1 M8-1 M3-4 M8-4 M3-9 M8-9	EN 15316-1	EN 15316-1	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: General and Energy performance expression
		TR 15316-6-1	New	Accompanying TR to EN 15316-1 (General and Energy performance expression)
7	M3-5 M4-5	EN 15316-2	EN 15316-2-1	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling)
		TR 15316-6-2	New	Accompanying TR to EN 15316-2 (Space emission systems (heating and cooling))
8	M3-6 M4-6 M8-6	EN 15316-3	EN 15316-2-3 EN 15316-3-2	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 3: Space distribution systems (DHW, heating and cooling)
		TR 15316-6-3	New	Accompanying TR to EN 15316-3 (Space distribution systems (DHW, heating and cooling))
9	M3-8-1 M8-8-1	EN 15316-4-1	EN 15316-4-1 EN 15316-3-3 EN 15316-4-7	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-1: Space heating and DHW generation systems, combustion systems (boilers, biomass)
		TR 15316-6-4	New	Accompanying TR to EN 15316-4-1 (Space heating and DHW generation systems, combustion systems (boilers, biomass))
10	M3-8-2 M4-8-2 M8-8-2	EN 15316-4-2	EN 15316-4-2	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-2: Space heating generation systems, heat pump systems

No.	Module	New EPBD numbering	Old standards replaced	Title of the new EPBD standard
		TR 15316-6-5	New	Accompanying TR to EN 15316-4-2 (Space heating generation systems, heat pump systems)
11	M3-8-3 M8-8-3 M11-8-3	EN 15316-4-3	EN 15316-4-3 EN 15316-4-6	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-3: Heat generation systems, thermal solar and photovoltaic systems
		TR 15316-6-6	New	Accompanying TR to EN 15316-4-3 (Heat generation systems, thermal solar and photovoltaic systems)
12	M3-8-4 M8-8-4 M11-8-4 M3-7/M8-7	EN 15316-4-4	EN 15316-4-4	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-4: Heat generation systems, building-integrated cogeneration systems
		TR 15316-6-7	New	Accompanying TR to EN 15316-4-4 (Heat generation systems, building-integrated cogeneration systems)
13	M3-8-5 M4-8-5 M8-8-5 M11-8-5	EN 15316-4-5	EN 15316-4-5	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-5: District heating and cooling
		TR 15316-6-8	New	Accompanying TR to EN 15316-4-5 (District heating and cooling)
14	M3-8-8	EN 15316-4-8	EN 15316-4-8	Heating systems and water based cooling systems in 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)
		TR 15316-6-9	New	Accompanying TR to EN 15316-4-8 (Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local))
15	M3-7 M8-7	EN 15316-5	New	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 5: Space heating and DHW storage systems (not cooling)
		TR 15316-6-10	New	Accompanying TR to EN 15316-5 (Space heating and DHW storage systems (not cooling))
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	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-10: Wind power generation systems

1 Scope

This Technical Report refers to standard EN 15316-1:2017, modules M3-1, M8-1, M3-4, M8-4, M3-9, M8-9.

It contains information to support the correct understanding, use and national adaptation of standard EN 15316-1:2017.

This Technical Report does not contain any normative provision.

The related standard EN 15316-1:2017 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 Figure 1) 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.

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 12831-3:2017, *Heating systems and water based cooling systems in buildings — Method for calculation of the design heat load — Part 3: Domestic hot water systems heat load and characterisation of needs*

EN 15316-2:2017, *Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling)*

EN 15316-3:2017, *Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 3: Space distribution systems (DHW, heating and cooling)*

EN 15316-5:2017, *Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 5: Space heating and DHW storage systems (not cooling)*

EN 15232-1:2017, *Energy performance of buildings - Part 1: Impact of Building Automation, Controls and Building Management - Modules M10-4,5,6,7,8,9,10*

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

prEN ISO 52000-1:2015, *Energy performance of buildings - Overarching EPB assessment - Part 1: General framework and procedures (ISO/DIS 52000-1:2015)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345, prEN ISO 52000-1:2015, prEN 15316-1:2014 and the following apply.

