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Systèmes de chauffage dans les bâtiments - Méthode de calcul des besoins énergétiques et des rendements des systèmes - Partie 1: Généralités

Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 1: General

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Systèmes de chauffage dans les bâtiments - Méthode de calcul des besoins énergétiques et des rendements des systèmes - Partie 1: Généralités

Heizsysteme in Gebäuden - Verfahren zur Berechnung der Energieanforderungen und Wirkungsgrade von Systemen - Teil 1: Allgemeines

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Foreword

This document (EN 15316-1:2007) has been prepared by Technical Committee CEN/TC 228 "Heating systems in buildings", the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2008, and conflicting national standards shall be withdrawn at the latest by January 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/343), and supports essential requirements of EU Directive 2002/91/EC on the energy performance of buildings (EPBD). It forms part of a series of standards aimed at European harmonisation of the methodology for calculation of the energy performance of buildings. An overview of the whole set of standards is given in prCEN/TR 15615.

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

— design of heating systems (water based, electrical etc.);

— installation of heating systems;

— commissioning of heating systems;

— instructions for operation, maintenance and use of heating systems;

— methods for calculation of the design heat loss and heat loads;

— methods for calculation of the energy performance of heating systems.

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

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

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

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

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

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

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

EN 15316 *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies* consists of the following parts:

Part 1: General

Part 2-1: Space heating emission systems

Part 2-3: Space heating distribution systems

Part 3-1: Domestic hot water systems, characterisation of needs (tapping requirements)

Part 3-2: Domestic hot water systems, distribution

Part 3-3: Domestic hot water systems, generation

Part 4-1: Space heating generation systems, combustion systems (boilers)

Part 4-2: Space heating generation systems, heat pump systems

Part 4-3: Heat generation systems, thermal solar systems

Part 4-4: Heat generation systems, building-integrated cogeneration systems

Part 4-5: Space heating generation systems, the performance and quality of district heating and large volume systems

Part 4-6: Heat generation systems, photovoltaic systems

Part 4-7: Space heating generation systems, biomass combustion systems

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard constitutes the general part of a set of standards on calculation method for determining system energy requirements and system efficiencies of space heating systems and domestic hot water systems. Other parts of this set of standards cover specific calculation methods related to the various sub-systems of the heating system.

The calculation method is used for the following applications:

— judging compliance with regulations expressed in terms of energy targets;

— optimisation of the energy performance of a planned building, by applying the method to several possible options;

— displaying a conventional level of energy performance of existing buildings;

— assessing the effect of possible energy conservation measures on an existing building, by calculation of the energy requirements with and without the energy conservation measure implemented;

— predicting future energy resource needs on a national or international scale, by calculation of the energy requirements of several buildings which are representative of the entire building stock.

1 Scope

This European Standard specifies the structure for calculation of energy use for space heating systems and domestic hot water systems in buildings. It standardises the required inputs and outputs for the calculations, in order to achieve a common European calculation method.

The calculation method facilitates the energy analysis of the different sub-systems of the heating system, including control (emission, distribution, storage, generation), through determination of the system energy losses and the system performance factors. This performance analysis permits the comparison between sub-systems and makes it possible to monitor the impact of each sub-system on the energy performance of the building.

Calculations of the system energy losses of each sub-system of the heating system are defined in subsequent standards (prEN 15316, parts 2-x, 3-x and 4-x). The system thermal losses, the recoverable system thermal losses and the auxiliary energy of the sub-systems of the heating system are summed up. The system thermal losses of the heating system contribute to the overall energy use in buildings (prEN 15603).

Ventilation systems are not included in this European Standard (e.g. balanced systems with heat recovery), but if the air is preheated or an air heating system is installed, system energy losses of these systems are covered by this European Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 15316-2-1, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 2-1: Space heating emission systems*

EN 15316-2-3, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 2-3: Space heating distribution systems*

prEN 15316-3-2, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 3-2: Domestic hot water systems, distribution*

prEN 15603[1)], *Energy performance of buildings — Overall energy use and definition of energy ratings*

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

EN ISO 13790, *Thermal performance of buildings — Calculation of building energy use for space heating (ISO 13790:2004)*

3 Terms and definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345:1995 and the following apply.

NOTE This European Standard is the reference for definitions for the whole set of prEN 15316 standards. Therefore not all definitions mentioned hereafter are used in this part.

1) To be published.

3.1.1
auxiliary energy
electrical energy used by technical building systems for heating, cooling, ventilation and/or domestic hot water to support energy transformation to satisfy energy needs

NOTE 1 This includes energy for fans, pumps, electronics etc. Electrical energy input to the ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy use for ventilation.

