BS EN 15316-4-1:2017

BSI Standards Publication

# 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

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# National foreword

This British Standard is the UK implementation of EN 15316-4-1:2017. It supersedes BS EN 15316-3-3:2007, BS EN 15316-4-7:2008 and BS EN 15316-4-1:2008, which are withdrawn.

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

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

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

© The British Standards Institution 2017
Published by BSI Standards Limited 2017

ISBN 978 0 580 87746 9

ICS 91.140.10; 91.140.65

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2017.

**Amendments/corrigenda issued since publication**

| Date | Text affected |
|---|---|

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 15316-4-1

May 2017

ICS 91.140.10; 91.140.65

Supersedes EN 15316-3-3:2007, EN 15316-4-1:2008, EN 15316-4-7:2008

English Version

# 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

Performance énergétique des bâtiments - Méthode de calcul des besoins énergétiques et des rendements des systèmes - Partie 4-1 : Systèmes de génération de chauffage des locaux et production d'eau chaude sanitaire, systèmes de combustion (chaudières, biomasse), Module M3-8-1, M8-8-1

Energetische Bewertung von Gebäuden - Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen - Teil 4-1: Wärmeerzeugung für die Raumheizung und Trinkwassererwärmung, Verbrennungssysteme (Heizungskessel, Biomasse), Modul M3-8-1, M8-8-1

This European Standard was approved by CEN on 27 February 2017.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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## European foreword

This document (EN 15316-4-1:2017) has been prepared by Technical Committee CEN/TC 228 “Heating systems and water based cooling systems in buildings”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2017, and conflicting national standards shall be withdrawn at the latest by November 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] 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.

This document supersedes EN 15316-3-3:2007, EN 15316-4-1:2008, EN 15316-4-7:2008.

In case this 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, in particular for the application within the context of EU Directives transposed into national legal requirements.

Further target groups are users of the voluntary common European Union certification scheme for the energy performance of non-residential buildings (EPBD art.11.9) and any other regional (e.g. Pan European) parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

The main changes compared to EN 15316-3-3:2007, EN 15316-4-1:2008 and EN 15316-4-7:2008 are:

a) the typology method was removed;

b) the boiler cycling method has been added for existing boilers to get the input parameters for the case specific boiler efficiency method.

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



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# Introduction

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

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

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

— energy performance calculation for heating systems;

— inspection of heating systems;

— design of heating systems;

— installation and commissioning of heating systems.

This standard is intended to replace EN 15316-3-3:2007, EN 15316-4-1:2008 and EN 15316-4-7:2008 and includes biomass boilers (former EN 15316-4-7:2008). This revision was required as a result of the EPBD recast (2010/31/EU). The set of standards developed under mandate M/343 will be revised to become consistent with the overarching standard under mandate M/480.

Other generation systems are covered in other sub modules of part M3-8 (see Table 1).

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

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

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

The main target group of this standard are all the users of the set of EPB standards (e.g. architects, engineers, regulators).

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, in particular for the application within the context of EU Directives transposed into national legal requirements. 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.

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, for certain applications, 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, the National Annex may refer to the legal texts where national choices have been made by public authorities.



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It is expected, if the default values and choices 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 users of the voluntary common European Union certification scheme for the energy performance of non-residential buildings (EPBD art.11.9) and any other Pan EU 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 15316-6-4).



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# 1 Scope

This European Standard is part of a series of standards on the method for calculation of system energy requirements and system efficiencies of space heating systems and domestic hot water systems.

This standard (EN 15316-4-1) specifies:

— required inputs;

— a calculation method;

— resulting outputs;

— a method to take into account the energy performance of heat generation devices based on fuel combustion;

for space heating generation by combustion sub-systems (boilers, biomass), including control.

This standard specifies methods for the calculation of:

— thermal losses from the heating and the domestic hot water generation system;

— recoverable thermal losses for space heating from the heating and the domestic hot water generation system;

— auxiliary energy of the heating and the domestic hot water generation systems.

This standard specifies the energy performance calculation of water based heat generation sub-systems including control based on combustion of fuels ("boilers"), operating with conventional fossil fuels as well as renewable fuels. This standard does not cover sizing or inspection of boilers.