3.1 zoning

“zones” are the results of dividing a building into a space or group of spaces with uniform properties

Note 1 to entry: Buildings may be partitioned for the following reasons:

- the evaluation boundary (e.g. building as a whole, building unit) in order to deliver different certificates,
- the building categories (e.g. occupancy patterns) or different indoor temperatures (e.g. due to different solar gains, in order to calculate the energy “needs” without the technical building systems.
- the technical building systems (e.g. heating systems, DHW systems) in order to calculate the energy “use” taking into account different operating conditions and equipment.

Note 2 to entry: As there are several “zones” the term “zone” should not be used alone. “Building zone” is the general term (see prEN ISO 52000-1:2015, 3.1.8).

Note 3 to entry: The “thermal zone” is related to the building thermal model where the “needs” and the “useful emission output” is calculated.

Note 4 to entry: The “heating system zone”, the “DHW system zone” are related to the “use”. For a better differentiation between the building envelope and the technical systems, for the technical building systems the term “zone” could be replace “area”.

Note 5 to entry: Other types of zones (area) already in the definitions of prEN ISO 52000-1:2015 (e.g. cooling, DHW, heating, ventilation, and a list for possible zoning criteria is provided). The type of zones and their names are listed in prEN ISO 52000-1:2015.

Note 6 to entry: The building partitioning into zones has to be defined before the calculation starts.

Note 7 to entry: For simplification of the zoning the following rules are defined:

- “subdivision rules” can be defined to distribute the emission output (based on the building “needs”) to the “heating system zones” (as starting point for the calculation) ;
- “distribution rules” can be defined to distribute the “recoverable losses” of technical building systems to the heat emission output calculation.

Example 1: Emission output distribution:

One thermal zone can be divided into several heating system having different properties related to the sub-systems (different emitters, different distributions, same generation). In this case the single thermal zone may be divided in several heating system zones (e.g. emitters). The emission output is distributed to the heating system zone by using subdivision rule (e.g. per m^2)

Example 2: Recoverable losses distribution:

Several thermal systems zones can be served by one domestic hot water system. The DHW recoverable losses are calculated for the two heating systems zones as a whole and distributed to them according to the distribution rule (e.g. per m^2)

4 Symbols and subscripts

4.1 Symbols

For the purposes of this document some special symbols are defined in EN 15316-1:2017 Only the specific symbols are listed in EN 15316-1:2017.

4.2 Subscripts

For the purposes of this document some special subscripts are defined in EN 15316-1:2017. Only the specific subscripts are listed in EN 15316-1:2017.

5 Description of the methods

5.1 General

5.1.1 Modular structure

The heating and domestic hot water systems are modelled by sub-systems. An overview of the modules related to the different sub-systems is given in Figure 1 (Position of EN 15316-1:2017 in the modular structure).

The calculation is based on the following sub-systems for each of the space heating and domestic hot water systems:

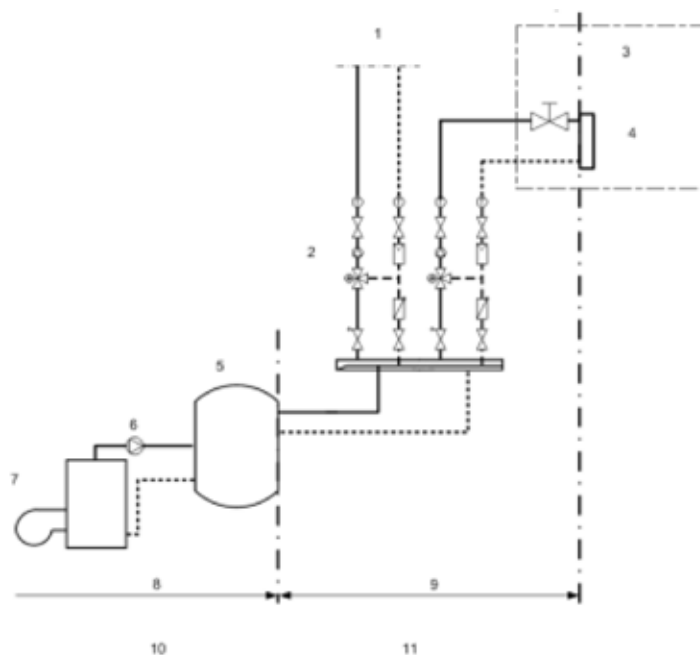
- the emission sub-systems;
- the distribution sub-systems including nodes;
- the storage sub-systems (can be included in the generation sub-system if tested as a whole or detailed as the storage sub-system);
- the generation sub-systems (e.g. boilers, solar collectors, heat pumps, cogeneration units).