NOTE 2 In EN ISO 9488, the energy used for pumps and valves is called "parasitic energy".

3.1.2
building
construction as a whole, including its envelope and all technical building systems, for which energy is used to condition the indoor climate, to provide domestic hot water and illumination and other services related to the use of the building

NOTE The term can refer to the building as a whole or to parts thereof that have been designed or altered to be used separately.

3.1.3
new building
for calculated energy rating: building at design stage or under construction
for measured energy rating: building too recently constructed to have reliable records of energy use

3.1.4
existing building
for calculated energy rating: building that is erected
for measured energy rating: building for which actual data necessary to assess the energy use are known or can be measured

3.1.5
building services
services provided by technical building systems and by appliances to provide indoor climate conditions, domestic hot water, illumination levels and other services related to the use of the building

3.1.6
calculated energy rating
energy rating based on calculations of the weighted delivered and exported energy of a building for heating, cooling, ventilation, domestic hot water and lighting

NOTE National bodies decide whether other energy uses resulting from occupants' activities such as cooking, production, laundering etc. are included or not. If included, standard input data need to be provided for the various types of building and uses. Lighting is always included except (by decision of national bodies) for residential buildings.

3.1.7
calculation step
discrete time interval for the calculation of the energy needs and uses for heating, cooling, humidification and dehumidification

NOTE Typical discrete time intervals are one hour, one month or one heating and/or cooling season, operating modes and bins.

3.1.8
calculation period
period of time over which the calculation is performed

NOTE The calculation period can be divided into a number of calculation steps.

3.1.9
conditioned area
floor area of conditioned spaces excluding non-habitable cellars or non-habitable parts of a space, including the floor area on all storeys if more than one

NOTE 1 The precise definition of the conditioned area is given by national authorities.

NOTE 2 Internal, overall internal or external dimensions can be used. This leads to different areas for the same building.

NOTE 3 Some services, such as lighting or ventilation, might be provided to areas not included in this definition (e.g. a car park).

NOTE 4 Conditioned area can be taken as the useful area mentioned in the Articles 5, 6 and 7 of the EPBD[2)] unless it is otherwise defined in national regulations.

3.1.10
conditioned space
heated and/or cooled space

NOTE The heated and/or cooled spaces are used to define the thermal envelope.

3.1.11
conditioned zone
part of a conditioned space with a given set-point temperature or set-point temperatures, throughout which there is the same occupancy pattern and the internal temperature is assumed to have negligible spatial variations, and which is controlled by a single heating system, cooling system and/or ventilation system

3.1.12
CO_2 emission coefficient
quantity of CO_2 emitted to the atmosphere per unit of delivered energy

NOTE The CO_2 emission coefficient can also include the equivalent emissions of other greenhouse gases (e.g. methane).

3.1.13
cogeneration
simultaneous generation in one process of thermal energy and electrical or mechanical energy

NOTE Also known as combined heat and power (CHP).

3.1.14
delivered energy
energy content, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (e.g. heating, cooling, ventilation, domestic hot water, lighting, appliances) or to produce electricity

NOTE 1 For active solar and wind energy systems, the incident solar radiation on solar panels or on solar collectors or the kinetic energy of wind is not part of the energy balance of the building. It is decided on a national level whether or not renewable energy produced on site constitutes part of the delivered energy.

NOTE 2 Delivered energy can be calculated for defined energy uses or it can be measured.

3.1.15
domestic hot water heating
process of heat supply to raise the temperature of the cold water to the intended delivery temperature

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[2)] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings

3.1.16
efficiency, distribution
ratio between the energy output of the distribution sub-system and the energy input of the distribution sub-system, taking into account the sub-system thermal losses and the auxiliary energy

3.1.17
efficiency, emission
ratio between the energy output of the emission sub-system (energy need) and the energy input of the emission sub-system, taking into account the sub-system thermal losses (e.g. non-ideal emission system causing non-uniform temperature distribution and non-ideal room temperature control). The efficiency includes the auxiliary energy

3.1.18
efficiency, generation
ratio between the energy output of the generation sub-system and the energy input of the generation sub-system (energy use), taking into account the sub-system thermal losses. The efficiency includes the auxiliary energy

3.1.19
energy indicator
energy rating divided by the conditioned area

3.1.20
energy conversion factor or energy conversion coefficient
factor or coefficient used to express the energy content in different ways (e.g. primary energy, CO_2 emissions)

NOTE 1 Coefficients have dimensions, factors are dimensionless.

NOTE 2 See also: total primary energy factor, CO_2 emission coefficient.

3.1.21
energy need for heating or cooling
heat to be delivered to or extracted from a conditioned space to maintain the intended temperature during a given period of time, not taking into account the technical building thermal systems

NOTE 1 The energy need is calculated and cannot easily be measured.