This standard is also applicable to heat generators for heating or for combined service as domestic hot water, ventilation, cooling and heating. Generators for domestic hot water only are taken into account into part M8-8.

This European Standard is the general standard on generation by combustion sub-systems (boilers, biomass) and is also intended for generation for domestic hot water production and/or space heating. These values are input data for calculation of the overall energy use according to EN ISO 52000-1 and EN 15316-1.

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

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

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



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## Table 1 — Position of EN 15316–4-1 within the modular structure

| 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<br>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 | 15316–4-6 | | | | | 15316–4-6 | | | |
| | | | | | 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 | | | | | | | | | |
| 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 | | | | | | | | | | | | | |



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## 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 89, *Gas-fired storage water heaters for the production of domestic hot water*

EN ISO 13790, *Energy performance of buildings — Calculation of energy use for space heating and cooling (ISO 13790)*

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

## 3 Terms and definitions

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

**3.1**
**heat transfer coefficient**
factor of proportionality of heat flow governed by a temperature difference between two environments

**3.2**
**boiler**
gas, liquid or solid fuelled appliance designed to provide hot water for space heating

**3.3**
**combustion power**
product of the fuel flow rate and the net calorific power of the fuel

**3.4**
**low temperature boiler**
non-condensing boiler which can work continuously with a water supply temperature of 35 to 40°C, possibly producing condensation in certain circumstances

**3.5**
**condensing boiler**
boiler in which, under normal operating conditions and at certain operating water temperatures, the water vapour in the combustion products is partly condensed, in order to make use of the latent heat of this water vapour for heating purposes

Note 1 to entry: Boilers not designed to or without the means to remove the condensate in liquid form, are called 'non-condensing'.

[SOURCE: EN 15502-1:2012+A1:2015, 3.1.10.2, modified - Note 1 to entry has been added.]

[SOURCE: EN 15034:2006, 3.4, modified – Slight different drafting and Note 1 to entry have been added.]

**3.6**
**modes of operation**
various modes in which the heating system can operate

EXAMPLE Set-point mode, cut-off mode, reduced mode, set-back mode, boost mode.

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**3.7**
**on/off boiler**
boiler without the capability to vary the fuel burning rate whilst maintaining continuous burner firing

Note 1 to entry: This includes boilers with alternative burning rates set once only at the time of installation, referred to as range rating

**3.8**
**multistage boiler**
boiler with the capability to vary the fuel burning rate stepwise whilst maintaining continuous burner firing

**3.9**
**modulating boiler**
boiler with the capability to vary continuously (from a set minimum to a set maximum) the fuel burning rate whilst maintaining continuous burner firing

**3.10**
**biomass boiler**
biomass fuelled appliance designed to provide heating medium (e.g. water, fluid)

**3.11**
**load factor**
ratio between the time with the boiler ON (burner 100%) and the total generator operation time

**3.12**
**operation cycle**
time period of the operation cycle of a boiler

**3.13**
**standard condition**
condition of 15 °C, 1 013,25 mbar, if there are no other information

# 4 Symbols and abbreviations

## 4.1 Symbols

For the purposes of this document, the symbols and indices of EN ISO 52000-1 and the symbols and units of Table 2 applies.

**Table 2 — Symbols and units**

| Symbol | Name of quantity | Unit |
|---|---|---|
| $D$ | day | d/mth |
| $h$ | specific latent heat | kJ/kg or Wh/kg |
| $\alpha$ | Heat transfer coefficient | W/(m² K) |
| $\beta$ | load factor | - |
| $\varepsilon$ | expenditure factor | - |
| $\vartheta$ | Temperature | °C |



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## 4.2 Abbreviations and indices

For the purposes of this document, the symbols and indices of EN ISO 52000-1 and the indices of Table 3 applies.