NOTE This structure is similar to the physical structure of heating systems. In a building there may be several independent heating systems.

Some of the sub-systems may be missing in a heating installation (e.g. heating systems may not include a storage)

Each sub-system calculation method includes the effect of relevant controls.

Figure 2 shows different sub-systems of of heating system.



Key

- | | |
|--------------------------------------|-----------------------------------|
| 1 heating system zone 1 | 6 storage pump |
| 2 distribution pump 1 | 7 heating generator |
| 3 heating system zone 2 | 8 generation + storage sub-system |
| 4 emission sub-system 2 | 9 distribution sub-systems |
| 5 heating system buffer-storage tank | |

Figure 2 — Scheme distribution and definitions of heating circuits

5.1.2 Heating system zoning

The heating system zoning has to be done before starting the calculation.

Heating system zoning consist of the grouping of similar emitter sub-systems and distribution sub-systems into heating system zones. Within the same assessed object (building or building unit) a heating system zone has to be defined according to the heating system zoning criteria (see Table A.1 and informative default value in Table B.1).

The subdivision of the thermal needs is made according to the sub-division criteria (see Table A.1 and informative default value in Table B.1).

Recoverable losses of the heating system shall be allocated to the relevant thermal zones. If the exact location of the losses is not known or if there are more heating systems zones then thermal zones, the recoverable losses shall be allocated to the relevant thermal zones according to the distribution criteria (see Table A.1 and informative default value in Table B.1).

Connecting the heating sub-system modules

The design of the heating system calculation structure and the connection of the different sub-systems have to be done before starting the calculation.

The heating system calculation structure is defined by three main parts:

- the heating system zone including the emitters and the connected distribution;

- the nodes (including storage)
- the generators and the directly connected distribution.

The heating system calculation structure is established as follows.

- 1) Group together the spaces served by similar emission sub-systems into heating system zones.

The emission sub-system is defined by the emitter type, the design characteristics, the hydraulic circuit and the control options.

These characteristics define the operating conditions determined in the emission operating condition calculation module (see Annex C).

- 2) Connect the emission sub-system to a node (if needed).

The output characteristics of node are those of the load distribution circuits (e.g. emitters). The input characteristics of a node are defined by the feeding circuits (e.g. the design characteristics, the hydraulic circuit and the control options).

The feeding circuits of a node are the generation module with its specific characteristics. For each of these modules specific operating conditions calculation modules are defined (see Annex C)

Storage tank

The calculation procedure for a storage tank is the same as for a node.

- 3) Connect the node to the generation modules.

If there are several generators a dispatch module define the priorities of feeding the node and distribute the needed node input between the generators.

If some of the modules are not present in the heating system structure then the other modules are connected directly.

5.1.3 Domestic hot water system zoning

The domestic hot water system zoning has to be done before starting the calculation.

Domestic hot water system zoning consist of the grouping similar domestic hot water systems (e.g. centralized, decentralized system, tapping patterns per building category) into domestic hot water system zones.

Within the same assessed object (building or building unit) a domestic hot water system zone has to be defined according to the Domestic hot water system zoning criteria (see Table A.2 and informative default value in Table B.2).

The subdivision of the domestic hot water needs is made according to the sub-division criteria (see Table A.2 and informative default value in Table B.2).

Recoverable losses of the domestic hot water system shall be allocated to the relevant thermal zones. If the exact location of the losses is not known or if there are more domestic hot water systems zones than thermal zones, the recoverable losses shall be allocated to the relevant thermal zones according to the distribution criteria (see Table A.2 and informative default value in Table B.2).

Connecting the domestic hot water sub-system modules

The domestic hot water system calculation structure is similar to the heating system calculation structure. The domestic hot water system may share the same generation sub-systems.

Domestic hot water distribution sub-systems distinguish between

- final distribution (stub);
- circulation loop distribution.