NOTE 2 The energy need can include additional heat transfer resulting from non-uniform temperature distribution and non-ideal temperature control, if they are taken into account by increasing (decreasing) the effective temperature for heating (cooling) and not included in the heat transfer due to the heating (cooling) system.

3.1.22
energy need for domestic hot water
heat to be delivered to the needed amount of domestic hot water, to raise its temperature from the cold network temperature to the prefixed delivery temperature at the delivery point, not taking into account the technical building thermal systems

3.1.23
energy use for space heating or cooling or domestic hot water
energy input to the heating, cooling or domestic hot water system to satisfy the energy need for heating, cooling (including dehumidification) or domestic hot water, respectively

NOTE If the technical building system serves several purposes (e.g. heating and domestic hot water) it can be difficult to split the energy use into that used for each purpose. It can be indicated as a combined quantity (e.g. energy need for space heating and domestic hot water).

3.1.24
energy use for ventilation
electrical energy input to the ventilation system for air transport and heat recovery (not including the energy input for preheating the air) and energy input to the humidification systems to satisfy the need for humidification

3.1.25
energy performance of a building
calculated or measured amount of energy delivered and exported actually used or estimated to meet the different needs associated with a standardised use of the building, which may include, inter alia, energy used for heating, cooling, ventilation, domestic hot water and lighting

3.1.26
energy rating
evaluation of the energy performance of a building based on the calculated or measured use of energy carriers

3.1.27
energy source
source from which useful energy can be extracted or recovered either directly or by means of a conversion or transformation process

NOTE Examples include oil or gas fields, coal mines, sun, forests etc.

3.1.28
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat, or to operate chemical or physical processes

[ISO 13600:1997]

NOTE The energy content of fuels is given by their gross calorific value.

3.1.29
exported energy
energy, expressed per energy carrier, delivered by the technical building systems through the system boundary and used outside the system boundary

NOTE 1 Exported energy can be specified by generation types (e.g. CHP, photovoltaic) in order to apply different weighting factors.

NOTE 2 Exported energy can be calculated or it can be measured.

3.1.30
grid electricity
energy delivered to the building from the public electricity network

3.1.31
gross calorific value
quantity of heat released by a unit quantity of fuel, when it is burned completely with oxygen at a constant pressure equal to 101 320 Pa, and when the products of combustion are returned to ambient temperature

NOTE 1 This quantity includes the latent heat of condensation of any water vapour contained in the fuel and of the water vapour formed by the combustion of any hydrogen contained in the fuel.

NOTE 2 According to ISO 13602-2, the gross calorific value is preferred to the net calorific value.

NOTE 3 The net calorific value does not take into account the latent heat of condensation.

3.1.32
heat gains
heat generated within or entering into the conditioned space from heat sources other than technical building thermal systems (e.g. heating, cooling or domestic hot water preparation)

NOTE 1 These include internal heat gains and solar heat gains. Sinks that extract heat from the building, are included as gains with a negative sign. In contrast to heat transfer, for a heat source (or sink) the difference between the temperature of the considered space and the temperature of the source is not the driving force for the heat flow.

NOTE 2 For summer conditions heat gains with a positive sign constitute extra heat load on the space.

3.1.33
heat recovery
heat generated by a technical building system or linked to a building use (e.g. domestic hot water) which is utilised directly in the related system to lower the heat input and which would otherwise be wasted (e.g. preheating of the combustion air by flue gas heat exchanger)

3.1.34
heating or cooling season
period of the year during which a significant amount of energy for heating or cooling is needed

NOTE The season lengths are used to determine the operation period of technical systems.

3.1.35
heated space
room or enclosure which for the purposes of the calculation is assumed to be heated to a given set-point temperature or set-point temperatures

3.1.36
heating system
technical building system, including the space heating system and the domestic hot water system

3.1.37
heating system thermal losses, distribution
heat losses of the heat distribution system, including recoverable heat loss

NOTE See also "system thermal loss" and "recoverable system thermal loss".

3.1.38
heating system thermal losses, emission
heat losses through the building envelope due to non-uniform temperature distribution and control inefficiencies in the heated space

3.1.39
heating system thermal losses, generation
heat generator heat losses occurring both during operation and stand-by, and heat losses due to non-ideal control of the heat generator, including recoverable heat loss

3.1.40
intermittent heating or cooling
heating or cooling pattern where normal heating or cooling periods alternate with periods of reduced or no heating or cooling

3.1.41
non-renewable energy
energy taken from a source which is depleted by extraction (e.g. fossil fuels)

3.1.42
non-renewable primary energy factor
non-renewable primary energy divided by delivered energy, where the non-renewable energy is that required to supply one unit of delivered energy, taking account of the non-renewable energy required for extraction, processing, storage, transport, generation, transformation, transmission, distribution and any other operations necessary for delivery to the building in which the delivered energy will be used

NOTE The non-renewable primary energy factor can be less than unity if renewable energy has been used.