**Table 3 — Indices**

| | | | | | |
|---|---|---|---|---|---|
| Hc | Heating circuit | ch | chimney | prio | priority |
| $O_2$ | Oxygen | cond | condensation | s | gross |
| $H_2O$ | humidity | corr | corrected/correction | sat | saturation |
| Pn | at nominal load | dry | dry gases | sim | simultaneous |
| Pint | at intermediate load | env | envelope | sink | sink |
| P0 | at zero load | fg | flue gas | st | stoichiometric |
| Px | Actual load | i | net | test | test |
| RT | Return | mech | mechanical (ventilation system) | tr | transmission |
| Hs/Hi | Ratio of gross calorific/net calorific value | n | radiator index, nominal | ve | ventilation |
| add | additional | op | operational | wfg | water in flue gas |
| air | Air | ref | Reference | Xc | Circuit of any considered building system |
| brm | boiler room | pa | partial area | S | storage |

# 5 Description of the method

## 5.1 Output of the method

For output quantities see Table 4



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**Table 4 — Output quantities**

| Description | Symbol | Unit | Calculation sub-clause | Validity interval | Destination module | Varying |
|---|---|---|---|---|---|---|
| Fuel heat input | $E_{gen;in}$ | kWh | see 6.2 | 0…∞ | M 3–1 | YES |
| Recoverable generation heat losses for heating system (in the calculation interval) | $Q_{gen;ls;rbl}$ | kWh | see 6.5 | 0…∞ | M 3–1 | YES |
| generation heat losses (in the calculation interval) | $Q_{gen;ls;}$ | kWh | see 6.4 | 0…∞ | M 3–1 | YES |
| Expenditure factor of the generator for the whole service | $\varepsilon_{gen}$ | - | See 6.1 | 1 - 10 | M 3–1 | YES |
| Expenditure factor of the generator for heating | $\varepsilon_{H;gen}$ | - | see 6.1 | 2 - 10 | M 3–1 | YES |
| Expenditure factor of the generator for cooling | $\varepsilon_{C;gen}$ | - | see 6.1 | 3 - 10 | M 3–1 | YES |
| Expenditure factor of the generator for ventilation | $\varepsilon_{V;gen}$ | - | see 6.1 | 4 - 10 | M 3–1 | YES |
| Expenditure factor of the generator for DHW | $\varepsilon_{W;gen}$ | - | see 6.1 | 5 - 10 | M 3–1 | YES |
| heat generation auxiliary energy for the heating system (in the calculation interval) | $W_{gen,}$ | kWh | see 6.3 | 0…∞ | M 3–1 | YES |
| Fuel type | | List | | not relevant | M 3–1 | NO |

## 5.2 General description of the method

The calculation method of the generation sub-system takes into account heat losses and/or recovery due to the following physical factors:

— heat losses to the chimney (or flue gas exhaust) and through the envelope of the storage tank and the generator(s) during total time of generator operation (running and stand-by);

— auxiliary energy.

The calculation is independent from the time steps.

There are a basic calculation for

— boilers at all (Clause 6.);

— direct heated domestic hot water heaters (6.11) and

— domestic hot water appliance tested with 24 h tapping cycles (6.12).

There are three possibilities inputs for the generation efficiency calculation:

— default values (5.5);

— product values (5.6);



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— measured values (5.7).

Default values are given in Annex B.

Product values by the manufactures shall be tested according to the appropriated EN standard (see bibliography).

Measured values are for existing boilers, condensing boilers and on-site inspection.

## 5.3 Input data

Input quantities from other parts of the heating system standards, see Table 5.