They may be connected in cascade.

The temperature in the final distribution is depending on the insulation and the tapping profiles.

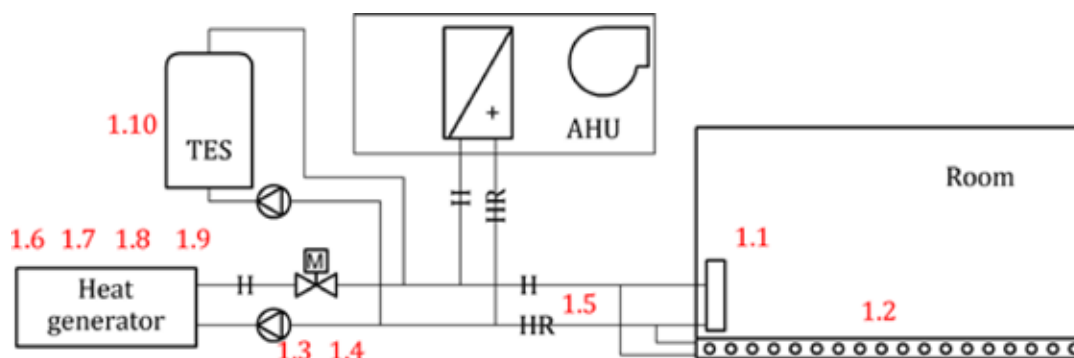
Attention has to be paid to the domestic hot water needs because the tapping patterns profiles often associate a volume to a temperature (e.g. 40 °C) which can be different from the tapping temperature.

5.1.4 Specification on interaction between BACS/space heating, cooling and DHW systems

The BACS (Building Automation and Control Systems) having an impact on the energy consumption of buildings are described and summarized in EN 15232-1:2017, Table 1.

Sub-system control functions for emission, distribution, storage, and generation of heating and DHW are listed and addressed by a specific control identifier (see Table control input data in Clause 6).

Figure 3 illustrates basic control functions for space heating.



Key

1.1, 1.2	Heat emission control
1.3, 1.4, 1.5	Heat distribution control
1.6, 1.7, 1.8	Heat generation control
1.9	Sequencing of multiple heat generators
1.10	Thermal energy storage (TES)
AHU	Air Handling Unit
M	Motor

Figure 3 — Example of BAC function types related to space heating system

The operating condition module provides some of the operating conditions to the specific sub-system modules (e.g. emission, distribution).

The impact on the energy use of BACS is determined in the specific heating or DHW module. The energy savings are related to BAC are calculated in the heating or DHW modules.

5.2 Description of the calculation method

5.2.1 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.

5.2.2 Operating conditions

For each sub-system the operating conditions (e.g. temperatures, mass flows) are calculated in related operating conditions modules (see Annex C). The operating conditions are taken into account control (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.

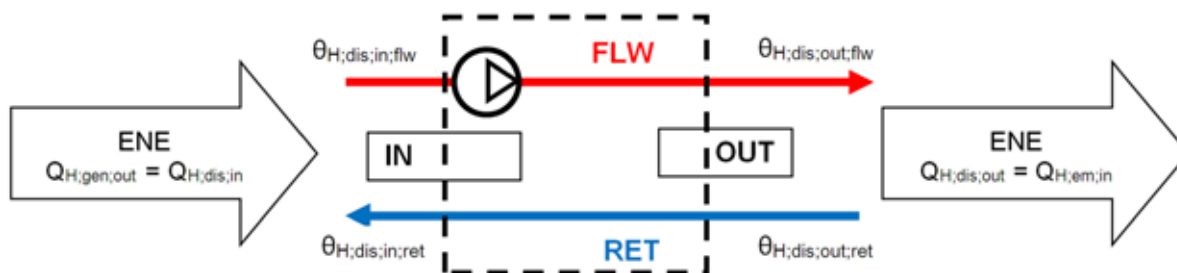
The calculation direction is the opposite of the energy flow (an “energy flow” input is a “calculation” output).

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 4 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 4 — Naming conventions for energy flows and heating system operating temperatures

5.2.3 Maximum heat supply and power check

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

For the monthly method 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.

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.

5.2.4 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.