3.1.43
part load operation
operation state of the technical system (e.g. heat pump), where the actual load requirement is below the actual output capacity of the device

3.1.44
primary energy
energy that has not been subjected to any conversion or transformation process

NOTE 1 Primary energy includes non-renewable energy and renewable energy. If both are taken into account, it can be called total primary energy.

NOTE 2 For a building, it is the energy used to produce the energy delivered to the building. It is calculated from the delivered and exported amounts of energy carriers, using conversion factors.

3.1.45
recoverable system thermal loss
part of the system thermal loss which can be recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

3.1.46
recovered system thermal loss
part of the recoverable system thermal loss which has been recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

3.1.47
renewable energy
energy from a source that is not depleted by extraction, such as solar energy (thermal and photovoltaic), wind, water power, renewed biomass

NOTE In ISO 13602-1, renewable resource is defined as "natural resource for which the ratio of the creation of the natural resource to the output of that resource from nature to the technosphere is equal to or greater than one".

3.1.48
renewable energy produced on the building site
energy produced by technical building systems directly connected to the building using renewable energy sources

3.1.49
room conditioning system
system capable of maintaining comfort conditions in a room within a defined range

NOTE Such systems comprise air conditioning and surface based radiative systems.

3.1.50
system thermal loss
thermal loss from a technical building system for heating, cooling, domestic hot water, humidification, dehumidification, ventilation or lighting that does not contribute to the useful output of the system

NOTE Thermal energy recovered directly in the sub-system is not considered as a system thermal loss but as heat recovery and is directly treated in the related system standard.

3.1.51
space heating
process of heat supply for thermal comfort

3.1.52
technical building system
technical equipment for heating, cooling, ventilation, domestic hot water, lighting and electricity production composed by sub-systems

NOTE 1 A technical building system can refer to one or to several building services (e.g. heating system, space heating and domestic hot water system).

NOTE 2 Electricity production can include cogeneration and photovoltaic systems.

3.1.53
technical building sub-system
part of a technical building system that performs a specific function (e.g. heat generation, heat distribution, heat emission)

3.1.54
total primary energy factor
non-renewable and renewable primary energy divided by delivered energy, where the primary energy is that required to supply one unit of delivered energy, taking account of the energy required for extraction, processing, storage, transport, generation, transformation, transmission, distribution and any other operations necessary for delivery to the building in which the delivered energy will be used

NOTE The total primary energy factor always exceeds unity.

3.1.55
occupied zone
part of a conditioned zone in which persons normally reside and where requirements as to the internal environment are to be satisfied

NOTE The definition of the occupied zone depends on the geometry and the use of the room and is specified case by case. Usually the term “occupied zone” is used only for areas designed for human occupancy and is defined as a volume of air that is confined by specified horizontal and vertical planes. The vertical planes are usually parallel with the walls of the room. Usually there is also a limit placed on the height of the occupied zone.

3.1.56
unconditioned space
room or enclosure which is not part of a conditioned space

3.1.57
ventilation
process of supplying or removing air by natural or mechanical means to or from any space

NOTE Such air is not required to have been conditioned.

3.2 Symbols and units

For the purposes of this document, the following symbols and units (Table 1) and indices (Table 2) apply.

Table 1 — Symbols and units

Symbol	Quantity	Unit
E	energy in general, including primary energy, energy carriers (except quantity of heat, mechanical work and auxiliary (electrical) energy)	J [a b]
e	expenditure factor	-
f	factor [c]	-
Q	quantity of heat	J [a]
W	auxiliary (electrical) energy, mechanical work	J [a]
η	efficiency factor	-

[a] Hours (h) may be used as the unit for time instead of seconds for all quantities involving time (i.e. for time periods as well as for air change rates), but in that case the unit for energy is Wh instead of J

[b] The unit depends on the type of energy carrier and the way its amount is expressed.

[c] Coefficients have dimensions; factors are dimensionless

Table 2 — Indices

aux	auxiliary	H	heating	st	storage
chp	combined heat and power	in	input to system	th	thermal
dis	distribution	ls	loss	out	output from system
el	electrical	nrbl	non-recoverable	W	domestic hot water
em	emission	ngen	without building generation device	i,j,y,z	indices
gen	generation	rvd	recovered		

4 Principle of the method

4.1 System thermal losses of a technical building system for space heating and domestic hot water

The calculation method for determining the system thermal losses of a technical building system is based on an analysis of the following sub-systems of the space heating and domestic hot water system:

— energy performance of the emission sub-system, including control;

— energy performance of the distribution sub-system, including control;

— energy performance of the storage sub-system, including control;

— energy performance of the generation sub-system, including control
(e.g. boilers, solar collectors, heat pumps, cogeneration units).