**Table 5 — Input quantities**

| Description | Symbol | Unit | Validity interval | Destination module | Varying |
|---|---|---|---|---|---|
| Fuel type | GEN_FUEL | List | not relevant | M 3–4, M 8–4 | NO |
| Generator Type | GEN_TYP | List | not relevant | M 3–4, M 8–4 | NO |
| Burner type | GEN_BURN | List | not relevant | M 3–4, M 8–4 | NO |
| Boiler location | TH_ZONE | List | not relevant | M 3–4, M 8–4 | NO |
| Type of control | HEAT_GEN_CTRL | List | not relevant | M 3–4, M 8–4 | NO |
| Generation circuit typology | GEN_CIRC_TYPOL | List | not relevant | M 3–4, M 8–4 | NO |
| number of dwellings within a building | $N_{flat}$ | - | 0…∞ | M 3–1 | YES |
| number of peak tappings per day | $n_{Sp}$ | - | 0…∞ | M 3–1 | YES |
| Heat load | $\Phi_h$ | kW | 0…∞ | M 3–3 | YES |
| Rated output for cooling system | $P_{n,C}$ | kW | 0…∞ | M 4–3 | YES |
| Rated output for ventilation system | $P_{n,V}$ | kW | 0…∞ | M 5–3 | YES |
| Rated output for DHW system | $P_{n,W}$ | kW | 0…∞ | M 8–3 | YES |
| Heat input to the heating distribution system (in the respective time) | $Q_{H,dis;in}$ | kWh | 0…∞ | M 3–6, | Yes |
| Heat input to the cooling distribution system (in the respective time) | $Q_{C,dis;in}$ | kWh | 0…∞ | M 4–6 | YES |
| Heat input to the ventilation distribution system (in the respective time) | $Q_{V,dis;in}$ | kWh | 0…∞ | M 5–6, | YES |
| daily energy need for domestic hot water, | $Q_{W,b,d}$ | kWh | 0…∞ | M 8–6 | YES |
| Heat input to the domestic hot water distribution system (in the respective time) | $Q_{W,dis;in}$ | kWh | 0…∞ | M 8–6 | YES |
| Usage period for heating (in the | $t_{H;use}$ | h or d | 0…8760 | M 3–4, M 8–4 | YES |

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| Description | Symbol | Unit | Validity interval | Destination module | Varying |
|---|---|---|---|---|---|
| calculation interval), | | | | | |
| Usage period for cooling (in the calculation interval) | $t_{C;use}$ | h or d | 0…8760 | M 4–4 | YES |
| Usage period for ventilation (in the calculation interval) | $t_{V;use}$ | h or d | 0…8760 | M 5–4 | YES |
| Usage period for domestic hot water (in the calculation interval) | $t_{W;use}$ | h or d | 0…8760 | M 8–4 | YES |
| Running time for heating (in the calculation interval) | $t_H$ | s/h or h/mth | 0…3600 | M 3–4, M 8–4, EN ISO 13790 | YES |
| running time for cooling system – when connected | $t_C$ | s/h or h/mth | 0…3600 | M 3–4, M 8–4 | YES |
| running time for ventilation system – when connected | $t_V$ | s/h or h/mth | 0…3600 | M 3–4, M 8–4 | YES |
| running time for DHW system – when connected | $t_W$ | s/h or h/mth | 0…3600 | M 3–4, M 8–4 | YES |
| external air temperature | $\vartheta_e$ | °C | −30 . . +30 | see external climate data, M 3–4, M 8–4 | YES |
| daily average design temperature | $\vartheta_{e;min}$ | °C | −30 . . +31 | see external climate data, M 3–4, M 8–5 | YES |
| generator average water temperature (or return temperature to the generator for condensing boilers) as a function of the specific operating conditions | $\vartheta_{Hc;mn}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| average return temperature to the generator for condensing boilers as a function of the specific operating conditions | $\vartheta_{Hc;RT}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| generator average water temperature as a function of the specific operating conditions for cooling systems - when connected | $\vartheta_{Cc;mn}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| generator average water temperature as a function of the specific operating conditions for ventilation systems - when connected | $\vartheta_{Vc;mn}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| generator average water temperature as a function of the specific operating conditions for DHW systems - when connected | $\vartheta_{Wc;mn}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| average return temperature to the generator for condensing boilers as a function of the specific operating conditions for cooling systems - when connected | $\vartheta_{Cc;RT}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| average return temperature to the | $\vartheta_{Vc;RT}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |



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| Description | Symbol | Unit | Validity interval | Destination module | Varying |
|---|---|---|---|---|---|
| generator for condensing boilers as a function of the specific operating conditions for ventilation systems - when connected | | | | | |
| average return temperature to the generator for condensing boilers as a function of the specific operating conditions for DHW systems - when connected | $\vartheta_{Wc;RT}$ | °C | 0 . . 110 | M 3–4, M 8–4 | YES |
| average return temperature to the generator for condensing boilers | $\vartheta$gen;RT | °C | −30 . . +30 | measured | YES |
| ambient temperature | $\vartheta_{brm}$ | °C | −30 . . +31 | M 3–4, M 8–4 | YES |
| cold water temperature | $\vartheta$k | °C | 0 . . 95 | M 3–4 | YES |
| Delivered energy input of the generation sub-system (measured fuel input) (in the calculation interval) | *E*gen;del;in | kg, m³ | 0...∞ | M 3–1 | YES |
| generator output at full load | *P*n | kW | 0...∞ | M 3–2 | YES |
| generator output at intermediate load | *P*int | kW | 0...∞ | M 3–3 | YES |
| temperature difference between boiler return water temperature and flue gas temperature at part load | $\Delta\vartheta$wfg | °C | −30 . . +30 | measured | YES |
| external air temperature | $\vartheta$e | °C | −30 . . +30 | see external climate data, M 3–4, M 8–4 | YES |
| ambient temperature | $\vartheta$brm | °C | −30 . . +31 | see external climate data, M 3–4, M 8–5 | YES |
| out of additional tests | | | | | |
| full load efficiency with mean water temperature ϑgen;test;Pn;add | *ηPn;add* | - | 0 . . 1 | measured | YES |
| mean water temperature at full load | *ϑgen;test;Pn;add* | °C | −30 . . +30 | measured | YES |
| part load efficiency with mean water temperature ϑgen;test;Pint;add | *ηPint;add* | - | 0 . . 1 | measured | YES |
| mean water temperature at part load | *ϑgen;test;Pint;add* | °C | −30 . . +31 | measured | YES |

## 5.4 Boundaries between distribution and generation sub-system

Boundaries between generation sub-system and distribution sub-system should be defined (see description in CEN/TR 15316-6-4).



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## 5.5 Default values

### 5.5.1 Default values for generator efficiency at full load and intermediate load as a function of the generator power output

The generator efficiency at full load as a function of the generator power output is calculated with Formula (1):

$$\eta_{\text{gen;Pn}} = \frac{c_1 + c_2 \cdot \log P_n}{100} \tag{1}$$

For condensing boiler the generator efficiency at full load shall be elaborated between 60 °C and 30 °C return temperature using Formula (2) for 60 °C and Formula (3) for 30 °C:

$$\eta_{\text{gen;Pn;60}} = \frac{c_1 + c_2 \cdot \log P_n}{100} \tag{2}$$

$$\eta_{\text{gen;Pn;30}} = \frac{c_1 + c_2 \cdot \log P_n}{100} \tag{3}$$

The generator efficiency at intermediate load as a function of the generator power output is calculated with Formula (4):

$$\eta_{\text{gen;Pint}} = \frac{c_3 + c_4 \cdot \log P_n}{100} \tag{4}$$

where

| | |
|---|---|
| $P_n$ | is the nominal power output, in kW limited to a maximum value of 400 kW. If the nominal power output of the generator is higher than 400 kW, then the value of 400 kW is to take; |
| $c_1$, $c_2$, $c_3$, $c_4$ | is the coefficients given in Tables A.1/A.2 and Tables B.1/B.2. |

### 5.5.2 Default value for the stand-by heat losses $f_{\text{gen;ls;P0}}$ as a function of the generator power output

$f_{\text{gen;ls;P0}}$ is calculated with Formula (5):

$$f_{\text{gen;ls;P0}} = \frac{c_5 \cdot \left(P_n\right)^{c_6}}{100} \tag{5}$$

where

| | |
|---|---|
| $c_5$, $c_6$ | parameters given in Table A.3 and Table B.3. |

### 5.5.3 Auxiliary energy

Default value for the power consumption of auxiliary equipment is calculated with Formula (6):

$$P_{\text{aux;Px}} = \frac{c_7 + c_8 \cdot \left(P_n\right)^n}{1000} \tag{6}$$

where

| | |
|---|---|
| $c_7$, $c_8$, n | parameters given in Table A.6 and Table B.6. |



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