5.2.5 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 should be identified according to the thermal zones.

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 send 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 net floor area.

5.2.6 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.

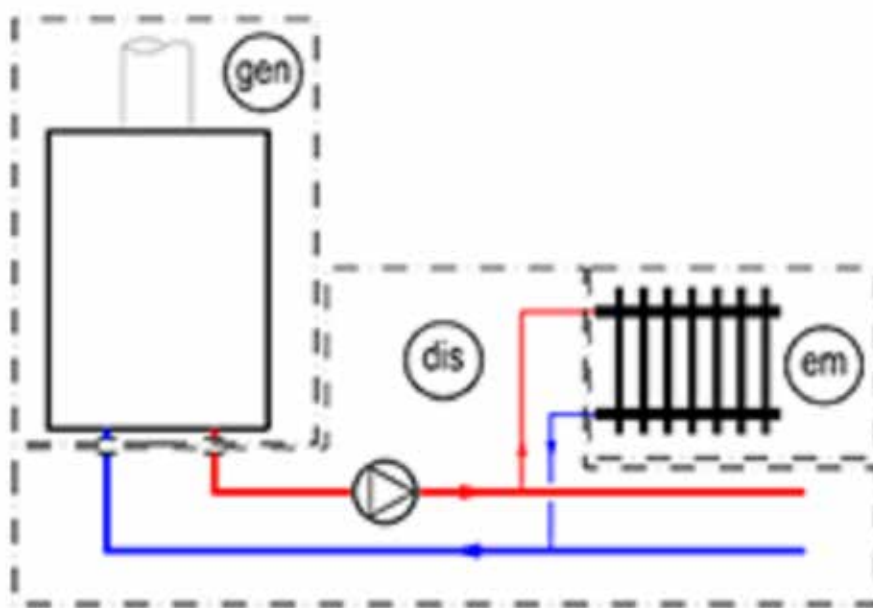
It has to be taken care, if the auxiliary energies is already included in the performance evaluations of the standard testing procedures or not (e.g. in heat pump standards auxiliary energy for control during the running time of the heat pump is taken into account in the COP value, the boiler standards 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 5 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 5 — Sample sub-systems boundaries - example 1

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

NOTE 1 See also 6.3.4 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 2 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 3 Thermal losses from domestic hot water cannot be recovered within the sub-system calculation. Only auxiliary energy can be recovered directly.

NOTE 4 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
$Q_{X;Y;ls;rb;H} = W_{X;Y;aux} \cdot f_{X;Y;aux;rb;H} + Q_{X;Y;ls} \cdot f_{X;Y;ls;rb;H}$	(2)

where:

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

NOTE 5 These are typical equations because the input of generation sub-systems is not calculated via the sum of losses.

5.2.8 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 added to the thermal load of the heating system.

5.3 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 chapters.

5.4 Application data

Application data shall be specified according to the template given in normative Annex A. The application data are mainly to determine the operating conditions.

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

6 Calculation procedure

NOTE Only main equations, needed for the understanding of the method, are listed in this technical report.

6.1 Output data

This method covers the calculation of

- delivered energy;
- auxiliary energy;
- recoverable losses;
- specific performance indicators;

of heating and/or domestic hot water systems.

An interesting output are the performance indicators or characteristic values. There is a need to be able to judge the results. For this reason, it is necessary to have for each system, sub-system or zone the characteristic results for a defined calculation interval (the year). The Over Arching Standard (M1-9) gives a general rule, to do so in Chapter “Partial energy performance indicators”.

These calculations are done in M3-1, (M3-4) for the heating system, since here all the values come together.

The boundaries for the balance of the subsystem are defined in the related sub-system standards.

Each output data shall be identified in a table giving:

- the description;
- the symbol;
- the unit;
- the intended destination module(s) where the output will be used.

The same output data shall be found in the “Method output” sheet in the accompanying spread sheet.

Clearly identify output that is meant to be used for regulatory purpose such as building elements properties

The output data of this method are listed in Table 2.