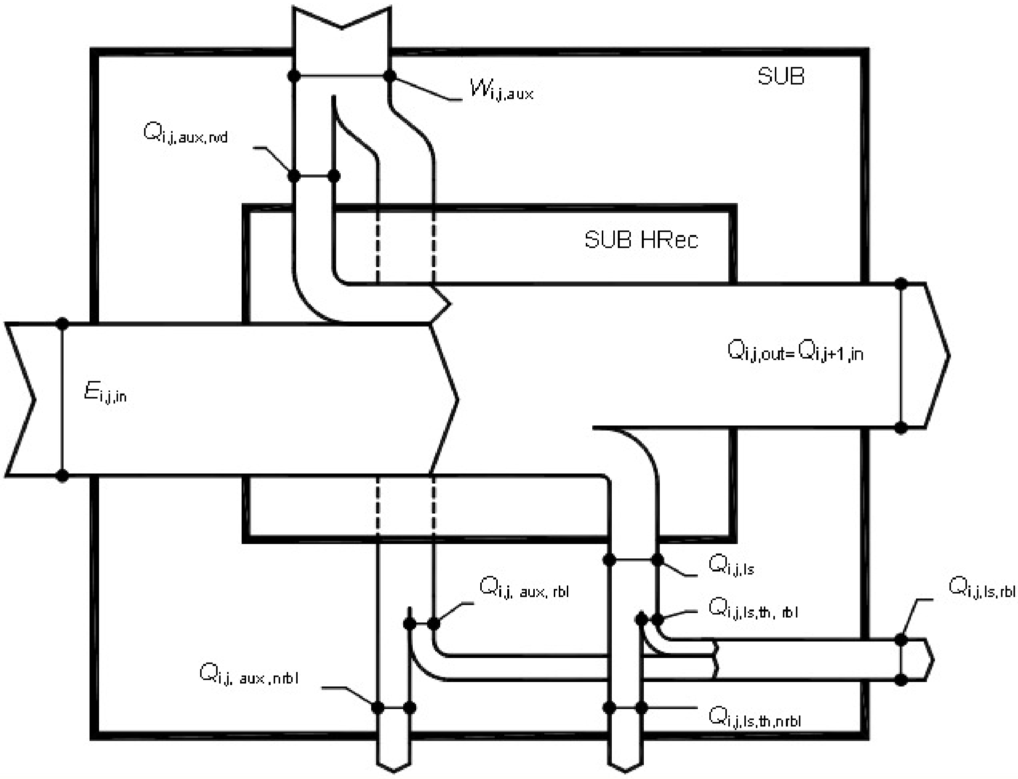
NOTE This structure is similar to the physical structure of heating systems.

The energy used by the heating system is calculated separately for thermal energy and auxiliary energy.

The energy performance of the generation sub-system is not detailed in this European Standard, as it is directly taken into account in prEN 15603.

The storage sub-system can be included in the generation sub-system or detailed as the storage sub-system. In the prEN 15316-4-x standards, the storage sub-system and buffer tanks are taken into account in the generation sub-system.

Figure 1 illustrates the calculation of input data and output data for a given sub-system, i.e. sub-system “j” of technical building system i.



Key

SUB	sub-system j balance boundary
SUB HRec	sub-system j heat recovery boundary
$Q_{i,j,out}$	sub-system j heat output (= $Q_{i,j+1,in}$ heat input of the next sub-system(s))
$E_{i,j,in}$	sub-system j energy carrier input
$W_{i,j,aux}$	sub-system j auxiliary energy
$Q_{i,j,aux,rvd}$	sub-system j auxiliary energy heat recovery in the sub-system
$Q_{i,j,ls}$	sub-system j thermal loss
$Q_{i,j,ls,rbl}$	sub-system j thermal loss recoverable for space heating (not in the sub-system)
$Q_{i,j,ls,th,rbl}$	sub-system j thermal loss (thermal part) recoverable for space heating
$Q_{i,j,aux,rbl}$	sub-system j auxiliary energy recoverable
$Q_{i,j,ls,th,nrbl}$	sub-system j thermal loss (thermal part) non recoverable
$Q_{i,j,aux,nrbl}$	sub-system j auxiliary energy non recoverable

Figure 1 — Input and output data for technical building system i, sub-system j

The index j should be replaced by the relevant sub-system index (e.g. em for emission, dis for distribution).

Based on these data, the output data from calculation of the sub-system shall comprise:

— energy inputs: energy carrier $E_{system,sub-system,in}$, thermal $Q_{system,sub-system,in}$ and electrical $E_{el,sub-system,in}$ (e.g. $E_{HW,gen,in}$, $Q_{H,em,in}$, $E_{el,gen,in}$);

— energy outputs: thermal $Q_{system,sub-system, out}$ and electrical (if relevant) $E_{el,sub-system,out}$ (e.g. $Q_{H,gen,out}$, $E_{el,chp,out}$);

— system thermal loss $Q_{system,sub-system,ls}$ (e.g. $Q_{HW,gen,ls}$);

— auxiliary energy $W_{system,sub-system,aux}$ (e.g. $W_{W,gen,aux}$);

— recoverable system thermal loss $Q_{system,sub-system,ls,rbl}$ (e.g. $Q_{H,gen,ls,rbl}$).

The calculations may be based on tabulated values or more detailed methods.

4.2 Calculation period

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.

System thermal losses should be calculated separately for each calculation period. The average values shall be consistent with the selected time intervals. This may be done in one of the following two different ways:

— by using annual data for the system operation period and performing the calculations using annual average values;

— by dividing the year into a number of calculation periods (e.g. months, weeks), performing the calculations for each period using period-dependent values and sum up the results for all the periods over the year.

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

4.3 Operating conditions

The calculation methods in the set of prEN 15316 standards basically concern the determination of:

— operating conditions (e.g. heat demand, water temperatures, generator room temperatures);

— energy performance (e.g. system thermal losses, recoverable losses) for given operating conditions.

The complexity of the actual application has to be taken into account by the system designer, through selection and adaptation of calculation methods. Some indications are given in informative Annex C.

The different parts of prEN 15316 contain different methods or indications for determination of the operating conditions. It is allowed, e.g. for achieving uniformity of calculations, to select one or more methods to determine the operating conditions. This approach may also be applied to obtain data on the heat contribution of different heat generators in multi-generator installations.

The selected method(s), the relevant input parameters and how to link these methods to determination of the energy performance, have to be described in a national annex.

4.4 Energy performance indicators of space heating and domestic hot water systems or sub-systems

The energy efficiency η of a sub-system i is defined as:

$$\eta_{\mathrm{i}} = \frac{Q_{\mathrm{i,out}} + f_{\mathrm{j}} \cdot E_{\mathrm{el,i,out}}}{f_{\mathrm{y}} \cdot Q_{\mathrm{i,in}} + f_{\mathrm{z}} \cdot W_{\mathrm{i,aux}}} \tag{1}$$

where

$f_{\mathrm{j,y,z}}$ is the energy conversion factor (or coefficient) j, y, z.
This factor shall be given at a national basis. Information is given in prEN 15603;

$E_{\mathrm{el,i,out}}$ electricity output of sub-system i ;

$Q_{\mathrm{i,out}}$ heat output of sub-system i ;

$Q_{i,in}$ heat input of sub-system i ;

NOTE 1 Q is replaced by E if the input is not heat (e.g. generator input).

$W_{i,aux}$ auxiliary energy of sub-system i.

NOTE 2 Efficiency is the most dimensionless term used to indicate effectiveness of a technical building system. Efficiencies serve a practical and straightforward comparison of effectiveness of systems or sub-systems of different types and/or different sizes.

Equation 1 is a very general equation. Not all parameters apply for every type of sub-system. The energy conversion factors can be the same in the numerator and enumerator.

The efficiencies can be calculated per sub-system (e.g. distribution efficiency, emission efficiency, generation efficiency). The global efficiency of the entire system should be calculated after summing up the system thermal losses and the energy supplies for all relevant sub-systems.

Another way of expressing the energy performance of a system or sub-system is the expenditure factor, *e*. This expression is the reciprocal value of the efficiency.

5 Energy calculation for a space heating and domestic hot water system

5.1 General

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. The calculation is structured according to the components of the heating system (emission, distribution, storage, generation).

For each sub-system i, its system thermal loss, $Q_{H,i,ls}$, is calculated and added to its heat output, to determine its required heat input.

The auxiliary energy $W_{H,i,aux}$ is calculated separately (if there is one) and contributes to the energy losses of the sub-system.

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 system thermal losses of the sub-system.

The recoverable system thermal losses for space heating are input values for EN ISO 13790 and prEN 15603, in which the recovered system thermal loss for space heating shall be calculated. The recovered system thermal loss is subtracted either from the energy needs (holistic approach) or from the energy use (simplified approach).

The system thermal losses recovered 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.