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 2 — Output data of method

Description	Symbol	Computed unit	Validity interval	Varying
Energy carrier i input for space heating	$E_{H;gen;in;cr,j}$	kWh	0...∞	YES
Energy carrier i identifier	GEN_FUEL,i	List	Not relevant	NO
Heating system auxiliary energy	$W_{H;aux}$	kWh	0...∞	YES
Energy carrier j input for DHW system	$E_{W;gen;in;cr,j}$	kWh	0...∞	YES
Energy carrier j identifier	GEN_FUEL,j	List	Not relevant	NO
DHW system auxiliary energy	$W_{W;aux}$	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

These outputs shall be for a defined calculation interval (e.g. year, heating season).

Table 3 — Partial performance indicators

Partial performance indicators				
Heating system expenditure factor	ε_H	–	0–10	NO
Heating system efficiency	η_H	–	0–10	
DHW system expenditure factor	ε_W	–	0–10	NO
DHW system efficiency	$\eta_{W;sys}$	–	0–10	NO
X can be “H” or “W” or “C” (“C” only if there are absorbers) Y can be any subsystem type				

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

6.2 Calculation interval and calculation period

6.2.1 General

Several time periods are defined in the standards. Hereafter a resume of definition of time periods related to the calculation is provided:

- Calculation period (prEN ISO 52000-1:2015)

Period of time over which the calculation is performed. The calculation period may be defined differently in an monthly or an hourly method. In the monthly method it may be a duration (h), whereas in the hourly method it may be defined by the start and the end of a period.

NOTE 1 Typical calculation periods are the year or the heating season (e.g. from October to April)

- Heating or cooling season (prEN ISO 52000-1:2015)

Period of the year during which a significant amount of energy for heating or cooling is needed. The heating or cooling season may be equal or different of the calculation period.

The heating or cooling season may be defined differently in an monthly or an hourly method. In the monthly method it may be a duration (h), whereas in the hourly method it may be defined by the start and the end of a period. In the hourly method the heating and cooling season may also be defined as Boolean with four values (no heating, nor cooling, heating only, cooling only, heating and cooling). The Boolean may be linked to control.

- Calculation interval (prEN ISO 52000-1:2015)

Discrete time interval for the calculation of the energy performance

NOTE 2 Possible time steps are one hour, one month.

NOTE 3 There can be different calculation intervals (e.g. month with 30 days, 31 days, etc).

- Operating schedule

Time sequence of operating conditions (e.g. related to different set-points) related to a service, system, or sub-system.

- System or sub-system operating time (running time of equipment)

Time when the equipment is running to deliver energy or for stand-by

- Equivalent running time at defined power

Time when the equipment is working at defined power (e.g. 3 h running at nominal power)

In EN 15316-3:2017 “calculation interval”, “total time operation”, “operation time of the distribution systems” are used. These topics should be clearly defined.

In EN 15316-4-1:2017 “usage period in the calculation interval”, “running time for heating” are used. These topics should be clearly defined.

6.2.2 Calculation interval

The objective of the calculation is to contribute to the evaluation of the annual energy use of the space heating and domestic hot water system.

The average values shall be consistent with the selected time intervals. This may be achieved by dividing the year into a number of calculation intervals (e.g. months, weeks, hours), performing the calculations for each interval using interval-dependent values and sum up the results for all the intervals over the year.

If there is seasonal heating in the building, the year should at least be divided into two calculation intervals, i.e. the time of the heating season and the time of the rest of the year.

The methods described are suitable for the following calculation intervals:

- month;
- hour;
- bin.

The same calculation interval shall be used for the calculation of all subsystems.

6.2.3 Calculation period

The length of the calculation period, also depending on the calculation interval (e.g. month, hour, etc), is given in prEN ISO 52000-1:2015, (M1-9).

The length of the calculation period should be worked out in prEN ISO 52000-1:2015.

By default the calculation period should be the whole year.

Attention should be paid the periods where the building can be at the same time heated and cooled.

It could be:

- conventional (fixed dates)
- linked to calculation (e.g. depending on control).

Information should be provided according Table A.5. Informative default values are given in Table B.5.

6.3 Input data

6.3.1 General

Input data shall be organized in the following categories:

- **product data;**
 - product description (qualitative, standardized Selection Properties);
 - product technical data (quantitative, standardized technical properties);
- **system design data (application case properties);**
 - process design data;
 - control type;
 - operating conditions;