NOTE 1 Annex A provides an example for the heat emission sub-system for space heating.

NOTE 2 The calculation sheet in Annex B provides an example for a space heating system with an electrical domestic hot water system. This sheet combines the results of the calculation for each sub-system, regardless of the calculation method used (e.g. detailed, simplified), to determine the system thermal losses of each sub-system.

5.2 Energy losses from the space heating system

The system thermal losses of the space heating system without building generation devices, $Q_{H,ngen,ls}$, shall be calculated as follows:

$$Q_{H,ngen,ls} = Q_{H,em,ls} + Q_{H,dis,ls} \quad (2)$$

where

$Q_{H,em,ls}$ are the system thermal losses of the heat emission sub-system, according to EN 15316-2-1;

$Q_{H,dis,ls}$ are the system thermal losses of the heat distribution sub-system, according to EN 15316-2-3.

The recoverable system thermal losses of the space heating system without building generation devices, $Q_{H,ngen,ls,rbl}$, shall be calculated as follows:

$$Q_{H,ngen,ls,rbl} = Q_{H,em,ls,rbl} + Q_{H,dis,ls,rbl} \quad (3)$$

where

$Q_{H,em,ls,rbl}$ are the recoverable system thermal losses of the heat emission sub-system, according to EN 15316-2-1;

$Q_{H,dis,ls,rbl}$ are the recoverable system thermal losses of the heat distribution sub-system, according to EN 15316-2-3.

The auxiliary energy of the space heating system without building generation devices, $W_{H,ngen,aux}$, shall be calculated as follows:

$$W_{H,ngen,aux} = W_{H,em,aux} + W_{H,dis,aux} \quad (4)$$

where

$W_{H,em,aux}$ is the auxiliary energy of the heat emission sub-system, according to EN 15316-2-1;

$W_{H,dis,aux}$ is the auxiliary energy of the heat distribution sub-system, according to EN 15316-2-3.

5.3 Energy losses from the domestic hot water system

The system thermal losses of the domestic hot water system without building generation devices, $Q_{W,ngen,ls}$, shall be calculated as follows:

$$Q_{W,ngen,ls} = Q_{W,em,ls} + Q_{W,dis,ls} \quad (5)$$

where

$Q_{W,em,ls}$ are the system thermal losses due to a non-ideal emission system (i.e. tap), e.g. delay before the outlet temperature reaches the desired temperature;

$Q_{W,dis,ls}$ are the system thermal losses of the domestic hot water distribution sub-system, according to prEN 15316-3-2.

NOTE The storage sub-system can be included in the generation sub-system or detailed as the storage sub-system. In the prEN 15316-4-x standards, the storage sub-system and buffer tanks are taken into account in the generation sub-system.

The recoverable system thermal losses of the domestic hot water system without building generation devices, $Q_{W,ngen,ls,rbl}$, shall be calculated as follows:

$$Q_{W,ngen,ls,rbl} = Q_{W,em,ls,rbl} + Q_{W,dis,ls,rbl} \quad (6)$$

where

$Q_{W,em,ls,rbl}$ are the recoverable system thermal losses of the domestic hot water emission sub-system;

$Q_{W,dis,ls,rbl}$ are the recoverable system thermal losses of the domestic hot water distribution sub-system, according to prEN 15316-3-2.

The auxiliary energy of the domestic hot water system without building generation devices, $W_{W,ngen,aux}$, shall be calculated as follows:

$$W_{W,ngen,aux} = W_{W,em,aux} + W_{W,dis,aux} \quad (7)$$

where

$W_{W,em,aux}$ is the auxiliary energy of the domestic hot water emission sub-system;

$W_{W,dis,aux}$ is the auxiliary energy of the domestic hot water distribution sub-system, according to prEN 15316-3-2.

5.4 Simplified and detailed methods for calculation of the system energy losses

For each sub-system, simplified and/or detailed calculation methods for determination of system energy losses may be available (according to the current technical knowledge and standards available) and may be applied according to the accuracy required.

The level of details can be classified according to the following:

Level A Losses or efficiencies are given in a table for the entire space heating and/or domestic hot water system. Selection of the appropriate value is made according to the typology (description) of the entire system.

Level B For each sub-system, losses, auxiliary energy or efficiencies are given as tabulated values. Selection of the appropriate value is made according to the typology (description) of the sub-system.

Level C For each sub-system, losses, auxiliary energy or efficiencies are calculated. Calculation is done on the basis of dimensions of the system, duties, loads and any other data, which are assumed constant (or averaged) throughout the calculation period. The calculation method may be based on physics (detailed or simplified) or correlation methods.

Level D Losses or efficiencies are calculated through dynamic simulations, taking into account the time history of variable values (e.g. external temperature, distribution water temperature, generator load).

Different levels of details may be used, as available, for the different sub-systems of the heating system.

Unless otherwise required, detailed calculation methods in accordance with level C or level D are applicable for new buildings with already designed space heating and domestic hot water systems, as well as for new domestic hot water systems installed in existing buildings.

Any parameter may be used for the calculations.

However, it is essential that the results correspond to the defined output values of the sub-system:

- energy input,
- energy output,
- system thermal losses,
- recoverable system thermal losses,
- auxiliary energy

and that the performance indicators follow the structure described in this European Standard, in order to ensure proper links to calculations for the following sub-systems and development of a common structure.

Annex A
(informative)

Sample of a heat emission sub-system for space heating

The heat input of the heat emission sub-system takes into account the extra losses through the building envelope due to the following factors:

— non-uniform internal temperature distribution in each thermal zone (e.g. stratification, heat emitters along outside wall/window);

— heat emitters embedded in the building structure towards the outside;

— control strategy (e.g. local, central, setback).

The influence of these effects on the energy use depends on:

— type of heat emitters (e.g. radiator, convector, floor/wall/ceiling systems);

— type of room/zone thermal control strategy and equipment (e.g. thermostatic valve, P, PI, PID control) and their capability to reduce the temperature variations and drift;

— emplacement of embedded heat emitters in the outside walls.

In accordance with the general structure of calculation of system energy losses, the performance of the heat emission sub-system should be given by:

— type of heat emission system;

— type of control system (including optimiser);

— characteristics of embedded heat emitters.

Based on these input data, the output data from calculation of the heat emission sub-system should comprise:

— system thermal loss of the heat emission sub-system $Q_{H,em,ls}$;

— auxiliary energy consumption of the heat emission sub-system $W_{H,em,aux}$;

— recoverable system thermal losses of the heat emission sub-system $Q_{H,em,ls,rbl}$.

The calculations may be based on tabulated values or more detailed methods, but no other input data should be required.

Annex B
(informative)

Sample calculation of a space heating system with electrical domestic hot water system

Table B.1

			SPACE HEATING			DOMESTIC HOT WATER		
			A	B	C	D	E	F
	NEEDS		Energy need for space heating Q_H			Energy need for domestic hot water Q_W		
L1		kWh/period	100			20		

	System losses		system thermal loss $Q_{H,i,ls}$	auxiliary energy $W_{H,i,aux}$	recoverable system thermal loss $Q_{H,i,ls,rbl}$	system thermal loss $Q_{w,i,ls}$	auxiliary energy $W_{W,i,aux}$	recoverable system thermal loss $Q_{W,i,ls,rbl}$
L2	Emission sub-system (i=em)	kWh/period	10	2	2	0	0	0
L3	Input emission (L1+L2)	kWh/period	110	2	2	20	0	0
L4	Distribution sub-system (i=dis)	kWh/period	15	4	10	10	2	5
L5	Input distribution (L3+L4)	kWh/period	125	6	12	30	2	5
L6	Storage sub-system (i=st)	kWh/period	-	0	0	10	1	6
L7	Input storage (L5+L6)	kWh/period	125	6	12	40	3	11
L8	Generation sub-system (i=gen)	kWh/period	25	1	16	0	0	0
L9	Input generation (L7+L8)	kWh/period	150	7	28	40	3	11

Annex C
(informative)

Splitting and/or branching of the heating system

The heating system structure may be complex, e.g. including:

— more than one type of heat emitter, serving multiple zones;

— more than one "load" connected to the same generation sub-system (typically space heating and domestic hot water production may be served by the same generation sub-system);

— more than one generation sub-system;

— more than one storage sub-system;

— different types of energy used in the building.

Use of overall average values may not be practical (as this requires proper weighting), may not be available or may lead to significant errors.

In general, these cases may be solved by following the physical structure of the heating system.

EXAMPLE 1 A common distribution sub-system serving more than one emission sub-system. Energy needs and system thermal losses may be calculated separately for each of the emission sub-systems, and may subsequently be added up to provide the heat output of the common distribution sub-system.

EXAMPLE 2 A common generation sub-system serving both a space heating distribution sub-system and a domestic hot water distribution sub-system. Energy input may be calculated separately for the space heating distribution sub-system and the domestic hot water distribution sub-system (and/or storage sub-systems), and may subsequently be added up to provide the heat output of the common generation sub-system.

EXAMPLE 3 A common distribution sub-system served by more than one generation sub-system. Energy input for the distribution sub-system may be calculated and split between the generation sub-systems (the splitting may change over time).

This kind of "modularity" is always possible as long as the principle of addition of losses is respected.

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